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Antoinette M. Davis

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Antoinette M. Davis, Student

Dr. Xin Ma, Major Professor

Dr. Mary Shake, Director of Graduate Studies

MEASURING STUDENT SATISFACTION IN ONLINE MATH COURSES

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DISSERTATION

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A dissertation submitted in partial fulfillment of the  
requirements for the degree of Doctor of Education in the  
College of Education  
at the University of Kentucky

By  
Antoinette M. Davis

Lexington, Kentucky

Director: Dr. Xin Ma, Professor of Education

Lexington, Kentucky

2014

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## Abstract of Dissertation

### MEASURING STUDENT SATISFACTION IN ONLINE MATH COURSES

Colleges and universities worldwide have struggled to find a way to measure student satisfaction in online courses. This study examined the growth of math courses that are delivered in the online format. This study aims to address many gaps in the research literature concerning distance education using technology. In particular, it is the intention of this study to investigate satisfaction and performance of students as a result of taking online courses.

There has been an expanding concern over whether students are satisfied and can perform well in courses taken in an online environment. Satisfaction and performance in distance education have always been examined in comparison with traditional education that implements instruction through face-to-face interactions. A careful examination of the research literature also indicates that researchers apply vastly different ways to measure satisfaction and performance. This situation may well be responsible for the inconsistencies among empirical studies in the research literature.

The first purpose was to develop and validate an instrument that measures satisfaction regarding taking online courses. The second purpose was to predict student satisfaction (measured through the developed instrument) from the learning characteristics of an online environment. The third purpose was to predict student performance from student satisfaction (measured through the developed instrument) in an online environment. A deductive approach was adopted for this research project and utilized a quantitative research design including surveys. Survey data was collected from adult students who were students in the online College Algebra course at a certain Community & Technical College.

The instrument was developed and found to be reliable through confirmatory factor analysis. Using multiple regression for the second question, it was found that age (of students) demonstrated statistically significant absolute and relative effects on satisfaction with online mathematics courses. In other words, satisfaction with online mathematics courses depended on age both individually and collectively. Lastly, using multiple regression and ANCOVA to answer question three, it was found that gains from pretest to posttest did not depend on individual characteristics, learning preferences, and online (learning) environment. Meanwhile, gains from pretest to posttest did not depend on satisfaction with online mathematics courses.

Key Words: Satisfaction, asynchronous, synchronous, hybrid, online education

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MEASURING STUDENT SATISFACTION IN ONLINE MATH COURSES

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## Chapter One: Statement of the Problem

With more than four and a half million students already taking courses online in the fall of 2008, recent statistics indicate that one out of every four higher education students take at least one online course (Allen & Seaman, 2010). Before the current online format, distance education existed in many forms that included courses taught through mail, by video tape, or via telephone hookups or satellite TV (Ko & Rosen, 2008). The growing presence of distance learning has changed the landscape of formal education (Larreamendy-Joerns & Leinhardt, 2006). Some signs of this change include that the United States Senate considered easing the requirement for a college to enroll no more than 50% of its students through distance programs if the students are to be eligible for federal aid (Carnevale, 2003a; Mayadas, 2001); that some universities, in their pursuit to educate “global scholars”, now require students to enroll in at least some online distance courses (Carr, 2000); and that a faculty commission at Harvard University has considered reducing the time of residence required for students to earn a degree due to online options (Young, 2002).

Sher (2009) found that the explosion of an adult student population, family and work responsibilities, travel costs, and transportation problems have resulted in demands for flexible and convenient learning opportunities. In recent years, distance learning has become a ubiquitous practice as a result of the spread of the Internet (Larreamendy-Joerns & Leinhardt, 2006). Students now learn informally as they navigate through virtual museums (Corredor, 2006; Crowley, Leinhardt, & Chang, 2001), seek advice from tutors who may be a few feet or a thousand miles away (Light, Colbourn, & Light, 1997; Lovett, 2001; Lovett & Greenhouse, 2000), experiment in virtual labs (Carnevale, 2003b; Cartwright & Valentine, 2002; Davies, 2002; Hmelo & Day, 1999; Larreamendy-Joerns, Leinhardt, & Corredor, 2005; Yaron et al., 2001; Yaron, Freeland, Lange, & Milton, 2000), participate in asynchronous discussions

(Vrasidas & Stock-McIssac, 1999), and enroll in online courses as regular resident students (Larreamendy-Joerns, Leinhardt, & Corredor, 2005; Malloy, 2001; Scheines, Leinhardt, Smith, & Cho, 2003; Scheines & Sieg, 1994).

Indeed, McBrien, Jones, and Cheng (2009) found that rapidly developing technology has facilitated distance education in all disciplines, and it has proven to be popular among students for various reasons, such as convenience and equal opportunity. This form of education has given students more flexibility when taking college courses. As a result, many universities and colleges in the United States and around the world offer online degree programs and courses, which give students the opportunity to access higher education without leaving their homes (Butner, Murray, & Smith, 1999). For some students, distance education allows them a chance to pursue their education without having to find childcare, eliminates the need to drive to the campus, and allows them to adequately interact with their instructors through electronic communication.

### **Definitions of Terms**

This study aims to address many gaps in the research literature concerning distance education using technology. In particular, it is the intention of this study to investigate satisfaction and performance of students as a result of taking online courses. The key concepts or terms involved in this study are defined as follows:

*Student satisfaction* is defined as “a student’s subjective evaluation of the various outcomes and experiences with education and campus life” (Elliott & Shin, 2002, p. 198).

*Student performance* is cognitively defined in terms of the class grade that a student gets when completing an online course in mathematics (i.e., it is course performance). *Online environment* is defined as “knowledge management that supports the creation, archiving, and sharing of

valued information, expertise, and insight within and across communities of people and organizations with similar interests and needs.” (Rosenberg, 2001, p. 66).

Specifically, a *synchronous learning environment* is defined as a place, in real time, where those involved in the communication process are present at the same time but not necessarily in the same place, whereas an *asynchronous learning environment* is defined as learning through communication between learners and the facilitator that is done via a computer forum of some description at different times (Joliffe, Ritter, & Stevens, 2001). A *hybrid learning environment* is defined as learning that combines both online and face-to-face components (Ko & Rosen, 2008).

*Personalized feedback* is defined as a broad range of responses by teaching staff to the work of their students (Kane & Williams, 2009). *Perception of learning* is defined as the process of determining the meaning of what is sensed (Woolfolk, 1998), occurring in educational settings when teachers interpret a given meaning to stimuli in their classroom environment or in their students’ classroom behaviors (Ahmad & Aziz, 2009). Furthermore, *student-student interaction* is defined as the exchange of information and ideas that occurs among students about the course in the presence or absence of the instructor, whereas *student-instructor interaction* is defined as the interaction between the learner and the instructor (Sher, 2009). Finally, *social presence* is defined as “a measure of the feeling of community that a learner experiences in an online environment” (Tu and McIssac, 2002, p. 131).

### **Satisfaction and Performance in Distance Education**

There has been an expanding concern over whether students are satisfied and can perform well in courses taken in an online environment. Satisfaction and performance in distance education have always been examined in comparison with traditional education that implements

instruction through face-to-face interactions. Traditional education has the advantage of immediacy behaviors (e.g., feedback, communication) that reduce social distance and alleviate information overload (Hughes, Ryan-Jones, Smith, & Wickersham, 2002). The current research literature is mixed regarding satisfaction and performance in distance education compared with traditional education. Lim, Kim, Chen, and Ryder (2008) found that a majority of published studies show no difference in student satisfaction and performance regardless of whether a course is taken traditionally or online, whereas others show an advantage for either online instruction or traditional instruction.

In terms of satisfaction, Klesius, Homan, and Thompson (1997) found that learner satisfaction with distance education is no different from learner satisfaction with traditional instruction. Similar findings support the argument that distance education does not diminish the level of student satisfaction when compared to traditional face-to-face methods of instruction (Allen, Bourhis, Burrell, & Mabry, 2002). In terms of performance, Hiltz, Coppola, Rotter, Turoff, and Benbunan (2000) suggested that students in an online class learn as much as they do in a traditional class if students are actively involved in the class material (see also Anstine & Skidmore, 2005). Brown and Kulikowich (2004) compared online and standard lecture course outcomes of graduate-level statistics students, indicating no significant membership differences in posttests after control for pretests.

On the other hand, in terms of satisfaction, Ponzurick, France, and Logar (2000) reported lower overall satisfaction with the distance education format and found that the traditional face-to-face instruction format is the preferred method of delivery. Fortune, Shiflett, and Sibley (2006) indicated that technological characteristics deliver minimal satisfaction whereas pedagogical characteristics (e.g., face-to-face instruction in the traditional classroom) are more

noteworthy indicators of course satisfaction over time. In terms of performance, traditional students perform better than online students because of the availability of better resource planning and implementation for traditional courses (Ury, McDonald, McDonald, & Dorn, 2005). Brown and Liedholm (2002), in a comparative study with 710 students, noted the performance differences in favor of traditional instruction and attributed the differences to student effort.

Meanwhile, in terms of satisfaction, “e-leaners” (i.e., online students) are high above the average level of satisfaction in their overall learning experience (Giannousi, Vernadakis, Derri, Michalopoulos, & Kioumourtzoglou, 2009). A comparison of course evaluations for three different academic programs shows that adult students are more satisfied with online courses that systematically implement simple and straight-forward principles for adult learning (Artz, 2006). In terms of performance, online students perform consistently better than both full-time and part-time face-to-face students (Stansfield, McLellan, & Connolly, 2004). Maki, Maki, Patterson, and Whittaker (2000), in a two-year quasi-experimental study of undergraduate students, found more learning as measured by questions on content and performance on examinations among students in the online sections of an introductory psychology course.

### **Need for this Study**

This study responds to the many gaps and inconsistencies in the research literature concerning satisfaction and performance of students as a result of taking online instruction using technology. Settle and Settle (2005) measured student satisfaction through student evaluations of the course and the instructor of the course. Their evaluation asked questions like “Was this course well organized?” and “Do you feel the course objectives were accomplished?” (p. 83). Although these questions are relevant, they are too primitive and simple to reflect the deeper

psychological attributes of satisfaction as an emotional construct, particularly under online conditions. Valid and reliable instruments represent a great potential solution to gaps like this in the research literature.

A careful examination of the research literature also indicates that researchers apply vastly different ways to measure satisfaction and performance. This situation may well be responsible for the inconsistencies among empirical studies in the research literature. For example, So and Brush (2008) and Summers, Waigandt, and Whittaker (2005) employed two satisfaction measures so far apart in terms of conceptual framework or structure that the results on satisfaction from these two studies (one for online learning and one against online learning) cannot be compared directly.

In addition, the relationship among online characteristics, satisfaction, and performance is not thoroughly addressed. For example, a team of researchers from multiple institutions presented an instrument developed for measuring student satisfaction and concluded that online learning is valid and reliable as far as satisfaction is concerned (Arbaugh et al., 2008). Unfortunately, they failed to pursue the relationship of student satisfaction with student performance and online characteristics. Zhu (2012) measured both performance and satisfaction of online students and studied the relationship between the two. Nevertheless, the potential impact of characteristics of online environment on the relationship was ignored.

Even when the relationship among online characteristics, satisfaction, and performance is examined, it is again often based on primitive measurement approaches. Examples of instrument statements include: “I am happy that I can work together with others on the assignments,” “Working online with group work (such as wiki) is new and exciting for me,” and “I am satisfied that each member of my group equally contributes his/her part in the group assignments” (Zhu,

2012, p. 130). Again, these instrument statements are relevant but not so theoretically insightful as to reflect satisfaction with learning and understanding in an online environment.

### **Purpose of this Study**

The purpose of this study is threefold. The first purpose is to develop and validate an instrument that measures satisfaction regarding taking online courses. This responds to the lack of instrumentation in the research literature on this issue. The second purpose is to predict student satisfaction (measured through the developed instrument) from the learning characteristics of an online environment. Although there are a few studies that examined this relationship, this study aims to apply a psychometrically validated instrument (rather than a survey) to measure satisfaction. This will likely provide critical feedback to the existing studies on the same issue. The third purpose is to predict student performance from student satisfaction (measured through the developed instrument) in an online environment. In other words, this study aims to find out if satisfaction is an indicator of performance in an online environment. Many studies have used surveys to measure student satisfaction in the online classroom. They seldom measure performance in the classroom and study the relationship between the two.

This study situates these research purposes in the context of mathematics education. The corresponding research questions are:

1. Is it possible to develop a valid and reliable instrument that measures the extent to which students are satisfied with learning mathematics in an online environment?
2. Is there a relationship between student satisfaction and the characteristics of an online environment of learning mathematics?
3. Is there a relationship between performance and satisfaction of students in an online environment of learning mathematics?

## **Theoretical Framework**

The first step to develop and validate an instrument is to establish a sound theoretical framework that outlines key conceptual components (factors) of the construct to be measured. An extensive review of the research literature leads to a framework that contains various components of student satisfaction. Some components are not unique to the online environment but shared with the traditional environment. Personalized feedback and perceptions of learning are components that are shared in both learning environments. Some components are common between the online and traditional environment but different in certain technical details. Student-student interaction and student-instructor interaction are shared in both environments but the method of communication is different. In the online environment, communication takes place at a distance, whereas communication in a traditional environment takes place in a face-to-face format. Finally, some components are unique to the online environment. Social presence is a component that is unique to the online environment because having a teacher at a distance requires a different social interaction than having a teacher in front of students. The theoretical framework that guided the development of the instrument will be discussed in further detail in the next chapter.

## **Organization of this Study**

In Chapter 2, there is a review of the literature on student satisfaction and performance in an online environment, on the theoretical framework of satisfaction with online learning (personalized feedback, the student-student/student-instructor interaction, and social presence), and on the relationship among online characteristics, satisfaction, and performance. In Chapter 3, the methodology of the research is explained in detail, including research design, data collection, instrument validation, and data analysis. In Chapter 4, the results of the research are reported

with various charts used to answer the research questions. Lastly, in Chapter 5, discussions are provided on significant results of the research study, exchanges with the current research literature, implications for educational policy and practice, limitations of the research study, and recommendations for future research.

## Chapter Two: A Review of Literature

This chapter reviews the research literature on student satisfaction, the key focus of the present research, how to form a framework of personalized feedback, student-student interaction, student-instructor interaction, and social presence as main components of student satisfaction in the online environment. The literature review compares and contrasts findings from previous studies to expose the gaps concerning empirical research on student satisfaction in the online environment. This helps determine whether student satisfaction can be measured adequately in order to relate to other factors critical in the online environment (e.g., student performance).

### **Sources of Materials for Review of Literature**

All of the sources used in this literature review were collected from credible and reliable academic journal and abstract databases including Research Navigator, Academic Search Premier, EBSCOhost, Education Full Text, ERIC, and Web of Science. Key terms used in the search for relevant publications include: *motivation, distance education, student satisfaction, online courses, feedback, perceptions, performance, student-student interaction, student-instructor interaction, social presence, student engagement, and higher education*. This literature review pays particular attention to the research and findings of top researchers in the areas of student satisfaction and online education.

### **Advantages and Disadvantages of Distance Education**

Current distance education is often referred to as web-based education that uses the Internet and communication technologies (Tallent-Runnels et al., 2006). In web-based education, the Internet is used to supplement instruction and communicate information to students in the same way that a traditional instructor would provide a lecture to students who are in a face-to-face class (Tallent-Runnels et al., 2006). Today, most distance courses use digitized lectures,

audio supplementation, discussion boards, and interactive software to incorporate the active use of writing, problem analysis, and collaborative learning (Navarro & Shoemaker, 1999). Jung (2001) contends that web-based learning is a practical and viable solution to meet the learners' educational needs. Pucel and Stertz (2005) found that "web-based delivery permits educational processes to be implemented at times and places that fit around a working student's job and family responsibilities" (p. 8).

Proponents of distance learning stress that properly designed online courses can better accommodate different learning styles and provide more individualized instruction to each student than can the traditional classroom (Navarro & Shoemaker, 1999; Sosin, 1997). Harrison and Stephen (1996) argued that online education shares some fundamental characteristics with the face-to-face educational environment such as interactive group communication (as students can interact with one another in such formats as dyads), seminars, group projects, role plays, take part in online lectures, or contact the instructor, tutors, and subject experts online. Offenholley (2006) found that online mathematics courses built a sense of community, encouraged higher-order thinking, and provided opportunities for peer collaboration. Hostetter and Busch (2006) found that instructor immediacy behaviors and social presence among students can be enhanced in an online course, thus creating a learning community that facilitates educational excellence. In comparison with traditional face-to-face classroom learning that centers on instructors who have control over class content and the learning process, online learning offers a learner-centered, self-paced learning environment (Hiltz & Turoff, 2002; Morales, Cory, & Bozell, 2001; Piccoli, Ahmad, & Ives, 2001). Swan (2002) reported that students perceived online discussions as more equitable and more democratic than traditional classroom discussions.

