A CAUSAL COMPARATIVE ANALYSIS OF MATHEMATICS SELF-EFFICACY OF FACE-TO-FACE AND ONLINE QUANTITATIVE LITERACY STUDENTS

by

LaRonda Lowery

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Education

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ABSTRACT

Mathematics self-efficacy has been shown to be a strong predictor of mathematics performance and mixed results have been found when examining the mathematics self-efficacy of face-to-face students based on gender and age. However, there is a lack of research studies that examine if differences exist in the mathematics self-efficacy of face-to-face and online students. The purpose of this ex-post facto causal comparative quantitative study was to determine if differences existed in the mathematics self-efficacy of Quantitative Literacy students, as measured by the Mathematics Self-Efficacy Scale, based on their choice of delivery method (face-to-face or online). Participants for this research study were comprised of select face-to-face and online Quantitative Literacy students at seven North Carolina community colleges. Data were examined using a one-way multivariate analyses of variance (MANOVA) and a statistically significant difference was found in the mathematics task self-efficacy and math-related school subjects' self-efficacy of students who enrolled in a face-to-face or online Quantitative Literacy course. Online Quantitative Literacy students possessed both a higher mathematics task self-efficacy and math-related school subjects' self-efficacy. Additional data analyses revealed no statistically significant differences in the mathematics self-efficacy of Quantitative Literacy students based on gender and method of placement (high school multiple measures, placement test scores, and developmental mathematics course completion).

Keywords: Self-efficacy, mathematics self-efficacy, quantitative literacy, online education

Dedication

This dissertation is dedicated to my parents and my children. To my parents, thank you for always believing in me and supporting me in everything that I do. You instilled in me early on in life the value of education and for that, I am thankful. To my children, Cole and Abigail, know that sometimes in life you must step out of your comfort zone to achieve your dreams. The fear of writing a dissertation kept me from pursing my dreams for a long time. Taking that leap of faith and facing that fear head on, has given me a refreshed outlook on life.

Acknowledgments

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To my family, a lot happened during this four year educational journey. Along with Jamie and I welcoming Abigail into the world making us a family of four, we also faced our first deployment. Whether right by my side or thousands of miles away, Jamie has always encouraged, supported, and believed in me. While Jamie has been deployed, my "village" helped me balance being a single mom with work and school. I would not be where I am today without my family.

Throughout this journey, the scripture verse that kept me pressing on was Jeremiah 29:11, "For I know the plans I have for you", declares the Lord, "plans to prosper you and not to harm you, plans to give you hope and a future". As I reflect on my life and look to the future, I am confident that God has great plans for me.

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List of Abbreviations

Achieving the Dream (AtD)

American Association of Community Colleges (AACC)

American Graduation Initiative (AGI)

High School Multiple Measures (HS MM)

Institutional Review Board (IRB)

Mathematics Self-Efficacy Scale (MSES)

National Center for Education Statistics (NCES)

North Carolina Community College System (NCCCS)

North Carolina Diagnostic Assessment and Placement (NC DAP)

Southern Association of Colleges and Schools Commission on Colleges (SACSCOC)

CHAPTER ONE: INTRODUCTION

Overview

For many community college students, what should be a gateway to achieving their academic goals and successfully completing their Quantitative literacy math course, has become a gatekeeper. Students' mathematical aptitude contributes to academic progression as most students are required to successfully complete a college level mathematics course as part of their general education requirements (Bragg, 2011). This research study addressed a gap in the literature by examining the mathematics task self-efficacy and math-related school subjects' self-efficacy of both face-to-face and online Quantitative literacy students. Chapter One outlines the background of the research study, problem statement, purpose statement, significance of study, research questions, and definitions.

Background

Most community colleges have an open door policy (Rao, 2004) and are tasked with preparing students to enter the workforce or transfer to a four-year university. In 2009, President Obama, through the American Graduation Initiative (AGI), called for 5 million additional community college graduates by the year 2020 (American Association of Community Colleges, 2017a). Since 2010, the American Association of Community Colleges (AACC) reported that enrollment in community colleges has slightly decreased as improving economic conditions provided employment opportunities for students (Juszkiewicz, 2016). Along with facing declining enrollment, community colleges also struggle with dismal graduation rates. For instance, the graduation rate at two-year public institutions for a 2012 cohort was approximately 22% (National Center for Education Statistics, 2016). In order for most students to graduate from a two-year public institution, they are required to successfully complete a gateway mathematics course. Achieving the Dream (AtD;Clery, 2011) data indicate that for the three years examined, 72% of students did not enroll in their required gateway mathematics course and of those who attempted their gateway mathematics course (28%), 9% did so three times or more.