English (2007) believes that discussions offer a forum for quiet students to develop and verbalize ideas, promote in-depth response and reflection, encourage peer affirmation, and provide opportunities for more student-instructor and student-student interaction. The online threaded discussion group is a valuable way for instructors to give all students an opportunity to find their voices comfortably, whether writing in response to literature or someone else's writing (English, 2007; Offenholley, 2006). Because students in a traditional classroom lecture can simultaneously observe a teaching process, listen to an instructor, and watch slides or transparencies (Zhang, Zhao, Zhou, & Nunamaker, 2004), they often feel a high level of connection with the instructor and that they truly are a part of the group (Hannay & Newvine, 2006). An online classroom can have a similar level of synchronization of mediums used to deliver course content (Latchman, Salzman, Gillet, & Bouzekri, 1999).

While online systems may be useful platforms with which instructors and students can exchange ideas and hold discussions, they are often insufficient for mathematical sciences courses to provide distance students the same learning possibilities as those traditional face-to-face students are benefiting from (Fedele & Li, 2008). The need to provide real time access for distance students to ongoing class discussions and lectures (Li, Uvah, Amin, & Hemasinha, 2009) has promoted both synchronous and asynchronous conferencing modes (see more discussion on these modes of learning later) that actually generate more frank discussion among students than traditional classroom instruction (Sproull & Keisler, 1993). A mixed-mode university course combining online learning and face-to-face meetings can encourage students to formulate and express their own ideas more than would be the case in traditional classrooms (Breton et al., 2005). What is best about the face-to-face and online formats can be combined to create a hybrid RST (reduced seat time) course, a fast-growing format for university courses, in

which the students meet face-to-face with the instructor and students for classes during the week and operate online at other times (Dolan, 2008).

The major factor that negatively affects distance students is the need to feel they belong to the class and that they are not “distant” (Amin & Li, 2010). It is a fact that limiting the exchange of feedback to online learning postings and discussion forums may not provide distance students with the interactive learning experience and feeling of belonging to a class they usually would get in a traditional face-to-face setting (Amin & Li, 2010). Distance students may feel less connected to the class as compared to face-to-face students (Li et al., 2009). One possible approach in helping distance students to stay enrolled is involving them in group work in the class (Amin & Li, 2010). Bielman, Putney, and Strudler (2000) noticed that simple emoticons, such as smiley faces, in online communications with one another can often compensate for the missing visual and nonverbal communication cues.

Gunawardena (1995) asserts that “the development of social presence and a sense of online community becomes key to promoting collaborative learning and knowledge building” (p. 164). According to Rovai (2002), it is the method of teaching, not the environment for delivering the course, that influences feelings of community. Wegerif (1998) found that students’ sense of community affected their success in the course. Hostetter and Busch (2006) found that students who felt more like insiders in the learning community were more likely to achieve success. In a computer-mediated environment, feelings of community and social presence may be considered to be strongly connected to each other and to online interaction (Tu & McIssac, 2002). Wegerif (1998) contends that it is essential for students to feel that they are members of a community in order to collaborate and learn, and that computer-mediated communication can provide support for the development of feelings of community.

Online learning does put new cognitive demands on distance education students and instructors. Howland and Moore (2002) found that self-management, self-monitoring, and motivation are more essential for success in an online course than in the face-to-face classroom. In another study, students with higher reported levels of learning and satisfaction in online courses were also those who indicated higher levels of activity (Swan, 2001). Harrington (1999) found that when students with a high GPA were enrolled in a distance-education statistics course, they did as well as those in a traditional class. However, when students with a lower GPA were enrolled in the online class, they did not do as well as their counterparts in the traditional statistics class.

Bee and Usip (1998) presented supplementary materials, tutorials, and general course information online and found that students who used these materials achieved improved course performance and improved knowledge of cyberspace to a greater extent than those who did not use the materials (see also Tallent-Runnels et al., 2006). Cooper (1999) provided online resources and course materials in folders for each week of the course and found that online students particularly valued timely course announcements, lecture notes, and chapter questions and answers. For distance learning to be successful, Moore (1993) suggests that instructors need to pay attention to all three elements of transactional distance theory (dialogue, structure, and learner autonomy) in order to reduce the “distance” experienced by the student. Rovai (2002) demonstrated that it is possible for students in online classes to have significantly stronger feelings of community in the virtual classroom.

Chao and Davis (2001) found that there are many facets to the online success of mathematics courses such as: paying attention to the design and utilization of effective online pedagogy, maintaining active communication between students and the instructor, encouraging

interaction between students in the classroom, and using computer programs like Excel as a way to illustrate statistical concepts in the classroom. Overall, research-based suggestions on online instruction emphasize establishing study groups early, modeling and reinforcing effective communication, identifying potential problems, and designing a plan for dealing with these potential problems (Tallent-Runnels et al., 2006).

### **Forms of Distance Education**

Learning can take different forms. Apart from the traditional face-to-face instruction in the classroom, conventional universities utilize face-to-face tutorials, summer schools, laboratory sessions, independent study, guided learning by tutors, and a variety of media (Guri-Rosenblit, 2005). The advent of new interactive communication technologies enables synchronous communication between students and instructors and among students from a distance (Guri-Rosenblit, 2005). There are many variations of distance education.

*Synchronous learning* takes place in real time with all participants present at the same time for the communications process, but not necessarily present in the same place (Joliffe, Ritter, & Stevens, 2001). In the case of the text-based, real-time synchronous channel, spontaneous interaction among participants is nearly analogous to that of spoken language (Edmondson, 1981). Rapid feedback is possible, and online group participants develop rapport by signaling their understanding or misunderstanding through back channel mechanisms that include linguistic and paralinguistic elements (Park, 2007). Synchronous dialogue not only allows continuous, structural modifications of course content, pace, and activities to accommodate students' individual needs, but also allows students' concerns to be addressed instantaneously, which can be an important factor in the reduction of transactional distance (Murphy & Collins, 1997). Such rapid feedback enhances social presence among group

participants and impels the building of social cohesion (Park, 2007). “The synchronous environment demonstrates the amazing power of a synchronous online system that empowers students in conversation and expression” (McBrien et al., 2009, p. 13).

*Asynchronous learning* occurs when communication between learners and the instructor is done via a computer forum of some description at a different time (Joliffe et al., 2001).

Various studies have been done to address the importance of asynchronous education. Students seem to prefer asynchronous because they have enough time to reflect and draft careful responses to others’ postings (Poole, 2000; Zafeiriou, Nunes, & Ford, 2001). The asynchronous environment is a place where students can learn on their own time because there are no regular class meetings. Sher (2009) found that “not only does the asynchronous nature of a Web-based course eliminate the constraints of time and location, but it also incorporates interactive communication that is unique to face-to-face classroom-based instruction” (p. 102). Courses that are largely or totally asynchronous do not require offices that are fixed in time or space (Edge & Loegering, 2000). Office hours for these courses can be anytime and anywhere that one has access to the Internet or e-mail as long as communication occurs regularly (e.g., once a day) (Edge & Loegering, 2000).

Shulte (2004) found that one benefit (of asynchronous learning) is the accessibility to students who may not be able to attend classes on college campuses on a regular basis, such as commuter students and students with physical disabilities. Another benefit is that computer-mediated interaction requires individuals to present themselves in a text-based environment, thereby providing regular opportunities to improve their writing skills (Shulte, 2004). Sher (2009) found that not only does the asynchronous nature of a web-based course eliminate the

constraints of time and location, but it also incorporates interactive communication that is unique to face-to-face classroom-based instruction.

Davidson-Shivers, Tanner, and Muilenburg (2000) compared the substantive quality of synchronous and asynchronous discourse to determine whether one discussion environment produced more content-related participation than the others. They found that chats provided a direct, immediate environment for responses, whereas listserv responses were delayed but more focused and purposeful. Sproull and Kiesler (1993) found that both synchronous and asynchronous conferencing modes promote more frank discussion and equality among students than traditional classroom interaction.

*Hybrid learning* is a concept that combines traditional education with some assignments that can be submitted online (Ko & Rosen, 2008). Hybrid courses attempt to integrate the advantages of face-to-face teaching with some of the rewards of web-based, computer-mediated learning, resulting in more online learning and less seat time (when students are seated in a classroom) than a traditional course (Garnham & Kaleta, 2002). This type of learning allows students to be flexible with their schedule since some classes will be in person while other classes will take place online. For some, blended learning means mixing modes of web-based technology, while for others it refers to integrating various pedagogical approaches (Bruner, 2006).

### **Student Satisfaction in Traditional and Online Environments**

Irons, Keel, and Bielema (2002) found that providing students with a choice of communication tools greatly increases student satisfaction (see also Lin & Overbaugh, 2007). When students have alternatives, student characteristics such as learning styles and life characteristics tend to influence the decision as to whether and how to use computer technology

to assist in the learning process (Wilson & Weiser, 2001). Kendall (2001) converted courses taught through traditional means into units using WebCT software as the primary means of delivery and, by reporting overall satisfaction of online students with the WebCT software and the organization and content of the units, argued that it is possible for online courses to achieve the same learning goals and course satisfaction. Clayton, Blumberg, and Auld (2010) conducted a study on the influences of hybrid, online, and traditional education as it relates to student satisfaction. They found that students who preferred traditional environments showed a mastery of goal orientation and a greater willingness to apply effort while learning; students who preferred less traditional environments presented themselves as more confident because they could manage a non-traditional class. Students tend to be more satisfied in the traditional environment because it gives them a chance to interact in a face-to-face classroom with their instructor and other students (Clayton et al., 2010).

Comparing web-based and traditional courses in terms of student satisfaction, Pucel and Stertz (2005) stated that “no statistically significant differences were found between the two versions of each of the courses on the student satisfaction measures” (p. 20). Settle and Settle (2005) aimed to determine graduate student satisfaction with an online discrete mathematics course and indicated that students’ distance-learning satisfaction with the online course did not differ in a statistically significant way from the satisfaction of the regular section students.

In contrast, Pollock and Wilson (2002) report on a comparison between traditional face-to-face courses and a reduced-seat time (RST) section in which the course met both face-to-face and online. Results showed that students in the RST section had higher levels of satisfaction with the course and scored better on a political knowledge index than students in the face-to-face course. Lim, Kim, Chen, and Ryder (2008) compared three different learning environments

(online, traditional, and hybrid) to find out how well students are satisfied with learning in these environments. Their results showed that

Students in the online and hybrid learning group had statistically significant higher levels of achievement than students in the traditional learning group. Students in the hybrid learning group had greater satisfaction levels with their overall learning experience than students in the traditional learning group. However, no significant differences were found between the online learning and traditional learning groups. (p. 1)

Although students in the web based course consistently scored an average of five percentage points higher on the final exam than did those in the lecture course, they consistently reported less satisfaction than those in the lecture course (Rivera & Rice, 2002). Although neither group ranked their experience as satisfactory, the average level of satisfaction for the online course is somewhat deficient compared with that of the traditional course (Herbert, 2006). Carr (2000) surmised that one of the reasons for less satisfaction could be that there is more time required to complete online assignments. Vamosi, Pierce, and Slotkin (2004) found that student satisfaction in an accounting course was significantly lower than expected primarily because of their lower satisfaction with the distance learning delivery mode.

### **Student Performance in Traditional and Online Environments**

According to a 2009 study conducted by the U.S. Department of Education, which reviewed more than 1,000 studies conducted on online learning between 1996 and 2008, students on average performed better in an online education situation than in face-to-face situations (Feintuch, 2010). Many research studies have shown that cognitive factors such as learning, performance, and achievement in distance education classes are comparable to those observed in traditional classes (Carr, 2000; Russell, 1999; Schoech, 2000; Sonner, 1999; Spooner, Jordan, Algozzine, & Spooner, 1999). For example, Cooper (2001) echoed the compilation of current literature comparing traditional classes to online classes: There is no large difference between the

two approaches to learning. Friday-Stroud, Green and Hill (2006) found no statistically significant difference in student performance between online and traditional management classes after examining eight semesters of data. Royse (1999) found no significant difference in students' course grades among students enrolled in web-based classes on social work research methods and those enrolled in the traditional class. Using final exam scores, Borthick and Jones (2000) also found no significant difference between the traditional class taught the semester before and the online class. Similarly, comparing students' grades on pretest, midterm, and final exams, Gagne and Shepherd (2001) as well as Piccoli et al. (2001) supported prior research, finding no significant difference in student performance between online and regular on-campus classes.

After compiling dozens of studies on distance education, Russell (1999) indicated no difference in student learning between traditional and online environments, conditional on the requirement that online students have to be actively engaged in the work. If students are just responding to posted material, doing assignments, e-mailing them, and having them graded, or otherwise following correspondence-type classwork, they do not learn effectively (Anstine & Skidmore, 2005). According to Harrington (1999), students taking a traditional statistics course did well overall regardless of GPA, students in the online course who had high GPAs also did well, and online students with previously low GPAs did not fare as well as either of the other groups (Harrington, 1999).

A few studies suggest that learning outcomes in the online environment are inferior or similar to those in the traditional environment (Anstine & Skidmore, 2005). After comparing two courses, one online and one traditional, Harris and Parrish (2006) reported that the in-class students received significantly higher grades and had a lower dropout rate than the online

students. Faux and Black-Hughes (2000) compared traditional, online, and hybrid sections of an undergraduate course in social work to determine the effectiveness of online learning. Their results showed the most improvement (from pretest to posttest) for students in the traditional, face-to-face setting. Pucel and Stertz (2005) compared web-based and traditional courses by looking at the effectiveness of learning in these courses, indicating that “although there were some differences in student performance between web-based instruction and traditional versions of the courses, students were able to learn effectively within both versions of the courses” (p. 20). Some major reasons for the lower performance of online students could be that online learning requires greater autonomy and self-direction and that students must be able to perform more independently (Artino, 2008).

### **Theoretical Framework of Student Satisfaction in Online Environments**

The review of studies on student satisfaction shows that student satisfaction is an important issue in online learning and develops a theoretical framework for measuring and explaining student satisfaction with their learning in the online environment. Some factors have been shown to be highly related to satisfaction of students taking online courses including presence (social, cognitive, and teaching) (Pelz, 2004), community (Sahin, 2007), and frequent feedback and assessment (Swan, 2003). The research literature indicates what can be considered as components or indicators of student satisfaction in the online environment. These components include: personalized feedback, student-student/student-instructor interaction, social presence, and the perceptions of learning.

Assessment feedback can have a great impact on a student because self-efficacy and motivation can be increased by providing personalized assessment feedback rather than generic comments (Allen, Montgomery, Tubman, Frazier, & Escovar, 2003). Feedback is a crucial

component to the satisfaction of students taking online courses. Campton and Young (2005) found that students ask for personalized feedback on their learning and it is a critical component of student satisfaction in the online environment.

Thurmond, Wambach, Connors, and Frey (2002) concluded that student satisfaction was influenced by instructional decisions and actions in the online environment rather than by student characteristics. Student satisfaction with distance learning is impacted by interaction with the instructor and the structure of the course (Settle & Settle, 2005). There is a positive relationship between levels of interaction among students and student satisfaction (Swan, 2002). Overall, interaction is an essential element to student learning and to the overall success and effectiveness of distance education (Bruning, 2005; Burnett, Bonnici, Miksa, & Kim, 2007; Fresen, 2007; Kim, Liu, & Bonk, 2005; Northrup, 2001; Sutton, 2001; Thorpe & Godwin, 2006, Yildiz & Chang, 2003).

Overall, students' perceptions of social presence significantly predict their perception of learning (Richardson & Swan, 2003). Research has demonstrated that social presence not only affects learning outcomes but also student (and possibly instructor) satisfaction with a course (Moore, Masterson, Christophel, & Shea, 1996). These researchers found that students with high perceptions of social presence also scored high in terms of perceived learning and perceived satisfaction with the instructor (Richardson & Swan, 2003). Originally construed as an inherent feature of differing media, social presence may be explored through a variety of issues that contribute to the social climate of the classroom (Gunawardena, 1995). Consequently, it has been argued that social presence is a factor embedded in both the medium and the communicators' perceptions of the presence of a sequence of interactions (Gunawardena & Zittle, 1997). The construct of social presence appears to have negated the negative effects of a lack of direct

instruction interaction by taking into consideration the fact that some media (e.g., computers, interactive video, and audiotape) alter learning environments (Richardson & Swan, 2003).

Researchers in the area of social presence and computer-mediated conferencing such as Gunawardena and Zittle (1997) have argued that “in reviewing social presence research, it is important to examine whether the actual characteristics of the media are the causal determinants of communication differences or whether users’ perceptions of media alter their behavior” (p. 150).

In general, research on asynchronous web-based learning reports high levels of association between students’ perceptions of learning and their satisfaction with the courses in which they enroll (Collins, 2000; Fredericksen, Pickett, Pelz, Shea, & Swan, 2000; Jiang & Ting, 1998; Motiwalla & Tello, 2010; Oliver & Omari, 2001; Swan, Shea, Fredericksen, Pickett, Pelz, & Maher, 2001). Drennan, Kennedy, and Pisarski (2006) found that student satisfaction is influenced by positive perceptions towards technology and by an autonomous learning mode.

Among the most important factors that influence the motivation of students are students’ interest in the content and students’ perception of the relevance of the course— i.e. do students have an interest in the content and do they believe it applies to them or their future jobs? (Adler, Milne, & Stablein, 2001; Benbunan-Fich & Starr, 2003; Brass, 2002; Burke & Moore, 2003; Geiger & Cooper, 1996). These results are consistent with research that shows that students exhibit greater motivation when course content interests them and when they perceive some personal relevance in the content. This may account for why students in the elective course were more positive in their attitudes than those enrolled in required courses (Adler et al., 2001; Benbunan-Fich & Starr, 2003; Brass, 2002; Burke & Moore, 2003; Geiger & Cooper, 1996).

Of course, these components of student satisfaction play a role in both online and traditional learning. To better understand each component in the online environment, it is helpful to classify these components according to how uniquely each component corresponds to online learning.

### **Shared Components of Student Satisfaction Between Traditional and Online Environments**

*Personalized feedback*, as used in this study, covers a broad range of responses by instructors to the work of their students (Kane & Williams, 2009). Students need feedback on their progress and performance to assist them in engaging with a subject (Higgins, Hartley, & Skelton, 2002; Soon, Sook, Jung, & Im, 2000; Thurmond et al., 2002). Feedback should be given with some level of immediacy and constructiveness to increase motivation (Ozden, Ertuck, & Sanli, 2004; Blayney & Freeman, 2004). Two major issues of concern to students with regard to assessment and feedback are the “lack of fairness in grading and too little feedback from their instructors” (Holmes & Smith, 2003, p. 318). The issue of consistency in assessment feedback can be assisted by the use of rubrics that incorporate clearly defined criteria (Moskal, Leydens, & Pavelich, 2002). Campton and Young (2005) found that students require personalized feedback on their learning, and it is a critical component of a successful online environment. In sum, personalized feedback is said to be an important factor in the learning process (Hisham, 2004; Soon et al., 2000; Thurmond et al., 2002).

Campton and Young (2005) found that there is no statistical difference in the level of satisfaction between feedback that embeds comments in the student’s work and one that automatically generates comments and outputs them into a personalized webpage for quantitative type assessments. Markers are able to override the suggested comments and create personalized comments (Hisham, 2004). The increase in efficiency in marking is translated into faster

feedback to students (Blayney & Freeman, 2004). Institutional student satisfaction surveys are a valuable source of data on the student experience of assessment and feedback but little used outside their immediate management improvement purposes (Kane, Williams, & Cappuccini, 2008). The students' comments suggest that feedback is valued by them, particularly as an indication of progress, but also with a very practical concern that it helps them to improve before the next assignment (Kane & Williams, 2009). Gibbs and Simpson (2004) found that feedback to the students on their assignments is the single most powerful influence on student achievement. The result of using student data, based on tailored inquiries, to inform improvements appears to have a direct impact on student satisfaction and reflects the research available that suggests that students respond well as a result of effective, transparent action that has been taken on the basis of their feedback (Powney & Hall, 1998).

*Student perception of learning* is typically measured through questionnaires in which the quality of learning is indirectly communicated to the students (Jackson & Helms, 2008). Lim et al. (2008) believe that gaining knowledge of student perceptions of online learning and its effectiveness is essential in order to improve online teaching and student learning. Research tends to support the view that students appear to be unable to separate their perception of the instructor's effectiveness from their perception of the technology and method of delivery (Anderson & Kent, 2002). Jackson and Helms (2008) found that meeting or exceeding the expectation of students in the use and application of technology affects their perception of the quality of education. Students reporting positive attitudes about their online course experience exhibited attributes of constructivist learners, recognizing the need to be more proactive and independent in learning (Howland & Moore, 2002). Students usually have positive perceptions regarding access to the instructor or teaching assistant when questions can be addressed in

multiple ways, such as via toll-free phone numbers, e-mail, class listserv, or local facilitators (Edge, Loegering, & Diebel, 1998). Students with negative attitudes seemed less able to understand the course content and to trust self-assessment of their learning, and reported the need for more guidance (Howland & Moore, 2002). Student perceptions and attitudes regarding college courses are important (Anderson & Kent, 2002). Students tend to return to programs where they perceive instruction as effective, and tend not to return to or remain in those they perceive as ineffective (Johnson, 1998).

Heiman (2008) conducted a study (through email questionnaires) on females with learning disabilities and their enrollment in online courses (including their perceptions of the learning environment). The participants included 73 females with learning disabilities and 50 females without learning disabilities at the Open University of Israel. Heiman found that females with learning disabilities perceived the learning environment as less supportive and less satisfactory than females without learning disabilities; they felt that the academic services were not sufficiently considerate of their special needs. However, “women with learning disabilities reported using more task-oriented and avoidance-oriented coping strategies and perceived their overall well-being as less satisfactory than female students without learning disabilities” (p. 4). Regardless of how accessible a university is for students with disabilities, these students may face major challenges in getting to class each day (Edge & Loegering, 2000). Having a course available in-home represents a significant opportunity for some physically disabled students (Edge & Loegering, 2000). Courses developed for distance delivery may already meet the needs of students with learning disabilities or are easily modified to do so (Powers, 1998).

Some researchers have found that learner-centered activities are central to student satisfaction in online courses (Ellis & Cohen, 2005). Cuthrell and Lyon’s (2007) investigation

discovered that students preferred a mix of instructional strategies that incorporated active and passive modes of instruction. The use of discussion boards and the completion of unit assignments are examples of active and passive instruction. Dennen (2008) found that half of the students felt that they learned through online discussions (both posting and reading messages), with students who reported that they participated in discussions only to meet course requirements and with those who focused more on posting rather than reading messages showing less positive impressions of the (discussion) impact on their learning.

*Student perception of the purpose of course evaluations* is a relevant issue in this study because student satisfaction with a course by nature is a form of student perception of the course. There are extremely few studies relating to student perceptions of the process, although there are studies on the purpose (Costin, Greenough, & Menges, 1971; Marsh, 1984). According to Marlin (1987), if students have no faith in the system and put little thought and effort into their evaluations, the results are useless regardless of the sophistication of the techniques used to test the validity of evaluation results. On the other hand, if students take the evaluation seriously and view it as a responsibility rather than a chore, evaluation results can become more meaningful. These arguments support the validity of student evaluation of teaching in that they infer that ratings of overall effectiveness are predictable from specific classroom behaviors of the instructor (Renaud & Murray, 2005).

Also, according to Marlin (1987), even though students apparently pay little attention to the evaluations, they still believe themselves to be conscientious in filling them out. Students also believe that existing procedures are adequate to evaluate the teacher, that there is no reason to falsify a rating in order to appease an instructor and that they are fair and accurate in their rating of faculty. Cadwell and Jenkins (1985) found that if students feel good about their

instructor, they might rate the instructor as accessible outside of class, even if they never attempted to contact the instructor outside of the classroom, or they might respond on the rating form that the instructor provided different points of view without any attempt to recall specific instances of this type of behavior.

Heine and Maddox (2009) found that female students believe that the evaluation process was more important than males. Male students, indicating some cynicism about the class evaluation process, are significantly different in a negative way from female students in terms of their perception that the higher the projected grade, the higher their evaluation of a professor, and their belief that professors adjusted their in-class behavior at the end of the semester to achieve higher evaluations (Heine & Maddox, 2009). Students believe that even though the machinery exists and is used to inform the faculty and administrators of student opinion, nobody pays much attention nor does much as a result of the outcome of the evaluation process (Marlin, 1987).

Few studies have inquired into students' general attitudes towards course evaluations, such as how conscientiously they respond, how seriously they take the process, and what purposes they think they are being used for (Spencer & Schmelkin, 2002). Students are skeptical about the use of their ratings because they are unsure of whether their opinions matter or for what purpose the ratings are put to use, even though they are not reluctant to evaluate and have no fear of bias (Spencer & Schmelkin, 2002). Although there have been cautions regarding bias (Marsh, 1984), the intent was to focus on potential difference that affects how students perceive evaluations, and reflects how the length of time students have partaken in the educational process influences their views (Spencer & Schmelkin, 2002).

Overall, there appear to be drawbacks of using student evaluation on the quality of a course to reflect student satisfaction with the course. For exactly the same reason, some measures

of student satisfaction based on course evaluation are considered primitive in the previous chapter. The goal of this study is to develop a psychometrically sound instrument to use as the tool to investigate student satisfaction in relation to student performance and learning characteristics in the online environment.

*Student perception of basic college mathematics courses* becomes an important issue when many students in college need to take mathematics courses because they previously did not perform well in other mathematics courses (Howard, 2008). In Mau's (1993) study, many of the students believed that simply memorizing formulas and algorithms was the best way to master course content. In brief, students held invalid beliefs about what they should do to master mathematical concepts, and those beliefs appeared to be a major reason for difficulty with the course (Mau, 1993).

Ashcraft (2002) found that highly mathematics-anxious people also espouse negative attitudes toward mathematics and hold negative self-perceptions about their abilities to do math. These individuals took their required mathematics courses apprehensively, almost expecting an unsuccessful experience (Howard, 2008). Students who are, therefore, either ill-prepared or too far removed from the discipline develop anxiety toward mathematics (Ferren & McCafferty, 1992). When students were unsuccessful, they unanimously chose an avoidance strategy to cope with their failures, which research indicates is a typical tactic (Middleton & Spanias, 1999; Turner, Thorpe, & Meyer, 1998). "Individuals who perceive mathematics as difficult and their ability to do mathematics as poor generally avoid mathematics, if possible" (Middleton & Spanias, 1999, p. 77). Students were found to feel frustrated that the mathematics courses were designed to filter students out of the (college) program rather than to encourage students to persist (Hake, Crow, & Dick, 2003).

Based on conversations and observations of the students, it was apparent that students' previous experiences and perceptions affected their ability to learn mathematics (Howard, 2008). It appears that a majority of students prefer taking no mathematics, or the easiest required mathematics course, instead of strengthening their quantitative skills (Ferren & McCafferty, 1992). Mau (1993) found that students believed they were working quite hard and that course expectations were unreasonable. One individual even called the remedial mathematics class the "course from hell" because of the pace at which she was expected to master new material (Mau, 1993, p. 1). Perception of one's ability in mathematics, which is a belief about one's self as a learner of mathematics, was a significant predictor of the value of mathematics and a strong predictor of the expectation of success (Eccles et al., 1985).

Pajares and Miller (1995) found that students' reported confidence to answer mathematics problems was a greater predictor of performance than their mathematics-related tasks or mathematics-related courses' self-efficacy. A number of students commented on a pre-assessment form that one reason they did not enjoy mathematics was because they did not feel confident doing mathematics (Hake et al., 2003).

*Student performance in basic college mathematics courses* is another relevant issue in this study because student satisfaction is examined in the context of college mathematics courses. Boli, Allen, and Payne (1985) found that, among highly capable students, women did as well as men in introductory college mathematics and chemistry courses when initial differences, such as mathematics background, were controlled. In fact, according to these researchers, having confidence in women's general mathematical ability (i.e., feeling that women are not inferior to men in mathematics) improves the performance of women in basic college mathematics and science courses. Ashcraft (2002) found that highly mathematics-anxious individuals perform

poorly on a test due to low competence and achievement rather than heightened mathematics anxiety.

Courses intended to prepare students with weak mathematics backgrounds for more advanced mathematics courses are common on university campuses (Stage & Kloosterman, 1995). Unfortunately, fewer than half the students who take these courses are successful on their first attempt (Hackett, 1985). Pugh and Lowther (2004) raised concern over the failure rate in mathematics core courses and low mathematics placement test scores when examining core course performance at a major research university. In a study of 85,894 students enrolled in remedial mathematics in 107 California community colleges, seventy five percent of these students did not pass or complete that required course (Bahr, 2008).

According to Siadat, Musial, and Sagher (2008), students enter into a continuous dialogue with the instructor through a specific medium—the mathematics tests—where the instructor conveys his or her expectations and policies, and students respond through their performance. Student performance, on the other hand, provides vital feedback to the instructor to adjust the pace and content of instruction. But when students are unprepared for the course, they tend to either get discouraged and drop out altogether or get weeded out at each articulation point, failing to pass from one course to the next (Bailey, 2009).

*Student perception of instructors' qualifications* is an issue related to student satisfaction. Spencer and Schmelkin (2002) found that sophomores, juniors, and seniors attending a private university perceived effective teaching as characterized by college instructors' personal characteristics: demonstrating concern for students, respect for student opinions, clarity in communication, and openness toward varied opinions. Greimel-Fuhrmann and Geyer's (2003) evaluation of interview data indicated that undergraduate students' perceptions of their

instructors and the overall instructional quality of the courses were influenced positively by instructors who provided clear explanations of subject content, who were responsive to students' questions and viewpoints, and who used a creative approach toward instruction beyond the scope of the course textbook. This could characterize a student-oriented with the instructor being defined as student friendly, patient, and fair (Onwuegbuzie et al., 2007).

Okpala and Ellis (2005) examined data obtained from 218 college students regarding their perceptions of instructor quality components. The following five qualities emerged as key components: caring for students and their learning (89.6%), teaching skills (83.2%), content knowledge (76.8%), dedication to teaching (75.3%), and verbal skills (73.9%). College students, overall, identified the interpersonal context as the most important indicator of effective instruction (Onwuegbuzie et al., 2007). This was also the case for pre-service instructors (Minor, Onwuegbuzie, Witcher, & James, 2002). Witcher, Onwuegbuzie, and Minor (2001) identified the following six characteristics of effective teaching perceived by pre-service instructors: student centeredness, enthusiasm about teaching, ethicalness, classroom and behavior management, teaching methodology, and knowledge of subject. These factors may explain why the role of connector, which includes accessibility, was deemed a characteristic of effective instructors by nearly one in four students (Onwuegbuzie et al., 2007).

Bennett (1982) found that female instructors were rated higher in terms of gender appropriate characteristics such as warmth and personal charisma and were negatively evaluated when they failed to meet these expectations. There is other evidence to indicate that women receive higher ratings by students of both sexes on items related to interpersonal aspects of instruction (Winocur, Schoen, & Sirowatka, 1989), although Ferber and Huber (1975) reported some bias of students in favor of their own sex.

Affiliative lecturers were seen as more effective lecturers as well as more confident, professional, and approachable ones; students also indicated that they would be more likely to approach lecturers who presented affiliatively to discuss content issues (Winocur et al., 1989). In fact, lecturers who presented material in an affiliative style were rated higher on both traditionally feminine and masculine characteristics, suggesting a more positive personality profile overall (Winocur et al., 1989). These findings are consistent with those of Bennett (1982) who found that women who are not perceived to have gender appropriate attributes, such as charisma, experience, and professionalism in instructional style, are unlikely to be accepted as offering authoritatively balanced instruction (Winocur et al., 1989).

### **Shared but Different Components of Student Satisfaction Between Traditional and Online Environments**

The most critical factors in distance learning are structure and interaction, instead of learner characteristics (e.g., their technical expertise) and course delivery format (Stein, Wanstreet, Calvin, Overtoom, & Wheaton, 2005). Structure refers to elements of the course's design, such as learning objectives, activities, assignments, and evaluation. Interaction is the key in order to maintain the communication between the instructor and learners, and among students (Moore & Kearsley, 2005). A few researchers also explore student-content interaction that refers to students interacting with the subject matter under study to construct meaning. This includes reading informational texts, using study guides, watching videos, interacting with computer-based multimedia, and completing assignments and projects (Lou, Bernard, & Abrami, 2006).

*Student-instructor interaction* can take place between the learner and the instructor in seminars, email messages, correspondence through feedback on assignments, and during online office hours (e.g., through an Instant Messenger) (Sher, 2009). Student-instructor interaction

facilitates student learning by providing not only cognitive guidance and feedback, but also motivational and emotional support (Anderson, 2003; Holmberg, 1989, 2003; Lou, Bernard, & Abrami, 2006; Moore, 1989; Moore & Kearsley, 1996, 2005). Greene and Land (2000) found that guidance oriented interaction (professor-developed, procedural scaffolding) helped students to focus and develop their projects. Students needed real-time, back-and-forth discussion with their instructors that helped them to better understand their course projects and begin thoughtful consideration earlier (Tallent-Runnels et al., 2006).

Sher (2009) found that “student-instructor interaction is one of the most critical factors in enhancing student satisfaction in an online course” (p. 116). Because instructors and students can be separated in time and space, as in the case of a video course distributed throughout the country for asynchronous delivery (i.e. courses delivered on a student-specific schedule) (Edge & Loegering, 2000), interaction with the instructor becomes important to learners in distance learning contexts (Fredricksen et al., 2000). According to Swan (2001), students in distance learning have significantly less interaction with the instructor, making student-instructor interaction a real issue that has a demonstrable influence on student satisfaction. Student-instructor interaction is often minimal, even with synchronous satellite or microwave systems that have two-way audio or video between instructors and learners (Diebel, McInnis, & Edge, 1998). Wagner (2001) argued that web-based learning presents a more customized format in which instructors can interact with each student. Many studies on interaction in web-based learning persist on positive pedagogical effects of interaction and present various interaction strategies for better learning (Beuchot & Bullen, 2005; Dennen, Durabi, & Smith, 2007; Garrison & Cleveland-Innes, 2005; Kehrwald, 2008; Russo & Campbell, 2004; Tu & McIsaac, 2002; Weaver, 2008). For example, regularly calling on distance learners by name during real-time

satellite- or microwave-delivered courses can encourage participation (Edge & Loegering, 2000). An online course with a few highly consistent modules resulted in both a perception of more interaction with the instructor and of better outcomes on the part of students (Swan, 2001). Sher (2009) stated that “the use of communication tools incorporated in a distance learning environment bridge[s] both physical and time dimensions to bring the faculty and students together as a virtual community” (p. 114).