While many factors contribute to the low graduation rate at two-year public institutions, many students' inability to pass their required gateway mathematics course is one of the reasons for non-completion. Wang, Wang, Wickersham, Sun, and Chan (2017) posited that a relationship exists between successful completion of mathematics requirements and graduation. Mathematic students may enter the classroom with preconceived notions and beliefs regarding their mathematical ability. An individual's perceived ability to accurately solve mathematical problems and successfully complete math-related college-level courses is what Betz and Hackett (1993) refer to as mathematics self-efficacy. Research studies have confirmed a positive correlation between mathematics self-efficacy and mathematical performance (Ayotolah & Adejdeji, 2009; Azar & Mahmoudi, 2014; Pajares & Kranzler, 1995) as students with high mathematics self-efficacy expectations have higher achievement scores in mathematics courses (Peters, 2012; Usher, 2009). Conversely, low mathematics self-efficacy expectations contribute significantly to students' inability to succeed in a mathematics course (Pajaras & Miller, 1994; Peters, 2012; Siegle & McCoach, 2007). Thus, for degree completion, students not only need to enroll in their required gateway mathematics course, they must successfully complete it.

Along with establishing a relationship between mathematics self-efficacy and mathematical performance, researchers have examined the differences in mathematics self-efficacy as it relates to gender and age. Numerous research studies have concluded that males self-report a higher mathematics self-efficacy than females (Baxter, Bates, & Al-Bataineh, 2017; Betz & Hackett, 1983; Cordero, Porter, Israel, & Brown, 2010; Junge & Dretzke, 1995; Pajares

& Miller; 1994; Peters, 2012); conversely, research from Hall and Ponton (2005) found no statistically significant difference in mathematics self-efficacy based on gender. As it relates to age, Jameson and Fusco (2014) stated that traditional students reported a higher level of mathematics self-efficacy when compared to their non-traditional counterparts.

Research regarding mathematics self-efficacy has been limited to students in the face-to-face learning environment (Baxter et al., 2017; Hall & Ponton, 2005; Jameson & Fusco, 2014), while most community colleges offer gateway mathematics courses utilizing both face-to-face and online delivery methods. While the overall enrollment for community colleges has decreased nearly 10% from 2013 to 2016, (American Association of Community Colleges, 2017b), online course enrollment continues to increase (Community College Research Center, 2013). From fall 2014 to fall 2015, two-year public institutions have experienced a 2.4% decrease in enrollment (American Association of Community Colleges, 2016); whereas, since 2010, online college courses have experienced a 29% increase in enrollment (Community College Research Center, 2013). The National Center for Education Statistics (NCES,2015) noted that 7.4 million undergraduate students took at least one distance education course during the 2011-2012 academic school year. The terms distance education and online education are often used interchangeably in the literature. For this research study, the term online education will be utilized.

As online course enrollment increases, researchers have attempted to determine if equity in learning exists for students enrolled in face-to-face and online courses (Jones & Long, 2013; Nelson, 2006; Xu & Jaggars, 2011). While online students are perceived to be more academically prepared than their face-to-face peers (Xu & Jaggars, 2011), attrition rates are generally higher in online courses (Nelson, 2006; Xu & Jaggars, 2011). Methods used for calculating success rates for online and face-to-face courses varies from institution to institution given that some schools exclude dropouts from the overall data (Ashby, Sadera, & McNary, 2011). With this inconsistency of calculating success rates, researchers have found mixed results when comparing the success rates of face-to-face and online students.