*Student-student interaction* as defined by Sher (2009) is the exchange of information and ideas that occurs among students about the course in the presence or absence of the instructor. Sher also argued that “both student-student and student-instructor interactions are significant contributors to the level of student learning and satisfaction in a technology-mediated environment” (p. 102). When researching different types of online interactions and their effect on satisfaction with the course, Jung, Choi, Lim, and Leem (2002) found that the learners’ satisfaction was more strongly related to the amount of student-student interaction than to the interaction with the instructor. They found that the students who collaborated with each other (e.g., problem solve on a discussion board) expressed the highest level of satisfaction. Student-to-student interaction, specifically over shared prior experiences, influenced student’s ideas and encouraged them to expand, formalize, and refine their reasoning (Tallent-Runnels et al., 2006). Distance education courses should be designed to require or challenge students to interact with other students in the class (Verduin & Clark, 1991; Wagner, 1997). Requiring a minimum number of postings or responses to a class listserv or forum, for example, can be an effective way to develop interaction among students (Edge & Loegering, 2000). In later generations of distance education, including two-way videoconferencing and web-based courses, student-

student interaction can be synchronous, as in videoconferencing and chatting, or asynchronous through discussion boards or e-mail messaging (Lou et al., 2006).

Ferguson and DeFelice (2010) indicate that connectedness to the course, by participating collaboratively with other students likely impacts student satisfaction, and that online courses offer the additional challenges and opportunities associated with not being physically connected to the class. Referring to online learning, Bray, Aoki, and Dlugosh (2008) reported that “opportunities for interaction with other students were available but not emphasized, and some students indicated a preference for more social interaction when learning” (p. 15). Although the individualized learning model affords the highest degree of flexibility for anytime, anywhere, and anyplace learning (Lou et al., 2006), it is low in interaction (Moore, 1989). McBrien et al. (2009) found frustrations of online students enrolled in undergraduate and graduate courses about having too many simultaneous interactions such as audio, typed chat, whiteboard, and PowerPoint, that could be answered simply using emoticons, yes or no, or multiple choice responses.

A more recent study by Nummenmaa and Nummenmaa (2008) showed that “lurkers” (i.e. students who did not actively participate in the course), had more negative emotional experiences with the course than those who interacted collaboratively—namely, visible collaborative activities in a web-based learning environment impacted students’ reactions to the course. Therefore, promoting student interactions in distance education courses is important for setting up an online learning community (Liu, 2008). Distance education is portrayed as possessing more potential and thus more promise in promoting student interactions and enhancing learning outcomes by utilizing advanced computer technology (Liu, 2008). For

example, Bruce, Dowd, Eastburn, & D'Arcy (2005) and Swan (2003) suggest the web has the ability to provide rich context for student interactions and multiple paths for learning.

### **Unique Components of Student Satisfaction to Online Environments**

*Social presence*, simply put, are social relationships in online education (Hostetter & Busch, 2006). When instructors connect with others in new social situations, they create social presence or a degree of interpersonal contact (Gunawardena & Zittle, 1997). Mama (2001) compares students' attitudes regarding site-based and web-based classes, finding that web-based students felt it was more personal or less social than site-based ones. Instructors must deliberately structure interaction patterns to overcome the potential lack of social presence of the medium (Mykota & Duncan, 2007). Hostetter and Busch (2006) surveyed undergraduate students in online and face-to-face classes to study whether social presence can be achieved in online classes in comparison to traditional classes. They found that

Experience in online courses had a statistically significant effect on online students' perceptions of social presence. Also, facilitating social presence in an online class is important for students' satisfaction in their learning. (p. 1)

Mykota and Duncan's (2007) findings reveal that the level of social presence is related to the number of online courses taken by students and their computer-mediated communication proficiency. Richardson and Swan (2003) found a positive correlation between social presence and students' perception of online learning. There is the positive correlation between the level of students' perception of social presence in their courses and higher results on learning measures (Picciano, 2002). Bray et al. (2008) found that "student interaction is a polarized issue, as some students clearly preferred to work independently of others, while others clearly wished for more interaction with other students in order to clarify understanding or reduce the sense of isolation" (p. 14).

While much of the research into social presence theory seeks to define it, measure it, or explore its benefits, little finds its sole focus on ways to cultivate it (Scollins-Mantha, 2008). Many researchers provide some listing of best practices as revealed by their findings, but few seek to fully categorize and test the ways in which social presence can be fostered and encouraged in the online community (Wise, Chang, Duffy, & Del Valle, 2004, p. 265). “Social presence can be cultivated in the online learning classroom” (Gunawardena, 1995, p. 162). This task falls in the hands of instructors, instructional designers, and students, and these three groups must work together to face the challenge of creating social presence in the virtual world (Scollins-Mantha, 2008).

Gunawardena and Zittle (1997) note that the students’ perceptions of social presence depend greatly on the atmosphere created by the instructor in the virtual setting. The instructor plays a critical part in establishing social presence for the entire learning community (Wise et al., 2004). The teacher who seeks to hone skills and techniques related to forming social presence most likely impacts students’ perceptions of social presence (Gunawardena, 1995).

While some instructors hesitate at breaking the barrier between personal and professional lives, in the online learning classroom sharing personal information offers teachers with a way to connect to students and to show them connections from the class to real world material, while building social presence (Aragon, 2003, p. 65).

In order to generate social presence between students and the instructor, the instructor must take into account the isolation felt by students when online communication lags (Scollins-Mantha, 2008). If time frame expectations (i.e. the student’s expectation for communication with the instructor within a twenty-four hour period) are not met, then the student will feel less socially connected in the online learning classroom (Tu & McIsaac, 2002, p. 144).

Raising social presence in online environments may help create impressions of quality related to the experience on the part of the student (Newberry, 2001). Rovai (2001) presents a

model of community that suggests that social presence, student-instructor ratio, transactional distance, instructor immediacy, lurking, social equality, collaborative learning, group facilitation, and self-directed learning all have an impact on the sense of community within online environments. Later, Rovai (2002) modified this framework by proposing transactional distance, social presence, social quality, small-group activities, group facilitation, teaching style & learning stage, and community size as positive correlates to a sense of community.

### **Effects of Student and Online Characteristics**

The benefits of online courses include flexibility, convenience, and cost-effective educational opportunities anywhere and anytime (Carnevale, 2000; Dutton, Dutton, & Perry, 2002). However, courses taught in an online format hold many challenges for the learner and instructor alike (Howell, Williams, & Lindsay, 2003). Many challenges are related to student and online characteristics. For example, support service and class size of online courses, as well as student autonomy (Biner, Welsh, Barone, Summers, & Dean, 1997; Rodriguez-Robles, 2006; Sahin, 2007), have all been shown to play a role in student satisfaction with online learning. Clarity of course design significantly influenced students' satisfaction and perceived learning (Swan, 2001). The need for computer literacy and navigation skills, greater electronic connection capabilities, and concerns over isolation for online learning are also descriptive of student and online characteristics (Howell et al., 2003). Many students enjoy the convenience of the online experience, but some are ill prepared to initiate the basic tenets of the work (Dutton et al., 2002).

The identification of characteristics associated with successful online students could provide the necessary information for teachers and admissions personnel to suggest or discourage a student from registering for an online course (Wojciechowski & Palmer, 2005). A student mistakenly placed in a course may encounter more difficulties and have reduced chances

for success compared to an appropriately placed student (White, Goetz, Hunter, & Barefoot, 1995). This issue is of particular concern for online courses, which are taken by a more heterogeneous population of learners, in terms of characteristics such as preferences, skills, and needs, than traditional college students who take classes on campus (Phipps & Merisotis, 1999). Students in an online course may appear typical, but there is a great degree of diversity within the online student population (Cheung & Kan, 2002).

Information on student characteristics can be extracted from a main campus database, which often contains personal data on individual students collected as they initially apply for admission (e.g., gender, date of birth, and achievement test scores) as well as information gathered and updated each semester the student is in attendance (e.g. courses enrolled in, grade point average, withdrawal from courses, semesters students are enrolled, and the number of credit hours registered for per semester) (Wojciechowski & Palmer, 2005). Earlier profiles of the online learner can be traced to classic distance education settings (e.g., correspondence courses or home study) where most learners were adults with occupational, social, and familial commitments (Hanson et al., 1997). Several other studies examined student attitudes, personality characteristics, study practices, course completion rates, and other academic, psychological, and social integration variables to identify barriers to persistence in distance education and determine predictors for successful course achievement (e.g., Bernt & Bugbee, 1993; Biner, Bink, Huffman, & Dean, 1995; Fjortoff, 1995; Garland, 1993; Laube, 1992; Pugliese, 1994; Stone, 1992). Overall, intrinsically motivated learners possessing a high internal locus of control, coupled with a positive attitude toward the instructor and a high expectation for grades and degree completion were more likely to succeed in a distance education course (Dabbagh, 2007).

## **Status of Current Research**

The research to date that has compared online and traditional courses has typically used student evaluations, grades given in classes, and survey questions asking students how much they have learned and how satisfied they are with learning (Anstine & Skidmore, 2005). Evidently, many researchers emphasize interactions in the online learning literature. As early as 1989, Moore proposed three types of interactions: student-content; student-instructor; and student-student. Young and Norgard (2006) supported the importance of these three types of interactions for student satisfaction with distance education. Shea, Pickett, and Pelz (2003) argued that the following issues are highly relevant to the research on students' satisfaction in online learning including instructional design and organization of the online courses, instructors' direct interaction with students, and instructors' discourse facilitation.

Due to the limited number of online students that could be reached in a study, it is suggested that future researchers accumulate data from different semesters to improve the number of student responses (Kuo, 2010). Indeed, many studies mentioned that more research is needed with a larger number of participants in order to draw more precise conclusions on student satisfaction in online classrooms (Ertmer et al., 2007; Richardson, 2005; Kuo, 2010).

Researchers have commonly used a single-item rating scale to assess overall satisfaction, but this approach fails to recognize the students' varying degree of satisfaction with each service or educational attribute (Elliott & Shin, 2002). Recognizing the drawbacks associated with this traditional approach of measuring student satisfaction, these researchers presented an alternative approach. Aimed to increase diagnostic value to both academicians and practitioners, a multiple-item weighted gap score (i.e., a score that indicates the gap that exists between the ideal rating

and actual performance rating assessed by students in the online course) analysis is used as an alternative method for assessing student satisfaction (Elliott & Shin, 2002).

The majority of the research on distance education has not compared student learning while controlling for prior knowledge of the material and taking other student characteristics into account (Anstine & Skidmore, 2005). Lin and Overbaugh (2007) found that

Factors contributing to “student satisfaction” become more complex when the focus moves from conventional face-to-face classrooms to online teaching/learning environments. However, whether greater student satisfaction results from environmental attributes or from personal preferences toward the learning process remains a viable question. (p. 402)

Kuo (2010) encouraged data collection and data analysis on the relationship between satisfaction and performance. In fact, the question of whether increased satisfaction leads to improved performance or improved performance leads to increased satisfaction has been debated for many years in the literature on work organizations (Locke, 1976; Organ, 1977; Schwab & Cummings, 1970). Similarly, whether students’ satisfaction improves their performance (e.g., measured by grade point average) or vice versa is becoming an interesting and important issue for education (Bean & Bradley, 1986). Either individually or in relationships, students’ perceived satisfaction and their performance in online collaborative learning are important factors to determine whether an innovative learning approach can be applied in a sustainable way (Zhu, 2012).

Understanding what motivates students to choose online courses, how to match learning styles with instructional design, and how to deliver this type of instruction are some of the issues researchers are just beginning to investigate (Tallent-Runnels et al., 2006). Seamon (2004) examined the long-term effects of different instructional formats and found that students’ performance in an intensive course (i.e., a course that is shorter than a full semester) was

superior initially, but three years later, the full-semester students outperformed the intensive course students. On the other hand, Anastasi (2007) argued that contrary to previous research students tend to perform just as well in abbreviated courses, and that the belief that shortened courses are somehow inferior to full-semester courses is unfounded. This is one of the issues that the online learning literature will soon need to face.

### **Connection to this Study**

Evidently, the status of the current literature on online learning shows many weaknesses, and this study attempts to fill in some gaps that exist within the area of student satisfaction and performance in relation to online mathematics courses. Specifically, this study strives to employ a large number of online participants to draw more precise conclusions on the measurement and interpretation of student satisfaction. Satisfaction is to be measured based on a psychometrically developed instrument, which is among the first wave of psychometrically-tested instruments targeting particularly online learning. This study also attempts to determine the effects of characteristics descriptive of the online environment on satisfaction. Lastly, this study attempts to examine if a relationship exists between satisfaction and performance in an online environment. Even though performance can be measured in various ways (e.g., formal tests, course assignments, and discussion board postings), this study intends to use course grades to avoid overloading students who are willing to participate in this study.

### Chapter Three: Methodology

With a large percentage of university students working part-time or full-time and using technology on a more frequent basis in their daily life than in the past, more and more colleges and universities have opened up their course offerings to include online mathematics courses in addition to traditional mathematics courses. Online education using the Internet and information technologies is becoming an increasingly popular tool for distance education to better meet students' needs, interests, learning styles, and work schedules (Lim, Kim, Chen, & Ryder, 2008). Published studies are not consistent in comparing performance and satisfaction of students in traditional and online instruction (Lim et al., 2008). Various weaknesses in research are responsible for this inconsistency as discussed in the previous chapter.

This study aimed to improve the quality of educational research on distance education by filling in some gaps (or overcoming some weaknesses) in the research literature. First, this study developed and validated an instrument that measured satisfaction of students taking online courses. Secondly, this study explored the relationship among student satisfaction, student performance, and the characteristics of individuals, learning preferences, and online (learning) environment. Specifically, this study predicted student satisfaction (measured through the developed instrument) from the characteristics of individuals, learning preferences, and online (learning) environment and predicted student performance from student satisfaction (measured through the developed instrument) together with the characteristics of individuals, learning preferences, and online (learning) environment. This chapter explains the methods used to accomplish these purposes. As a result, this study contributed to a better measurement of student satisfaction in an online environment and will help researchers and practitioners better

understand the complex relationship among student satisfaction, student performance, and the characteristics of individuals, learning preferences, and online (learning) environment.

### **Data Sources**

In this study, the target participants were all students enrolled in an asynchronous online course, College Algebra, at a certain community and technical college in the midwest region of the United States ( $N = 300$  students). The campus is located totally online because students are being evaluated based on their enrollment in the online mathematics course. The students in the online course are of mixed age, gender, and ethnicity. Students were invited to participate in the study, and they did not receive any compensation for participation. Students were surveyed anonymously. Data on characteristics of students, their learning preferences, and characteristics of online (learning) environment were collected via an online survey. Students' viewpoints on personal feedback, perception of online learning, student-student interaction, student-instructor interaction, and social presence in an online course were also collected (using the developed instrument). Pretest and posttest of relevant mathematics knowledge and skills were also conducted.

### **Instrumentation**

The instrument, entitled Satisfaction of Online Learning (SOL) (see Appendix A), included 24 items embedded in eight components that were developed based on the theoretical framework discussed in the previous chapter (see Table 1). The validity of this instrument was established by carefully constructing or selecting items based on empirical evidence or references that closely reflect each of the components. That is, empirical evidence or references functioned to provide clues for the wording or description of each item. Each piece of evidence or each reference served as a foundation for the construction of each item in SOL.

Table 1

*Foundation for Instrument Development*

Factor	Item
Effectiveness of the feedback	1, 2, 3
Timeliness of the feedback	4, 5, 6
Use of discussion boards in the classroom	7, 8, 9
Dialogue between instructors and students	10, 11, 12
Perception of online experiences	13, 14, 15
Instructor characteristics	16, 17, 18
The feeling of a learning community	19, 20, 21
Computer-mediated communication	22, 23, 24

This approach helped to validate the instrument with stronger proof and greater clarity.

Table 2 presented specifications and validations of SOL items in detail. The items were developed in this study to isolate certain behaviors that were closely associated with each of the eight factors (components) in Table 1. They were constructed using responses to positive statements. Responsive options for each statement (item) included *Strongly Disagree*, *Disagree*, *Neutral*, *Agree*, and *Strongly Agree* (ranging from 1 to 5 respectively). Students with a higher score indicated more satisfaction to a certain area of a certain factor.

Table 2

*Item Construction and Evidence of Validity*

Item	Description	Reference
	I am satisfied with my online learning experience because effective feedback related to my coursework is constantly provided to me in terms of:	
1	clarification for my inquiries about the course (e.g., assignments).	Lam, Yik, & Schaubroeck, 2002
2	instruction on how to correct mistakes (e.g., conceptual, factual) in assignments.	Alvero, Bucklin, & Austin, 2001; Cusella, 1987; Ilgen, Fisher, & Taylor, 1979; Jussim, Coleman, & Nassau, 1989; Kluger &

Table 2 (continued)		
		DeNisi, 1996; Locke & Latham, 1990; Nadler, 1979; Saavedra, Earley, & Van Dyne, 1993; Stajkovic & Luthans, 1997
3	verification and elaboration on my specific questions related to my course work.	Kulhavy & Stock, 1989; Bangert-Drowns, Kulik, Kulik, & Morgan, 1991; Mason & Burning, 2001; Shute, 2008
	I am satisfied with my online learning experience because timely feedback related to my course work is constantly provided to me so that:	
4	I am able to have plenty of time to complete my assignments.	Lam, Yik, & Schaubroeck, 2002
5	I am able to revise my assignments for better quality (grades).	Shute, 2008
6	I am motivated to learn.	Blayney & Freeman, 2004; Ozden, Ertuck, & Sanli, 2004
	I am satisfied with my online learning experience because:	
7	discussion boards offer more opportunities for me to participate than traditional approaches of discussions.	Swan, 2002
8	asynchronous discussions (where I can post my discussions at any time of the day) are more convenient than traditional discussions.	Poole, 2000; Zafeiriou, Nunes, & Ford, 2001
9	I am not anxious given that there is plenty of time for me to think and draft my responses for online discussions.	Poole, 2000; Zafeiriou, Nunes, & Ford, 2001
	I am satisfied with my online learning experience because	
10	I have sufficient communication with my instructor throughout the semester.	Chen & Willits, 1999; Jung, 2001; Moore, 1993
11	online dialogue with my instructor facilitates my learning process and outcome.	McBrien, Jones, & Cheng, 2009
12	online dialogue with my instructor helps me feel less “distant” in the online environment.	Moore, 1989; Murphy & Collins, 1997
	I am satisfied with my online learning experience because:	

13	my personal needs as a student are met in the online environment.	Mama, 2001; Howland & Moore, 2002
14	online education seems to have features most of which I come to enjoy.	Astani, Ready, & Duplaga, 2010
15	overall I seem to prefer online courses over traditional courses.	Astani, Ready, & Duplaga, 2010
<hr/>		
	I am satisfied with my online learning experience because:	
16	I can get the same clear explanation on the subject content from online instructors as I can get from traditional instructors.	Greimel-Fuhrmann & Geyer, 2003
17	I can get the same help for my learning issues from online instructors as I can get from traditional instructors.	Spencer & Schmelkin, 2002
18	online instructors have unique technological means to become very creative in approach towards instruction that traditional instructors cannot compete.	Greimel-Fuhrmann & Geyer, 2003
<hr/>		
	I am satisfied with my online learning experience because the online environment:	
19	is like a community where I can share my experiences with other students.	Brueggemann, 2002
20	promotes sufficient relating and caring among students.	Wise, Chang, Duffy, & del Valle, 2004
21	is a safe place where I can boldly collaborate with other students on course-related work.	Bonk & Cunningham, 1998
<hr/>		
	I am satisfied with my online learning experience because computer-mediated communication	
22	makes me feel like a real person when I communicate in the online environment.	Gunawardena, 1995
23	is meaningful enough to form real relationships among students in the online environment.	Jones, 1995; Gunawardena, 1995
24	makes me feel the presence of my instructor and other students in the online environment.	Hostetter & Busch, 2006; Gunawardena, 1995
<hr/>		

After the construction of the instrument, a pilot was conducted during the Spring 2013 semester to field-test its functions. The instrument was emailed to 15 students in the online course who had one week to work on the instrument. Students were instructed to highlight an option that corresponded most closely to their response to each statement that described a behavior or factor associated with student satisfaction in regards to the online mathematics course. Students were also instructed to answer all items, take notes on anything that causes confusion, and record the time that they need to complete all items. The result of this pilot served to improve the instrument. The effort helped to answer the first research question, Is it possible to develop a valid and reliable instrument that measures the extent to which students are satisfied with learning mathematics in an online environment?

The formal, comprehensive data collection started in the summer of 2013 with the participation of students in all sections of the asynchronous online course, College Algebra (with consents). At the end of this semester, students were administered (a) the SOL, (b) an online survey that measured individual characteristics, learning preferences, characteristics of online learning environment (see Appendix B); and (c) a test of mathematics knowledge and skills (see Appendix C). The test of mathematics knowledge was developed by the researcher and this content aligned with the course curriculum. To validate SOL, the factorial structure of this instrument was validated through confirmatory factor analysis, and the reliability of this instrument was established by calculating the reliability coefficients of each component and all components as a whole. The online survey was a straightforward design with questions that collected information about individual characteristics, learning preferences, and online learning environment.

The test of mathematics knowledge and skills covered in the online course (i.e., College Algebra) was given to students within the first two weeks and within the last two weeks of the course so that gains in mathematics knowledge and skills could be measured. The test included multiple-choice items and open-ended items concerning mathematics knowledge and skills taught in the online course (e. g. operations of addition, subtraction, multiplication, and division). Specifically, various aspects of content included mean price, total price, purchase price, rounding, simplifying, combining like terms, ratio, mixed numeral, length, width, angles, and problem solving. This test had been used for many years in the same course, and for this study, this test was examined for the mathematical correctness of the items and the practical appropriateness of the test for the course (i.e., an expert validation process) by an experienced mathematician who was familiar with similar courses.

### **Measures and Variables**

The online survey had three parts to collect informative descriptions of student characteristics, learning preferences, and characteristics of the online learning environment. Specifically, the first part collected individual data including gender, age, financial aid (as a measure of socioeconomic status or SES), ethnicity, geographic location, highest mathematics course taken in high school, distance learning experience, working experience, and educational level in college. The second part collected data on students' learning preferences including visual learning, aural learning, verbal learning, physical learning, logical learning, social learning, and solitary learning. The third part collected characteristics of the online learning environment including instructional format, what time of day to meet, and what technique was used for delivery. Data collected were used to answer the second and third research questions. The second research question concerned whether there is a relationship of student satisfaction with online

mathematics courses to individual characteristics, learning preferences, and online learning environment. The third research question concerned whether there was a relationship between performance and satisfaction of students in an online environment of learning mathematics. The relationship of student performance to individual characteristics, learning preferences, and online learning environment was also explored in this research question.

For the second research question, the dependent variable was student satisfaction. The independent variables were individual characteristics of students, their learning preferences, and characteristics of online learning environment. Because randomization was impossible in this study to select participants (i.e., the sample consists of volunteers), it was important to include student characteristics in data analysis.

For the third research question, the dependent variable was student performance in posttest. The independent variables included student performance in pretest (functioned actually as a covariate), student satisfaction with online mathematics courses, individual characteristics of students, their learning preferences, and characteristics of online learning environment. Data analysis aimed to compare the importance between student satisfaction, individual characteristics of students, their learning preferences, and characteristics of online learning environment to student performance in the online course.

### **Statistical Procedures**

The statistical procedure for the validation of SOL followed closely the one that is used by Shen et al. (2012). It began with an item analysis to make sure that students were using the full range of the responsive options, which was performed “by examining the frequencies on the responsive options for each statement” (Shen et al., p. 9). Next was the examination of factorial validity of the instrument. A series of confirmatory factor analyses were performed to examine whether the eight-factor structure identified through the literature review were present within the

sample of online mathematics students. Specifically, the eight-factor model was compared with two other models including the null model and the one-factor model. Comparison of a proposed model with the null and one-factor models is a routine procedure in instrument validation (Shen et al., 2012). Model-data-fit statistics included  $\chi^2$ , SRMR, TLI, CFI, AIC, and BIC.

The  $\chi^2$  statistic gave an indication of overall fit of the data to the model with a small  $\chi^2$  value indicating a good fit. As one of the absolute measures of fit that do not use an alternative model as the base for comparison, the  $\chi^2$  statistic provided only a rough idea about model-data-fit being quite sensitive to sample size, model size, and variable distribution. The standardized root mean square residual (SRMR) was a much better alternative absolute index. A SRMR value smaller than .08 is considered a good fit (see Hu & Bentler, 1999). The comparative fit index (CFI) and the Tucker-Lewis index (TLI) could be considered as relative measures of fit because they used an alternative model as the basis for comparison. CFI avoided the underestimation of the model-data-fit, often occurring when a sample is small. TLI provided a measure of model-data-fit that was independent of sample size. Because both CFI and TLI measured the proportion of variance explained in relation to the null model, a value greater than .90 indicated a good fit (see Hu & Bentler, 1999). Lastly, because the models in this study were non-nested ones, information-based estimates were also used to evaluate goodness of fit, including Akaike information criterion (AIC) and Bayesian information criterion (BIC). A best fitting model had the smallest estimate on both AIC and BIC.

Once the factorial structure was “empirically supported, we combined items within each scale in order to produce the mean and standard deviations for each scale” and this task was “performed by taking the average of valid responses within each scale” (Shen et al., p. 14). Distribution of scale scores were then examined with “two distribution indices: *skewness*, to

make sure that scores were roughly symmetrical around the mean; and *kurtosis*, to make sure that the distributions were not overly peaked or overly flat” (Shen et al., p. 15). Finally, Cronbach’s alpha was used as the measure of internal consistency. Reliability analysis was performed on each scale and the instrument as a whole (see Shen et al., 2012). This statistical procedure concluded statistical analysis of the first research question.

For the second research question, a multiple regression analysis was performed with student satisfaction as the dependent variable and variables descriptive of individual characteristics, learning preferences, and online learning environment as the independent variables. After handling missing data on the dependent variable (i.e., SOL),  $N = 102$  students remained for data analysis. For the third research question, a multiple regression analysis was performed with student posttest performance as the dependent variable and student pretest performance as a measure of prior ability (a covariate by nature). The independent variables were the same as those used in addressing the second research questions (i.e., variables descriptive of individual characteristics, learning preferences, and online learning environment). After handling missing data on the dependent variable (i.e., posttest),  $N = 68$  students remained for data analysis.

Because the sample size was relatively small in the case of both research questions, independent variables were examined individually first to test their absolute effects. Absolute effects of a variable refer to the effects of that variable that will occur without the presence of other variables in the statistical model. So each variable was tested independently. Variables that are found to have absolute effects were then tested together in the statistical model to see if relative effects appear. Relative effects of a variable refer to the effects of that variable that will occur in the presence of other variables in the statistical model. This strategy successfully

avoided entering a large number of independent variables together into the regression model (the so-called stepwise approach that was not a sound statistical practice when the regression model runs on a small sample).

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## Chapter Four: Results

The purpose of this study was threefold. The first purpose was to develop and validate an instrument that measures satisfaction regarding taking online courses. This responds to the lack of instrumentation in the research literature on this issue. The second purpose was to predict student satisfaction (measured through the developed instrument) based on the learning characteristics of an online environment. Although a few studies examined this relationship, this study employs a psychometrically validated instrument (rather than a survey) to measure satisfaction and information on a set of theory-informed predictors collected by a survey. The third purpose was to predict student performance from student satisfaction (measured through the developed instrument) in an online environment with controls of the learning characteristics of an online environment.

### **Instrument Validation**

#### *Item Analysis*

After the pilot study as part of the validation of the instrument referred to as Satisfaction of Online Learning (see Appendix A), empirical data were collected using the instrument. A series of analyses were performed on the collected data for the purpose of validating the instrument. First, an item analysis was done to make sure that students were using all of the possible options on the Likert scale. This task was performed “by examining the frequencies on the responsive options for each statement [item]” (Shen et al., 2012, p. 9). Table 3 presents the distribution of responses and descriptive statistics across items that form the instrument. All five response options have been used on each and every item. For each item, the choices were heavier from *Neutral* to *Strongly Agree*. Each item indicated a mean greater than 3 (on a scale of 1 to 5) and a *SD* about 1.

Table 3

*Distribution of Responses and Descriptive Statistics across Items*

Item	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	SD
Q1	.10	.05	.19	.35	.32	3.74	1.23
Q2	.11	.04	.18	.33	.34	3.76	1.26
Q3	.10	.05	.20	.34	.31	3.72	1.23
Q4	.11	.02	.19	.34	.35	3.81	1.23
Q5	.12	.02	.17	.29	.40	3.83	1.31
Q6	.09	.05	.22	.34	.30	3.70	1.20
Q7	.08	.12	.37	.21	.21	3.35	1.18
Q8	.09	.08	.28	.28	.27	3.55	1.22
Q9	.09	.09	.22	.33	.27	3.60	1.22
Q10	.10	.03	.23	.28	.37	3.78	1.25
Q11	.10	.06	.24	.32	.29	3.65	1.23
Q12	.10	.05	.30	.28	.28	3.59	1.22
Q13	.08	.07	.25	.32	.28	3.66	1.19
Q14	.09	.07	.19	.37	.28	3.68	1.21
Q15	.13	.08	.27	.19	.33	3.51	1.37
Q16	.12	.09	.26	.24	.28	3.48	1.32
Q17	.12	.09	.27	.25	.26	3.44	1.30
Q18	.11	.11	.31	.19	.28	3.40	1.31
Q19	.15	.10	.30	.23	.23	3.29	1.32
Q20	.14	.14	.30	.22	.20	3.21	1.30
Q21	.11	.09	.34	.21	.24	3.38	1.26
Q22	.12	.08	.35	.22	.22	3.35	1.26
Q23	.15	.15	.34	.18	.19	3.11	1.29
Q24	.12	.16	.32	.20	.20	3.19	1.27

*Note.* Values other than means and SDs represent percentages.

### *Confirmatory Factor Analysis*

Validation of the factorial structure of the instrument was based on a series of confirmatory factor analyses to examine whether the eight-factor structure identified through theoretical synthesis of research literature was present in our sample of online mathematics students. In essence, a confirmatory factor analysis tests whether and, if so, how well a proposed theoretical model fits the observed empirical data among items (see Shen et al., 2012). Figure 1 and Figure 2 schematically illustrate the models on whose factorial validity was tested.

Figure 1

*The One-Factor Model*

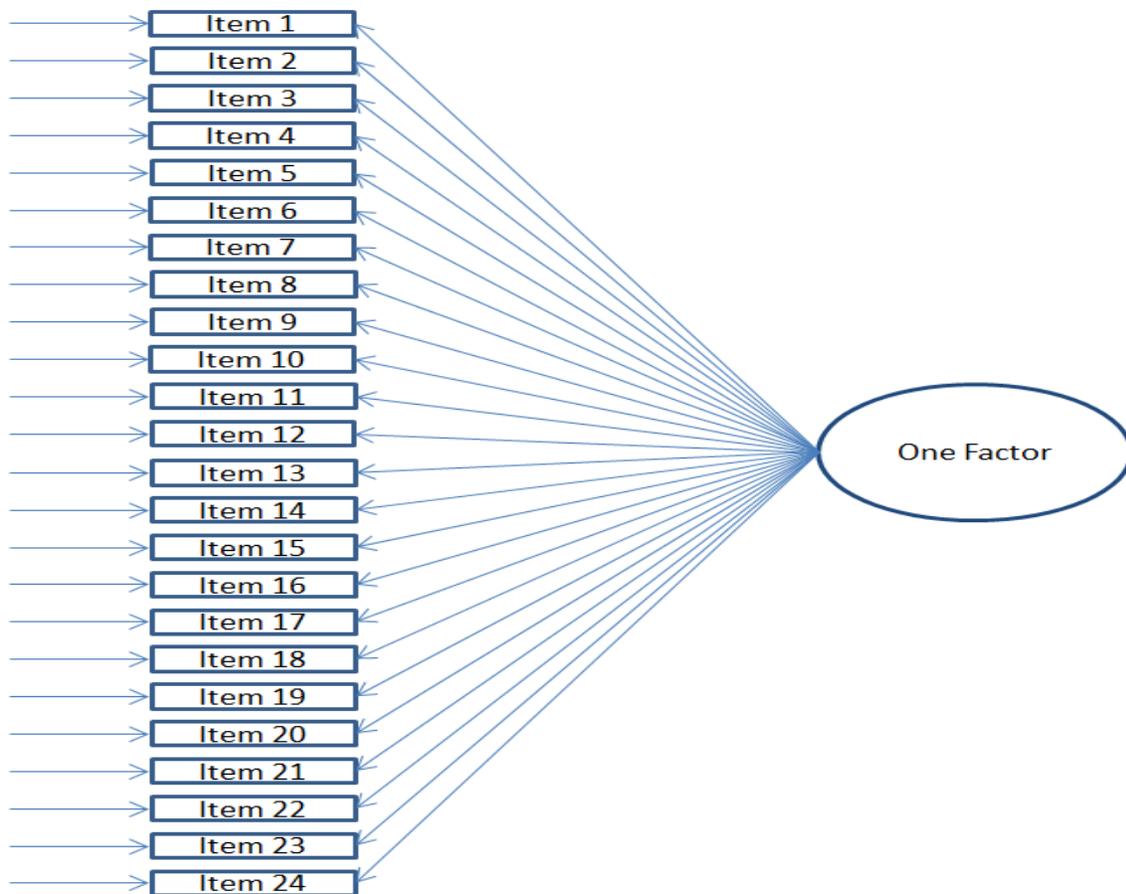
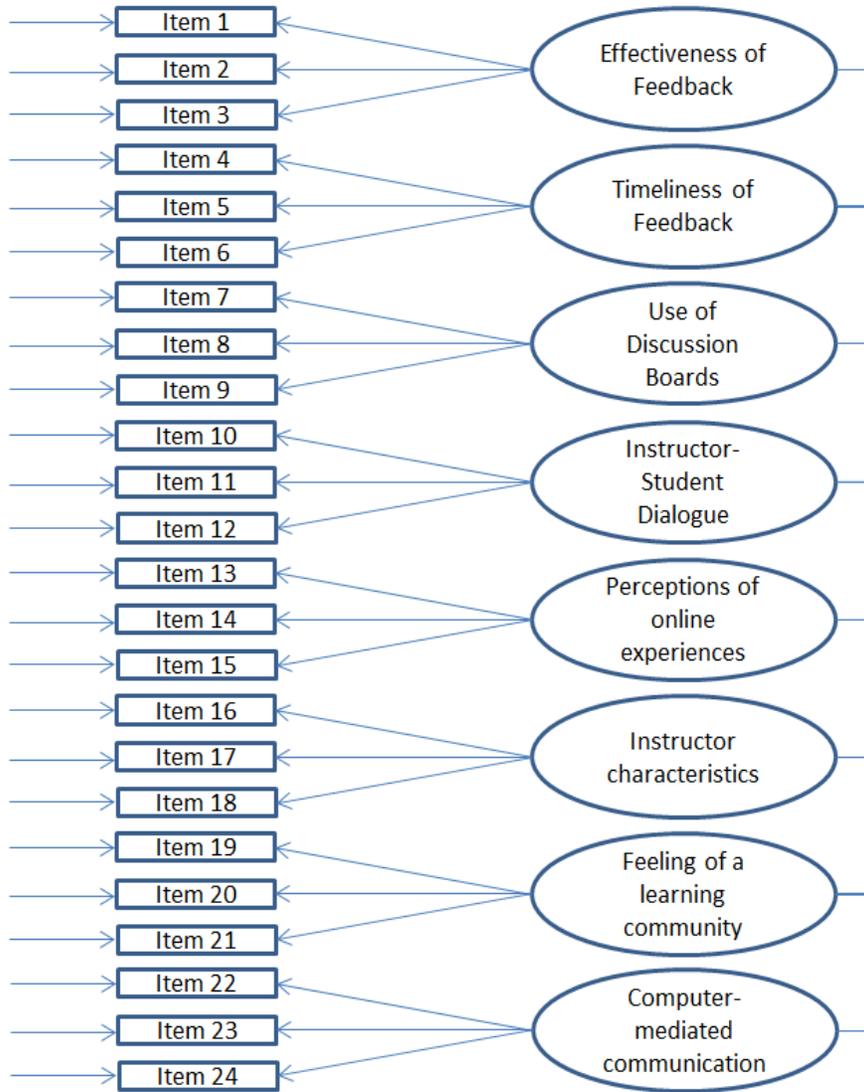