The theoretical framework for the current study is Bandura's (1997) theory of self-efficacy. Self-efficacy, defined as an individual's belief that he/she can successfully perform a given task (Bandura, 1997), can be a predictor of students' academic achievement (Komarraju & Nadler, 2013). Students with a high self-efficacy will embrace a challenge and strive to persist (Bandura, 1986; Ertmer & Schunk, 1997), which are characteristics needed in order to be successful academically. In constructing self-efficacy, Bandura insists there are four principal sources of information: enactive mastery experiences, vicarious experiences, verbal persuasion, and physiological and affective states. Of the four principal sources of information, enactive mastery experiences are the most influential. One's previous experiences have the potential to significantly alter future choices. The mind is a powerful tool, as one's perceptions often becomes one's reality. If community colleges hope to increase graduation rates, determining the mathematics self-efficacy of face-to-face and online mathematics students is an appropriate starting point.

Problem Statement

Although President Obama called for five million additional community college graduates by 2020 (American Association of Community Colleges, 2017a), data reveal that the enrollment for community colleges continues to decrease (American Association of Community Colleges, 2016). Along with decreasing enrollment, NCES (2016) data indicated that approximately 22% of public two-year institution students graduate with a certificate or associates' degree within 150% of normal time. While many factors are attributed to the dismal graduation rates at two-year institutions, the required mathematics course for some students' degree program has become a gatekeeper instead of a gateway to college success. With Achieving the Dream data indicating 72% of students did not enroll in their gateway mathematics course (Clery, 2011), Waller (2006) suggested that a lack of self-efficacy is the reason many students fail to enroll in their required mathematics course. If students perceive they will not be successful in a mathematics course, they may delay enrollment in the course. Wang et al. (2017) insisted, "If college-level math requirements are fulfilled in a timely fashion, students are on a promising trajectory toward timely completion of their educational programs at 2-year colleges" (p. 100). Failure to enroll in or successfully complete the required gateway mathematics course hinders students from reaching their academic goals.

As gateway mathematics courses are offered in a variety of delivery methods (face-to-face, online, and hybrid), researchers have examined the mathematics self-efficacy of face-to-face students and examined if differences exist in the mathematics self-efficacy of students based on gender and age. The problem is that while researchers have examined the mathematics self-efficacy of face-to-face students, research is lacking that examines the mathematics self-efficacy of online students. Such research is imperative as online course enrollments continue to increase (Community College Research Center, 2013) even as the enrollment in community colleges decreases (Juszkiewicz, 2016).

Purpose Statement

The purpose of this quantitative, ex-post facto causal comparative study was to determine if there is a statistically significant difference in the mathematics task self-efficacy and math-related school subjects' self-efficacy of North Carolina community college Quantitative Literacy students who enroll in a face-to-face course versus an online course. Given some of the courses selected for this study were hybrid courses, for the purpose of this study, face-to-face courses were defined as courses in which no more than 40% of the content was delivered online. Online courses were defined as courses in which at least 80% of the course content was delivered online (Allen, Seaman, Poulin, & Straut, 2016). Mathematics task self-efficacy is an individual's confidence in his/her ability to effectively solve math problems, and math-related school subjects' self-efficacy is an individual's confidence in his/her ability to obtain a final grade of B or higher in a math-related or math course (Betz & Hackett, 1993).

Significance of the Study

The main goal of this study was to determine if significant differences exist in the mathematics self-efficacy of students who enroll in a face-to-face or online Quantitative Literacy course. There is a positive correlation between high mathematics self-efficacy and mathematical performance (Ayotolah & Adejdeji, 2009; Azar & Mahmoudi, 2014; Pajares & Kranzler, 1995), and if students are successful in a college-level mathematics course, they are more likely to reach their academic goals (Wang et al., 2017). Determining if a significant difference exists in the mathematics self-efficacy of face-to-face versus online students could aid college educators in utilizing best practices to create a learning environment that effectively improves the self-efficacy of students. In addition, some states have adopted a community college funding model that is predicated on a specific set of performance measures or indicators that focus on student success and progression; therefore, if students can experience success in their gateway mathematics courses, colleges can improve overall graduation rates and thereby receive additional funding.