Figure 2

*The Eight-Factor Model*



Procedurally, the 8-factor model was compared with the null model and the one-factor model. Comparison of a proposed model with the null and one-factor model is a routine procedure in instrument validation (Shen et al., 2012). Assuming zero covariance among items, the null model contained no factor and functions as a baseline comparison (Shen et al., 2012). Meanwhile, assuming that all items load on a single factor, the one-factor model aimed to test the existence of a unitary concept of student satisfaction with online mathematics courses.

Specifically, a confirmatory factor analysis similar to Shen et al. (2012) was performed to examine how closely data from the 24 specific items fit into the 8-factor structure of student satisfaction with online mathematics courses. Table 4 presents estimates of indices that measure the extent to which a model fits the data at hand. In a comparative sense, results indicated that the eight-factor model represented substantial improvement in model-data-fit over the null and the one-factor model. In particular, the one-factor model showed indices that fell seriously short of expected standards.

Table 4

*Results of Model Data Fit from Confirmatory Factor Analysis*

Model	$\chi^2$	CFI	TLI	SRMR	AIC	BIC
Null	5052.41					
One-factor	1474.15	.74	.72	.06	6277.32	6479.80
Eight-factor	590.71	.92	.90	.05	5449.88	5731.10

The  $\chi^2$  statistic gives an indication of overall fit of the data to the model with a small  $\chi^2$  value indicating a good fit (Shen et al., 2012). Given that the  $\chi^2$  statistic for the null model was 5052.41, the 8-factor model indicated a considerably huge improvement in the  $\chi^2$  statistic, reducing the index to 590.71. Therefore, the 8-factor model indicated a considerably better fit to the data than the null model. Meanwhile, the  $\chi^2$  statistic for the one-factor model (1474.15) was much better than that for the null model (5052.41), but was worse than that for the 8-factor model. Overall, the  $\chi^2$  statistic consistently identified the 8-factor model as the best fitting model for the data. Nevertheless, as one of the absolute measures of fit that do not use an alternative model as the baseline for comparison, the  $\chi^2$  statistic provides only a rough idea about model-data-fit because it is sensitive to sample size, model size, and variable distribution (Shen et al., 2012).

The standardized root mean square residual (SRMR) is a much better alternative absolute index (Shen et al., 2012). A SRMR value smaller than .08 is considered a good fit (Hu & Bentler, 1999). The eight-factor model showed a SRMR value of .05 which was better than the SRMR value of .06 for the one-factor model. Therefore, the SRMR index identified the 8-factor model as the better fitting model for the data.

The comparative fit index (CFI) and the Tucker-Lewis index (TLI) can be considered as relative measures of fit because they use an alternative model as the base for comparison (Shen et al., 2012). CFI avoids the underestimation on the model-data-fit often occurring when a sample is small, and TLI provides a measure of model-data-fit that is independent of sample size (Shen et al., 2012). Because both CFI and TLI measure the proportion of variance explained in relation to the null model, a value greater than .90 indicates a good fit in cases of both indices (Hu & Bentler, 1999). The eight-factor model had both CFI and TLI above this standard (.93 and .91 respectively) and showed a substantial improvement on both CFI and TLI than the one-factor model (.74 and .72 respectively).

Last, because the models in Table 4 are non-nested ones, information-based estimates to evaluate goodness of fit, including the Akaike information criterion (AIC) and Bayesian information criterion (BIC) were also considered. A better fitting model has a smaller estimate in both AIC and BIC (Shen et al., 2012). The eight-factor model had smaller estimates on both AIC and BIC (5449.88 and 5731.10 respectively) than the one-factor model (6277.32 and 6479.80 respectively).

In sum, confirmatory factor analysis revealed that all model-data-fit indices unanimously supported the 8-factor structure as a sound representation or measurement of the construct conceptualized as student satisfaction with online mathematics courses.

### Scale Analysis

With the scales (factorial structure) of the construct empirically supported, items relating to each scale can be combined in order to produce means and standard deviations for each scale. This task was performed by taking the average of valid responses across items within each scale (Shen et al., 2012). It is therefore possible to look at the distribution as it relates to each of the scales. Specifically, two distribution indices were examined. *Skewness* makes sure that scores are roughly symmetrical around the mean, and *kurtosis* makes sure that the distributions are not overly peaked or overly flat (Shen et al., 2012).

Table 5

#### *Descriptive Statistics across Scales*

Scale	Mean	SD	Skewness	Kurtosis
Effectiveness of feedback	3.74	1.24	-0.92	0.01
Timeliness of feedback	3.78	1.25	-0.99	0.15
Use of discussion boards	3.50	1.21	-0.54	-0.49
Dialogue between instructors and students	3.67	1.23	-0.77	-0.19
Perceptions of online experiences	3.62	1.26	-0.69	-0.40
Instructor characteristics	3.44	1.31	-0.44	-0.81
Feeling of a learning community	3.29	1.30	-0.31	-0.85
Computer-mediated communication	3.22	1.27	-0.20	-0.83

Table 5 represents descriptive statistics (means and standardized deviations) and distributional properties (skewness and kurtosis) of each scale on the instrument. There were greater response variations among instructor characteristics. Smaller variations occurred in terms of (a) use of discussion boards, (b) dialogue between instructors and students, (c) effectiveness of feedback, and (d) timeliness of feedback. Such results were within the expectation of the study, given that these descriptive elements are common when students are making the decision about

taking online mathematics courses. In general, analytical results on skewness and kurtosis did not raise serious concerns about the data distribution of each scale on the questionnaire (Shen et al., 2012).

### *Reliability Analysis*

Lastly, a reliability analysis was performed to investigate the internal consistency of each scale and the instrument as a whole. For this purpose, Cronbach's alpha was used as the measure of internal consistency (Shen et al., 2012). The results are represented in Table 6.

Table 6

### *Reliability Statistics across Scales*

Scales	Number of Items	Reliabilities
Effectiveness of feedback	3	0.98
Timeliness of feedback	3	0.98
Use of discussion boards	3	0.98
Dialogue between instructors and students	3	0.98
Perceptions of online experiences	3	0.98
Instructor characteristics	3	0.98
Feeling of a learning community	3	0.98
Computer-mediated communication	3	0.98
Instrument as a whole	24	0.98

Using Cronbach's alpha, it was found that all scales were internally highly reliable with alpha coefficients above .98 across scales and for the instrument as a whole. In other words, there was a strong indication that this instrument had a high level of internal consistency. Therefore, this instrument was considered reliable.

## **Relationship of Satisfaction to Individual Characteristics, Learning Preferences, and Online Environment**

The second research question addressed the potential for a comprehensive relationship between students' satisfaction with online mathematics courses and characteristics of individuals, learning preferences, and online learning environment. Multiple regression analysis was performed to address this research question based on 107 students who had valid responses (scores) on satisfaction with online mathematics courses that were the dependent variable for this analysis. This relatively small sample size might not support the common stepwise entry of all independent variables at once into the regression equation. Instead, independent variables were entered into the regression equation in a one-by-one fashion to first examine what is often referred to as the absolute effects (see definition in Chapter 3). After the examination of absolute effects, only independent variables that were statistically significant were entered (together) into the regression equation to examine what is often referred to as the relative effects (see definition in Chapter 3).

Table 7 presents results of multiple regression analysis concerning the effects of individual characteristics, learning preferences, and characteristics of the online learning environment on students' satisfaction with online mathematics courses. Independent variables came from three categories including individual characteristics, learning preferences, and online environment. The final regression model under relative effects contained three variables (age, pre-calculus/calculus vs. below pre-calculus, visual learning). Age (of students) demonstrated statistically significant absolute and relative effects on satisfaction with online mathematics courses. In other words, satisfaction with online mathematics courses depended on age both individually and collectively.

Table 7

*Multiple Regression Results Estimating Effects of Individual Characteristics, Learning Preferences, and Online Environment on Satisfactory with Online Mathematics Courses*

Variables	Absolute Effect	SE	Relative Effect	SE
<b>Individual characteristics</b>				
Age (continuous)	-.87*	.24	-.59*	.28
Male (vs female)	-2.87	6.21		
White (vs non-White)	3.20	8.02		
Pre-calculus/calculus (vs below pre-calculus)	16.37*	8.11	15.84	8.80
Up to associate degree (vs high school diploma)	.40	5.89		
Bachelor and beyond (vs high school diploma)	-13.19	6.94		
Financial aid (vs no financial aid)	-7.26	7.98		
Years of working experience (continuous)	-.55	.61		
Number of online courses (continuous)	.24	2.18		
<b>Learning preferences</b>				
Visual learning (continuous)	4.98*	2.41	3.51	2.65
Aural learning (continuous)	-1.26	2.97		
Verbal learning (continuous)	3.31	2.75		
Physical learning (continuous)	2.32	2.56		
Logical learning (continuous)	2.89	2.69		
Social learning (continuous)	3.94	2.92		
Solitary learning (continuous)	-2.93	2.79		
<b>Online environment</b>				
Preference on online (vs face-to-face)	9.67	6.72		
Preference on hybrid (vs face-to-face)	6.92	8.31		
Scheduled sessions (vs non-scheduled sessions)	-6.18	6.78		
Asynchronous (vs synchronous)	3.72	5.84		

Specifically, the effects of age were negative, indicating that younger students were more satisfied with online mathematics courses than older students. Consider the relative effects with

two students one year apart. The younger one would score .59 points higher on satisfaction with online mathematics courses than the older one. The scale of satisfaction with online mathematics courses ranged from 24 to 100. Therefore, if two students were ten years apart, the younger one would score 6 points higher than the older one, which might not indicate strong age effects. What is often referred to as  $R^2$  is a model-data-fit statistic measuring the proportion of variance explained by a regression model. In case of the final model containing only variables with statistically significant absolute effects (i.e., age, pre-calculus/calculus vs below pre-calculus, and visual learning),  $R^2 = .18$ , indicating that 18% of the total variance in satisfaction with online mathematics courses was accounted for by the final regression model. Such a magnitude is considered adequate in social sciences (see Gaur & Gaur, 2006).

Nevertheless, age demonstrated statistically significant absolute and relative effects on satisfaction with online mathematics courses. Age was therefore stable; that is, even in the presence of other variables with statistically significant absolute effects, age remained statistically significant. In statistical practice, predictor variables like this variable can be considered robustly important to a certain outcome variable (see Ma, Shen, & Krenn, in press). On the other hand, pre-calculus/calculus (vs. below pre-calculus) and visual learning showed statistically significant absolute relationships only. In the presence of other variables, pre-calculus/calculus and visual learning became rather secondary so as to cease to be statistically significant (without statistically significant relative relationships). Predictor variables like this can be considered not important to a certain outcome variable (see Ma et al., in press). Finally, the critically important variable of age came from the category of individual characteristics (see Table 7). It appears that individual characteristics had some isolated effects on satisfaction with online mathematics courses. Meanwhile, the other two categories of

independent variables, learning preferences and online environment, did not have any effects on satisfaction with online mathematics courses. Therefore, satisfaction with online mathematics courses had nothing to do with learning preferences and online environment.

### **Relationship of Performance to Satisfaction, Individual Characteristics, Learning Preferences, and Online Environment**

The third research question concerned mainly about the determination on whether a relationship exists between students' performance in online mathematics courses and their satisfaction with online mathematics courses. Similar to the previous research question, this one also took a comprehensive approach to include characteristics of individuals, learning preferences, and online learning environment to determine their relationships with students' performance in online mathematics courses. The multiple regression approach to analysis of covariance (ANCOVA) was used to address this research question. In the regression equation, the dependent variable was posttest scores and the covariate was pretest scores. Independent variables came from the same three categories as used in addressing the second research question (i.e. in addition to satisfaction with online mathematics courses). This analysis was based on 67 students who had valid posttest scores. Similar to the strategy used to deal with the small sample size in addressing the second research question, each independent variable was examined separately for its absolute effects and only independent variables with statistically significant absolute effects were considered together in the final regression model.

Table 8 presents the results of multiple regression analysis that estimates the effects of individual characteristics, learning preferences, and characteristics of online learning environment on gains over an academic semester in students' performance in online mathematics courses.

Table 8

*Multiple Regression Results Estimating Effects of Individual Characteristics, Learning Preferences, Online Environment, and Satisfactory with Online Mathematics Courses on Gains in Mathematics Performance*

Variables	Absolute Effect	SE
<b>Individual characteristics</b>		
Age (continuous)	.03	.04
Male (vs female)	.71	.65
White (vs non-White)	1.29	.86
Pre-calculus/calculus (vs below pre-calculus)	.16	.75
Up to associate degree (vs high school diploma)	-.12	.61
Bachelor and beyond (vs high school diploma)	.55	.65
Financial aid (vs no financial aid)	1.30	.86
Years of working experience (continuous)	.01	.08
Number of online courses (continuous)	.39	.26
<b>Learning preferences</b>		
Visual learning (continuous)	-.20	.23
Aural learning (continuous)	-.01	.33
Verbal learning (continuous)	-.31	.30
Physical learning (continuous)	-.07	.25
Logical learning (continuous)	-.03	.26
Social learning (continuous)	-.10	.29
Solitary learning (continuous)	-.19	.30
<b>Online environment</b>		
Preference on online (vs face-to-face)	.19	.80
Preference on hybrid (vs face-to-face)	-1.15	1.18
Scheduled sessions (vs non-scheduled sessions)	-.55	.88
Asynchronous (vs synchronous)	-.43	.61
Satisfactory with Online Mathematics Courses (continuous)	-.02	.01

\*  $p < .05$

This table did not contain estimates on relative effects because not one independent variable demonstrated statistically significant absolute effects. Therefore, gains from pretest to posttest did not depend on individual characteristics, learning preferences, and online learning environment. Meanwhile, neither did gains from pretest to posttest depend on satisfaction with online mathematics courses.

## Chapter Five: Discussion and Conclusions

### **Summary of Principal Findings**

The instrument, Satisfaction of Online Learning (SOL), was found to be highly valid and highly reliable. Specifically, both item analysis and scale analysis did not show any abnormal distributional properties of SOL. According to the common comparative practice in confirmatory factor analysis, the eight-factor model represented substantial improvement in model-data-fit over the null model and the one-factor model. Reliability analysis indicated a substantially higher internal consistency across scales and as a whole instrument.

Multiple regression analysis was performed with student satisfaction, with online mathematics courses as the dependent variable, and variables descriptive of individual characteristics, learning preferences, and online learning environment as the independent variables. All of the independent variables were tested for absolute effects and relative effects. Overall, age demonstrated both absolute effects and relative effects and was considered robustly important to student satisfaction. Younger students were more satisfied with online mathematics courses than older students. Pre-calculus/calculus (vs/ below pre-calculus) and visual learning showed absolute effects but not relative effects and were considered unimportant to student satisfaction. All other variables did not show absolute effects on student satisfaction. Therefore, students' satisfaction was related only to their age.

Multiple regression analysis was also performed with posttest scores as the dependent variable, pretest scores as the covariate, and variables descriptive of individual characteristics, learning preferences, online learning environment, and satisfaction with online mathematics courses as the independent variables. None of the independent variables showed absolute effects. Therefore, gains in mathematics knowledge and skills from pretest to posttest in the course were

not related to individual characteristics, learning preferences, and online learning environment. Lastly, gains were not related either to satisfaction with online mathematics courses.

In sum SOL, as an instrument, filled in the significant gap in the research literature for measuring students' satisfaction with online mathematics courses. It now provides a valid and reliable alternative evaluative tool to traditional course evaluation for colleges and universities to determine student satisfaction in their online courses. Although this study attempted to determine the effects of variables descriptive of individual characteristics, learning preferences, and online learning environment on student satisfaction, age was the only significant factor separating student satisfaction. Lastly, this study aimed to examine the relationship between student performance and satisfaction in an online environment. However, gains of students in mathematics knowledge and skills were not related to their satisfaction (as well as individual characteristics, learning preferences, and online environment).

### **Revisiting Research Literature**

The present study took the position that information technology does not bring about a new learning culture independent of pedagogical settings (Blömeke, Muller, & Eichler, 2006; Schulz-Zander, 2005; Tergan, 2003; Vovides, Sanchez-Alonso, Mitropoulou, & Nickmans, 2007). Instead, there is a strong need to describe adequate settings of learning and instruction for all kinds of e-learning (Giest, 2010). The present study attempted to understand the pedagogical settings from three essential aspects (i.e. characteristics of individuals, learning preferences, and online learning environment) that may associate with performance and satisfaction in the online learning of mathematics.

### *Online Environment*

A vehement argument has long been waged, pitting distance education against traditional face-to-face education (Tucker, 2001). There are arguments in the research literature that support the superiority of alternative instructional environments. For example, Kendall (2001) asserts that online courses can achieve learning goals and student satisfaction as much as, if not more than, traditional courses. Some researchers praise hybrid courses for their attempt to integrate the advantages of face-to-face teaching with some of the rewards of web-based, computer-mediated learning, arguing that hybrid courses result in more learning time and less seat time (i.e., students are seated in a classroom) and encourage students to formulate and express their own ideas more than traditional courses for students to improve their performance (see Breton, Taylor & Boulos, 2005; Garnham & Kaleta, 2002). Among students in hybrid, online, and traditional education, those who prefer either online or hybrid instructional environments demonstrate greater confidence in managing a non-traditional environment (e.g., Clayton, Blumberg, & Auld, 2010). After comparing these three different learning environments, Lim et al. (2008) reported that students in the online learning group and the hybrid learning group have statistically significant higher levels of achievement than students in the traditional learning group, and that students in the hybrid learning group also have greater satisfaction levels with their overall learning experience than students in the traditional group.

There are arguments in the research literature that support the no worse off alternative instructional environments. For example, Friday-Stroud, Green, and Hill (2006) found no statistically significant difference in student performance between online classes and traditional classes after examining eight semesters of data (see also Gagne & Shepherd, 2001; Piccoli,

Ahmad, & Ives, 2001). Pucel and Stertz (2005) added that “no statistically significant differences were found between the two versions of each of the courses on the student satisfaction measures” (p. 20) (see also Settle & Settle, 2005). Lim et al. (2008) reported no significant differences in satisfaction of students between the online learning and traditional learning groups. In fact, Cooper (2001) reported that the compilation of the literature comparing traditional classes to online classes indicates no large difference between the two learning environments.

There are also arguments in the research literature that support the inferiority of alternative instructional environments. For example, Fox (1998) argued that the issue at hand is not whether distance education can work but whether it is adequate to merit a university degree, alluding to an argument that a student learns more from a teacher than a textbook (i.e., students learn more when teachers are personally present). Faux and Black-Hughes (2000) found the largest improvement in performance (from pretest to posttest) for students in the traditional face-to-face environment. Students who prefer traditional environment show a stronger mastery goal orientation and greater willingness to apply effort while learning than students who prefer either online or hybrid environment (Clayton et al., 2010).

The present study did not have separate groups in various online environments; instead, preferences for online learning environments were compared in relation to student performance and satisfaction in the online learning of mathematics. In other words, the present study focused on student preferences for online learning environment (i.e., online vs face-to-face, hybrid vs face-to-face). Results of the present study indicated that students who preferred hybrid instructions were as satisfied with their online learning experiences in mathematics as students who preferred traditional instructions (see Table 7). Meanwhile, students who preferred hybrid instructions gained as much in mathematics knowledge and skills in the course as students who

preferred traditional instructions (see Table 7). These conclusions hold true to the comparisons between online instructions and traditional instructions. That is, students who preferred online instructions were as satisfied with their online learning experiences in mathematics as students who preferred traditional instructions, and students who preferred online instructions gained as much in mathematics knowledge and skills in the course as students who preferred traditional instructions (see Table 7). Based on the above findings, this study could not support either superiority or inferiority of both hybrid instructions and online instructions over traditional instructions from the perspectives of student performance and satisfaction in the online environment of learning mathematics. In particular, the pretest and posttest design of the present study added important insights into the research literature because comparisons based on the longitudinal perspective has been rather rare in the research literature.

#### *Individual Characteristics*

The majority of the research on distance education has not compared student learning while controlling for prior knowledge of the learning material and taking other student characteristics into account (Anstine & Skidmore, 2005). Although students in an online course may appear “typical,” there is a great degree of diversity within the online student population (Cheung & Kan, 2002). The limited research literature on individual differences in online learning focuses mainly on age and gender differences. Previous research indicated significant gender differences in performance, attitudes, motivation, and experiences (Ashby, Sadera, & McNary, 2011; Branden & Lambert, 1999; Chen, 1999; Muilenberg & Berge, 2005; Owens, 1998). Previous research also found age to be a significant factor for learning (educational) outcomes in online courses (Ashby et al., 2011; Muilenberg & Berge, 2005; Rekkedal, 1989).

In the present study, age was found to be robustly important to satisfaction with online mathematics courses but unimportant to performance in online mathematics courses. Furthermore, gender differences were not found in either performance or satisfaction concerning the online learning of mathematics. These findings all represent new contributions to the field of online mathematics education. In particular, Thurmond, Wambach, Connors, and Frey (2002) asserted that student satisfaction is influenced by instructional decisions and actions in the online environment but not by student characteristics. The present study suggests that certain individual characteristics (e.g., age) may still have influence on student satisfaction.

### *Learning Preferences*

The research literature on online education contains some information on what learning preferences (styles) fit better to the online learning environment such as active vs reflective, sensing vs intuitive, visual vs verbal, and sequential vs global (Kim & Moore, 2005). Schellens and Valcke (2000) noticed that developers of online courses tend to favor visual, applied, spatial, social, and creative styles of learning. Granted, learning preferences influence students' learning behaviors in the online learning environment (Karuppan, 2001; Sabry & Baldwin, 2003; Terrell, 2002; Terrell & Dringus, 1999). Nevertheless, how learning preferences relate to performance and satisfaction remains an under-researched issue, which partially motivated the present study. There are conflicting results regarding whether learning preferences (styles) relate to academic performance (Fahy & Ally, 2005). Some studies on online learning suggest that students' learning preferences are associated with their course performance (Douzenis, 1999; Sabry & Baldwin, 2003; Terrell, 2002). Meyer (2003) argued that visual learners are more academically successful than aural and kinesthetic learners in an online learning environment (see also Ozbas, 2008 for gender differences in academic performance in an online learning environment that

emphasizes visual learning). On the other hand, Santo (2001, 2006) found no relationship of learning preferences to both course grades and test scores. Nash (2008) joined the debate and argued that learning preferences need to be mapped onto learning activities to obtain improved student learning.

According to Henry (2008), the visual-verbal dimension of students' learning preferences (styles) correlates positively with satisfaction as learners in a hybrid (e-blended) course delivery mode but negatively with satisfaction as learners in a traditional course delivery mode. Overall, however, Kearsley (2000) indicated no relationship between students' learning preferences and their satisfaction with online courses.

The present study provided some further insights into the relationship of learning preferences to performance and satisfaction in the online learning environment. Specifically, learning preferences were related to performance and satisfaction in the online learning of mathematics. Confidence is high in the present study in that satisfaction was measured with a validated instrument and performance was measured in a pretest and posttest design. These features of the present study are rather rare in the research literature. In this sense, the present study has contributed unique insights into the research literature.

#### *Relationship between Performance and Satisfaction*

Currently, the research literature on this issue is very thin from the perspective of online education, even though performance and satisfaction in the online collaborative learning environment are important factors to determine whether an innovative learning approach can be applied in a sustainable way (Zhu, 2012). The assumption of the relationship is well recognized, as Yatrakis and Simon (2002) stated that "it might reasonably be assumed that students reporting higher levels of satisfaction ... should also perform better as measured by course grades" (p. 4).

Inferences can be drawn from some studies indirectly examining the relationship. Although students in the face-to-face format achieve higher on both examination course grades than students in the online format, students' satisfaction do not differ between the two formats (Driscoll et al., 2012). Online students consistently score higher on final exams but lower in satisfaction than traditional students (Rivera & Rice, 2002). Driscoll et al. (2012) noticed that students may report higher satisfaction with courses that they perceive as easy, fun, or less demanding, none of which is necessarily linked to successful learning. These studies seem to suggest a lack of relationship between performance and satisfaction. Yatrakis and Simon (2002) directly rejected the relationship. On the other hand, learner satisfaction is a significant predictor of learning outcomes (Eom, Wen, & Ashill, 2006).

The present study explored the relationship between performance and satisfaction in the online learning of mathematics. Satisfaction was not a significant predictor of performance. Again, confidence is high in the present study due to the fact that satisfaction was measured with a strictly validated instrument and the performance measures came from a rigid pretest and posttest design. These features of the present study are rather uncommon in the research literature, permitting the present study to make unique contributions to the current understanding of the relationship between performance and satisfaction.

### **Theoretical Structure of Student Satisfaction in Online Courses**

The research literature has no systematic account for the theoretical structure of student satisfaction in the online learning environment. Kane, Williams, and Cappuccini (2008) argued that student institutional satisfaction surveys are a valuable source of data for instructional improvement. However, these surveys fail to illustrate conceptually or theoretically what student satisfaction is as a whole. In fact, this vacuum is the motivation of the present study. The strategy

employed to deal with this vacuum is to search for various perspectives of student satisfaction that researchers have addressed and combine them into a comprehensive theoretical structure. The results of this compilation showed that the synthesis of these various perspectives indeed describes the conception and measurement of student satisfaction in a valid and reliable manner.

Specifically, the theoretical structure of student satisfaction with the online learning environment is multi-dimensional. The theoretical structure contains eight critical factors (dimensions) that precisely indicate where students obtain information to develop affective reactions that result in various degrees of satisfaction with their online learning environment, including: effectiveness of the feedback, timeliness of the feedback, use of discussion boards in the classroom, dialogue between instructors and students, perception of online experiences, instructor characteristics, the feeling of a learning community, and computer-mediated communication. As a redrawing of Figure 2 that focuses primarily on measurement properties, Figure 3 is created to attempt to function as a conceptual map for the description of student satisfaction with the online learning environment.

SOL is now an instrument that can accurately help describe and measure student satisfaction in online learning environment. The eight scales (factors) within the instrument can be used individually or as a whole to determine student satisfaction in online courses. Overall, not only is SOL a valid and reliable research tool (as a measurement instrument), but also SOL can provide a valid and reliable alternative to traditional evaluation of online courses for colleges and universities. Finally, Figure 3 as the concept map can serve as a basis for extensions into many other areas of research that deal with online satisfaction (e.g., examination of cultural invariance in satisfaction with the online learning environment).

Figure 3

*Theoretical Structure of Student Satisfaction with Online Learning Environment*



**Tentative (Theoretical) Hypotheses**

Lin and Overbaugh (2007) have provided a good description about both complicity and opportunity regarding the issue of students' satisfaction with their online learning environment:

Factors contributing to “student satisfaction” become more complex when the focus moves from conventional face-to-face classrooms to online teaching/learning environments. However, whether greater student satisfaction results from environmental attributes or from personal preferences toward the learning process remains a viable question. (p. 402)

Based on the results of the present study, tentative hypotheses can be formulated to partially address these comments. Given that much detail about the meanings of these hypotheses has

been proposed in many different places in the previous sections, only formula-like statements are provided here. These hypotheses are tentative because of the limitations of the present study (to be discussed in later sections).

*Tentative Hypothesis One:* Students' satisfaction with their online learning tends to be independent of learning preferences and characteristics of online learning environment and may have very limited correlation with individual characteristics with age emerging as a key factor.

*Tentative Hypothesis Two:* Students' performance in their online learning tends to be independent of individual characteristics, learning preferences, characteristics of online learning environment, and students' satisfaction with their online learning.

All in all, in contrast to prevailing speculations about the merits of online instruction (distance education) (Rovai, Ponton, & Baker 2008; Simonson, Smaldino, Albright, & Zvacek 2009), learning outcomes may only vary as a function of the particular course being taught (Estelami, 2012). The present study hypothesizes that this position may hold true as far as students' performance in and satisfaction with online instruction are considered as learning outcomes.

## **Implications**

### *Instrument Application*

Kane, Williams, and Cappuccini (2008) argue that student institutional satisfaction surveys are a valuable source of data for instructional improvement but little has been used outside their immediate management improvement purposes. Meanwhile, researchers have commonly used a single-item rating scale to assess student satisfaction, but this approach fails to recognize the complexity of students' reactions to educational service (Elliott & Shin, 2009). The SOL that has been validated in the present study can help improve both situations in that SOL

generate specific information on many aspects of student institutional satisfaction. This information can then be easily applied to instruction as well as management of online courses. All of the eight scales within the instrument can be used either individually or collectively to measure student satisfaction for various purposes of instruction and management.

### *Age Factor*

The present study found that older students tended to be less satisfied with online mathematics courses than younger students. As the age factor grows, the SOL score decreases. One way to understand the age effects is to use the final multiple regression model to predict SOL scores for specific ages (holding the other two variables constant in the model). For a 25 year-old person, the SOL score is 76; for a 35 year-old person, the SOL score is 69; and for a 45 year-old person, the SOL score is 61. This finding may serve as a call for instructors to be more attentive to the way that they communicate information to older students in an online classroom.

Moore (1993) suggested that for distance learning to be successful, instructors need to pay attention to three elements of transactional distance theory (dialogue, structure, and learner autonomy) in order to reduce the distance experienced by students. When distance is felt by students in the online course, they tend to feel isolated and may stop participating in the subsequent learning activities. The best way to reduce distance is to structure the course in such a way that all learners (both young and old) can benefit from the material that is presented in the online mathematics course. According to Chao and Davis (2001), there are many facets to the online success of math courses such as paying attention to the design and utilization of effective online pedagogy, maintaining active communication between students and the instructor, encouraging interaction between students in the classroom, and using computer programs like Excel as a way to illustrate statistical concepts in the classroom.

In addition, it is important to identify characteristics of students who feel successful with their online learning experiences so as to provide necessary information for instructors and admission officers to either encourage or discourage a student from registering for an online course (Wojciechowski & Palmer, 1995). The present study, in this sense, is useful to administrators at colleges and universities. Younger students are more likely to be satisfied with taking mathematics courses in the online environment than older students can become a factor to aid decision making.

### *Design Issue*

One of the principal findings of the present study is that student performance and satisfaction in the online learning of mathematics are largely independent of learning preferences and online environment. To some extent, these findings are good news in that the design of an online mathematics course may be made easier because instructors do not need to be too concerned about accommodating different learning preferences and characteristics of online environment. Instead, the focus of effort may be on the effective development and implementation of course materials and learning events (activities). Often times, these learning materials can be of great assistance to students who are learning in the online course. These materials, if well designed, can compensate for the absence of a face-to-face instructor.

Performance and satisfaction with the online learning may rest on the quality of these materials. Bee and Usip (1998) found that students who make use of comprehensive materials (general course information, supplementary materials, and tutorials) improve course performance and increase knowledge of cyberspace than those who do not use these materials (see also Tallent-Runnels et al., 2006). Cooper (1999) provided online resources and course materials in folders for each week of the course and found that online students particularly value timely

course announcements, lecture notes, and chapter questions and answers. Learning activities geared towards the content and the individual learner may effectively create an online environment that provides more individualized instruction to each student (e.g., Navarro & Shoemaker, 1999; Sosin, 1997).

### **Limitations**

Sampling related issues represent the major limitations of the present study. The initial sample size of 259 students was promising, but the three separate data collection procedures (SOL; online survey of individual characteristics, learning preferences, and online environment; mathematics test in pretest and posttest format) seriously produced missing data. As a result, the confirmatory factor analysis was based on 123 students with valid SOL scores. Confirmatory factor analysis based on such a sample size is less ideal (see Shen et al., 2012). Missing data reduced sample size again when it came to answering the second and third research questions. Multiple regression analysis to address the second research question was based on 102 students, and that to address the third research question was based on 68 students. Although the strategy of examining absolute effects individually first is effective and sufficient analytically, results regarding the second and third research questions need to be considered tentative. Due to the limited number of online students that can often be reached in any study, it is suggested that future researchers accumulate data from different semesters to improve the number of student responses (Kuo, 2010).

The use of volunteer sample represents another major limitation. Although the difficulty in obtaining a random sample is adequately realized in educational research, a large number of studies based on volunteer samples need to be conducted for any meaningful synthesis of results across studies. It is suggested that future researchers continue this line of research with various

volunteer samples if random sampling is impractical. Indeed, several researchers have suggested that more research be done to collectively deal with the lack of large random samples concerning online learning (e.g., Ertmer et al., 2007; Kuo, 2010; Richardson, 2005).

The scope of the present study was limited. The part of the online survey that collected information on individual characteristics was not as comprehensive as one would like. For example, Dabbagh (2007) found that intrinsically motivated learners with a positive attitude toward the instructor and a high expectation for grades and degree completion are more likely to succeed in a distance education course. The space limitation prevented the present study from looking into whether students' attitudes and expectations can predict performance and satisfaction in the online learning of mathematics. This issue leaves sufficient opportunities for future researchers.

### **Recommendations for Further Research**

Although some recommendations for further research have been offered in the previous section, more discussion on this line of research may be beneficial. SOL is a valid and reliable instrument, but nevertheless it was developed based on a particular college-level mathematics course (i.e., College Algebra). Therefore, this instrument needs to be validated and even modified within and beyond the area of mathematics education. For example, SOL can be validated for more advanced mathematics courses taught in an online environment; and SOL can also be validated for college science courses. Although it is reasonable based on the review of research literature to expect SOL to be a general measure of satisfaction with any online courses, further validation is necessary.

Because of the tentative nature of the results from multiple regression analyses, there is a need for future researchers to replicate studies concerning the comprehensive relationship among

student performance and satisfaction in online learning of mathematics as well as individual characteristics, learning preferences, and online (learning) environment. Following similar logic, further studies may include different variables that are descriptive of individual characteristics, learning preferences, and online (learning) environment.

Although the present study found that older students were not as satisfied in online mathematics courses as younger students, it is not equipped to investigate the reasons why they are less satisfied. Future research can look into possible reasons. Some research may even focus on older students and their reasons for taking math courses online. As a result, future online courses can be built with more resources and help so that their time in the online environment may become a good experience.

## Appendix A

### Satisfaction of Online Learning instrument

#### Effectiveness of the feedback

1. I am satisfied with my online learning experience because effective feedback related to my class work is constantly provided to me in terms of clarification for my questions about the course (e.g. assignments)

**1 (Strongly Disagree)**      **2 (Disagree)**      **3 (Neutral)**      **4 (Agree)**      **5 (Strongly Agree)**

●                                      ●                                      ●                                      ●                                      ●

2. I am satisfied with my online learning experience because effective feedback related to my class work is constantly provided to me in terms of instruction on how to fix incorrect problems in assignments.

**1 (Strongly Disagree)**      **2 (Disagree)**      **3 (Neutral)**      **4 (Agree)**      **5 (Strongly Agree)**

●                                      ●                                      ●                                      ●                                      ●

3. I am satisfied with my online learning experience because effective feedback related to my class work is constantly provided to me in terms of sufficient explanations on my specific questions related to my class work

**1 (Strongly Disagree)**      **2 (Disagree)**      **3 (Neutral)**      **4 (Agree)**      **5 (Strongly Agree)**

●                                      ●                                      ●                                      ●                                      ●

#### Timeliness of the feedback

4. I am satisfied with my online learning experience because timely feedback related to my class work is constantly provided to me so that I am able to complete my assignments efficiently

**1 (Strongly Disagree)**      **2 (Disagree)**      **3 (Neutral)**      **4 (Agree)**      **5 (Strongly Agree)**

●                                      ●                                      ●                                      ●                                      ●

5. I am satisfied with my online learning experience because timely feedback related to my class work is constantly provided to me so that I am able to improve my assignments for better grades

**1 (Strongly Disagree)**      **2 (Disagree)**      **3 (Neutral)**      **4 (Agree)**      **5 (Strongly Agree)**

●                                      ●                                      ●                                      ●                                      ●

6. I am satisfied with my online learning experience because timely feedback related to my class work is constantly provided to me so that I am more focused on learning

<b>1 (Strongly Disagree)</b>	<b>2 (Disagree)</b>	<b>3 (Neutral)</b>	<b>4 (Agree)</b>	<b>5 (Strongly Agree)</b>
●	●	●	●	●

### Use of Discussion Boards

7. I am satisfied with my online learning experience because discussion boards make me more comfortable in participating than traditional modes of discussion

<b>1 (Strongly Disagree)</b>	<b>2 (Disagree)</b>	<b>3 (Neutral)</b>	<b>4 (Agree)</b>	<b>5 (Strongly Agree)</b>
●	●	●	●	●

8. I am satisfied with my online learning experience because asynchronous discussions (where I can post my discussions at any time of the day) are more convenient to my schedule than traditional discussions

<b>1 (Strongly Disagree)</b>	<b>2 (Disagree)</b>	<b>3 (Neutral)</b>	<b>4 (Agree)</b>	<b>5 (Strongly Agree)</b>
●	●	●	●	●

9. I am satisfied with my online learning experience because I have plenty of time to think and draft my responses for online discussions

<b>1 (Strongly Disagree)</b>	<b>2 (Disagree)</b>	<b>3 (Neutral)</b>	<b>4 (Agree)</b>	<b>5 (Strongly Agree)</b>
●	●	●	●	●

### Dialogue between instructors and students

10. I am satisfied with my online learning experience because I am able to communicate effectively with my instructor throughout the semester

<b>1 (Strongly Disagree)</b>	<b>2 (Disagree)</b>	<b>3 (Neutral)</b>	<b>4 (Agree)</b>	<b>5 (Strongly Agree)</b>
●	●	●	●	●

11. I am satisfied with my online learning experience because online dialogue with my instructor helps me as I learn in the online course

**1 (Strongly Disagree)**      **2 (Disagree)**      **3 (Neutral)**      **4 (Agree)**      **5 (Strongly Agree)**  
●                                      ●                                      ●                                      ●                                      ●

12. I am satisfied with my online learning experience because I feel less distant in my online learning due to online dialogue with my instructor

**1 (Strongly Disagree)**      **2 (Disagree)**      **3 (Neutral)**      **4 (Agree)**      **5 (Strongly Agree)**  
●                                      ●                                      ●                                      ●                                      ●

**Perceptions of online experiences**

13. I am satisfied with my online learning experience because my personal needs as a student are met in the online environment

**1 (Strongly Disagree)**      **2 (Disagree)**      **3 (Neutral)**      **4 (Agree)**      **5 (Strongly Agree)**  
●                                      ●                                      ●                                      ●                                      ●

14. I am satisfied with my online learning experience because many aspects (features) of online education are enjoyable to me as a learner

**1 (Strongly Disagree)**      **2 (Disagree)**      **3 (Neutral)**      **4 (Agree)**      **5 (Strongly Agree)**  
●                                      ●                                      ●                                      ●                                      ●

15. I am satisfied with my online learning experience because overall, I would rather take online courses than traditional courses

**1 (Strongly Disagree)**      **2 (Disagree)**      **3 (Neutral)**      **4 (Agree)**      **5 (Strongly Agree)**  
●                                      ●                                      ●                                      ●                                      ●

**Instructor characteristics**

16. I am satisfied with my online learning experience because I still get the same explanation from online instructors as I do from traditional instructors

**1 (Strongly Disagree)**      **2 (Disagree)**      **3 (Neutral)**      **4 (Agree)**      **5 (Strongly Agree)**  
●                                      ●                                      ●                                      ●                                      ●

17. I am satisfied with my online learning experience because online instructors and traditional instructors offer the same amount of help with my learning issues

<b>1 (Strongly Disagree)</b>	<b>2 (Disagree)</b>	<b>3 (Neutral)</b>	<b>4 (Agree)</b>	<b>5 (Strongly Agree)</b>
●	●	●	●	●

18. I am satisfied with my online learning experience because technology makes online instructors more creative in teaching than a more traditional classroom

<b>1 (Strongly Disagree)</b>	<b>2 (Disagree)</b>	<b>3 (Neutral)</b>	<b>4 (Agree)</b>	<b>5 (Strongly Agree)</b>
●	●	●	●	●

**The feel of a learning community**

19. I am satisfied with my online learning experience because the online environment is like a community where I can communicate with other students

<b>1 (Strongly Disagree)</b>	<b>2 (Disagree)</b>	<b>3 (Neutral)</b>	<b>4 (Agree)</b>	<b>5 (Strongly Agree)</b>
●	●	●	●	●

20. I am satisfied with my online learning experience because the online environment promotes sufficient sharing and caring among students

<b>1 (Strongly Disagree)</b>	<b>2 (Disagree)</b>	<b>3 (Neutral)</b>	<b>4 (Agree)</b>	<b>5 (Strongly Agree)</b>
●	●	●	●	●

21. I am satisfied with my online learning experience because the online environment is a safe place where I can be confident in completing group work with other students in the class

<b>1 (Strongly Disagree)</b>	<b>2 (Disagree)</b>	<b>3 (Neutral)</b>	<b>4 (Agree)</b>	<b>5 (Strongly Agree)</b>
●	●	●	●	●

### Computer-mediated communication

22. I am satisfied with my online learning experience because computer-mediated communication makes me feel like a real person when I communicate in the online environment

**1 (Strongly Disagree)**      **2 (Disagree)**      **3 (Neutral)**      **4 (Agree)**      **5 (Strongly Agree)**  
●                                      ●                                      ●                                      ●                                      ●

23. I am satisfied with my online learning experience because computer-mediated communication makes it easier to form meaningful relationships among students in the online environment

**1 (Strongly Disagree)**      **2 (Disagree)**      **3 (Neutral)**      **4 (Agree)**      **5 (Strongly Agree)**  
●                                      ●                                      ●                                      ●                                      ●

24. I am satisfied with my online learning experience because computer-mediated communication allows me to feel the presence of my instructor and other students in the online environment

**1 (Strongly Disagree)**      **2 (Disagree)**      **3 (Neutral)**      **4 (Agree)**      **5 (Strongly Agree)**  
●                                      ●                                      ●                                      ●                                      ●

## Appendix B

### Demographic Survey

#### *Student Characteristics*

1. What is your age? Specify: \_\_\_\_\_
2. Gender:
  - A. \_\_\_\_\_ Female
  - B. \_\_\_\_\_ Male
3. Ethnicity:
  - A. \_\_\_\_\_ Black/African American
  - B. \_\_\_\_\_ Hispanic/Latin American
  - C. \_\_\_\_\_ Others
  - D. \_\_\_\_\_ White (Non-Hispanic)
4. Geographic Location
  - A. \_\_\_\_\_ Inside the United States
  - B. \_\_\_\_\_ Outside the United States
5. What is the highest mathematics course that you successfully completed in high school?
  - A. \_\_\_\_\_ Algebra
  - B. \_\_\_\_\_ Calculus
  - C. \_\_\_\_\_ Geometry
  - D. \_\_\_\_\_ Pre-Calculus/Trigonometry
6. How many online courses have you taken? Specify: \_\_\_\_\_
7. How do you learn best? (1 for most preferred and 7 for least preferred)
  - A. \_\_\_\_\_ Visual (learn through the use of pictures and images)
  - B. \_\_\_\_\_ Aural (learn through the use of sound and music)
  - C. \_\_\_\_\_ Verbal (learn through the use of words)
  - D. \_\_\_\_\_ Physical (learn through body, hands, and sense of touch)
  - E. \_\_\_\_\_ Logical (learn through logic and reasoning)
  - F. \_\_\_\_\_ Social (learn through working with groups or other people)
  - G. \_\_\_\_\_ Solitary (learn through working alone)
8. How many years have you been employed at your job? Specify: \_\_\_\_\_

9. What is your highest educational achievement?

- A. \_\_\_\_\_ High School Diploma
- B. \_\_\_\_\_ Taken 0-30 college credits
- C. \_\_\_\_\_ Taken 30-60 college credits
- D. \_\_\_\_\_ Associate's degree
- E. \_\_\_\_\_ Bachelor's degree
- F. \_\_\_\_\_ Master's degree
- G. \_\_\_\_\_ Beyond a Master's degree

10. What is your preference on taking college courses?

- A. \_\_\_\_\_ Traditional (face-to-face) courses
- B. \_\_\_\_\_ Online courses
- C. \_\_\_\_\_ Hybrid courses

11. Are you receiving needs-based financial aid?

- A. \_\_\_\_\_ Yes
- B. \_\_\_\_\_ No

*Characteristics of Online Environment*

12. How long is a class session for this course? Specify: \_\_\_\_\_

13. What time of day does your class meet?

- A. \_\_\_\_\_ Morning
- B. \_\_\_\_\_ Afternoon
- C. \_\_\_\_\_ Evening
- D. \_\_\_\_\_ No scheduled class sessions

14. What technique is used for delivery?

- A. \_\_\_\_\_ Asynchronous method (no face-to-face communication online)
- B. \_\_\_\_\_ Synchronous method (face-to-face communication online)

## Appendix C

### PreTest/PostTest

1. Multiply.

$$(-7) \times (-8)$$

- 56
- 56
- 15
- 15

2. Solve.

At the beginning of the summer, Jon was 60.3 inches tall. By the end of the summer, he had grown 1.6 inches. What was his height at the end of the summer?

- 76.3 inches
- 60.9 inches
- 61.9 inches
- 62.0 inches

3. Add and simplify.

$$\frac{3}{5} + \frac{1}{10}$$

- $\frac{7}{10}$
- $\frac{7}{5}$
- $\frac{2}{5}$
- $\frac{4}{15}$

4. Solve.

Midtown Antiques has found that sales have decreased 3% from last year. Sales this year are \$164,916. Find the amount of last year's sales. Round your answer to the nearest dollar.

- \$169,916
- \$170,006
- \$171,016
- \$170,016

5. Add.

$$83 + (-99)$$

- 16
- 182
- 16
- 182

6. Subtract.

$$-8 - (-15)$$

- 23
- 8
- 7
- 7

\*

7. Divide.

$$-135 / (-9)$$

- Divide.  $-135 / (-9) = 5$
- 1/15
- 15
- 15

\*

8. Solve.

$$5x + 35 = 10x + 12$$

- Solve.  $5x + 35 = 10x + 12 \Rightarrow x = 4.6$
- 1.4
- 1.4
- 4.6

\*

9. Solve.

Assume that simple interest is being calculated in each case. Round your answer to the nearest cent.

John forgot to pay his \$423 income tax on time. The IRS charged a penalty of 19% interest for the 72 days the money was late. Find the penalty that was paid. (Use a 365 day year.)

- \$438.85
- \$15.63
- \$15.85

- \$4.40

10. Solve.

Anthony wanted to buy a particular kind of cheese. He checked in five different stores and found the following prices per pound: \$6.20, \$5.50, \$6.25, \$5.80, \$5.00.

What was the mean price per pound?

- \$6.20
- \$5.80
- \$5.75
- \$5.85

11. Subtract.

$$(6y + 16) - (-2y + 11)$$

- $13y$
- $-8y - 5$
- $8y + 27$
- $8y + 5$

12. Add.

$$(6x + 3) + (-2x + 4)$$

- $4x + 7$
- $9x + 2$
- $8x + 7$
- $11x$

13. Solve.

A boat travels 3 mi south and then 10 mi south. How far is the boat from its starting point?

A = 3 mi.

B = 10 mi

(Use the Pythagorean Theorem)

- Square root of 19
- Square root of 13
- Square root of 109
- Square root of 139

14. Multiply.

$$(2x + 10)(x - 12)$$

- $2x^2 - 38x - 120$
- $x^2 - 14x - 38$
- $x^2 - 120x - 14$
- $2x^2 - 14x - 120$

15. Use a proportion to solve this problem.

The ratio of the height to the width of a packaging label is 5 to 19. If the height of the label is 2 inches, what is the width?

- 7 inches
- 7.6 inches
- 21 inches
- 0.5 inches

16. Combine like terms.

$$(7 \frac{1}{16})t - (3 \frac{1}{2})t$$

- $3 \frac{9}{16}t$
- $3 \frac{15}{16}t$
- $3 \frac{3}{8}t$
- $3 \frac{3}{4}t$

17. Simplify.

$$11 - |9 - 11| \times 6$$

- 131
- 23
- 1
- 109

18. Solve.

The total price (including sales tax) of a VCR is \$539.32. The sales tax rate is 2%. What is the purchase price of the VCR (the price before taxes are added)? Round your answer to the nearest cent.

- \$528.75
- \$449.43
- \$533.98
- \$523.61

19. Solve.

$$45 = -9x + 9$$

- 49
- 14
- 4
- 45

20. Multiply.

$$12y(11y - 10)$$

- $12y^2$
- $132y^2 - 10y$
- $132y^2 - 120y$
- $11y^2 - 120y$

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