As a gateway mathematics course, success in the Quantitative Literacy course factors into

North Carolina Community College System's Performance Measures. Quantitative Literacy is a three credit, four contact hour gateway mathematics course offered at all community colleges in North Carolina. The North Carolina Community College System (NCCCS) utilizes a common course library, which includes a course description, number of credit hours, contact hours, and student learning outcomes for every course offered. The course description for the Quantitative Literacy course is:

> This course is designed to engage students in complex and realistic situations involving the mathematical phenomena of quantity, change and relationship, and uncertainty through project- and activity-based assessment. Emphasis is placed on authentic contexts which will introduce the concepts of numeracy, proportional reasoning, dimensional analysis, rates of growth, personal finance, consumer statistics, practical probabilities, and mathematics for citizenship. Upon completion, students should be able to utilize quantitative information as consumers and to make personal, professional, and civic decisions by decoding, interpreting, using, and communicating quantitative information found in modern media and encountered in everyday life. (NC Community Colleges, 2017, para. 1)

Students are placed in the Quantitative Literacy course offered at each community college in North Carolina via three placement measures: (a) completion of required developmental modules, (b) meeting the multiple measures for placement criteria, and (c) appropriate North Carolina Diagnostic Assessment and Placement (NC DAP) scores.

In North Carolina, community colleges are measured partly based on the "percentage of first-time Associate Degree seeking and transfer pathway students passing a credit-bearing math course with a "C" or better within their first two academic years" (NC Community Colleges, 2016, p. 7). According to fall 2013 cohort data, system-wide, only about 28% of first-time associate degree seeking and transfer pathway students passed a gateway mathematics course within their first two academic years. Data retrieved from the NCCCS indicate that percentages from the 58 North Carolina community colleges range from as low as 9% to as high as 47%. These data confirm that a large number of students either never enroll in their gateway mathematics course or fail to be successful once enrolled.

North Carolina is not the only state in which community colleges are partially funded based on performance metrics. For Texas community colleges, 10% of state funding is based on student achievement on specific performance metrics and attainment of vital educational milestones (McKinney & Hagedorn, 2017). One of the intermediate performance metrics for Texas community colleges focuses on successful completion of a college-level mathematics course. In Massachusetts, 50% of each community college's funding allocation is tied to performance (Salomon-Fernandez, 2014), with one of the variables used in the performance funding formula being student progress and success. With student success in gateway mathematics courses tied to funding, college administrators and educators should focus on these courses to ensure that these courses are a gateway to overall academic success and not a hindrance.

Research Questions

The research questions for this study are:

RQ1: Is there a difference in mathematics task self-efficacy and math-related school subjects' self-efficacy, as measured by the Mathematics Self-Efficacy Scale, between students enrolled in a face-to-face or online Quantitative Literacy course?

RQ2: Is there a difference in mathematics self-efficacy, as measured by the Mathematics Self-Efficacy Scale, between male and female Quantitative Literacy students?

RQ3: Is there a difference in mathematics self-efficacy, as measured by the Mathematics Self-Efficacy Scale, of Quantitative Literacy students based on method of placement (high school multiple measures, placement test scores, or completion of developmental mathematics courses)?

Definitions

1. *Achieving the Dream (AtD)* – Achieving the Dream is a nongovernmental reform movement aimed at improving success for community college students by assisting colleges in making data-driven decisions (Mayer et al., 2014).
2. *Community college* – A community college is a postsecondary institution that (a) prepares students to transfer to a 4 -year institution, (b) provides skills and workforce development training, and (c) offers noncredit programs (American Association of Community Colleges, 2017c).
3. *Face-to-face courses* – Courses in which 29% or less of the content is delivered online are considered face-to-face courses. Face-to-face courses include traditional, web facilitated, and blended/hybrid courses (Allen et al., 2016).
4. *Gatekeeper mathematics course* – The first college-level mathematics course taken by students for their program of study is a gatekeeper mathematics course (Xu & Jaggars, 2011).
5. *Graduation rate* – Colleges compute the graduation rate as the percentage of first-time full-time degree/certificate seeking students who complete within 150% of normal

completion time (Ginder et al., 2017). For community college students, first-time full-time students completing their degree within three years are considered graduates.

6. *Mathematics self-efficacy* – Mathematics self-efficacy is one's confidence concerning one's ability to successfully perform various mathematics-related behaviors or tasks (Betz & Hackett, 1993).
7. *Mathematics Self-Efficacy Scale (MSES)* – The MSES is an instrument used to measure college students' mathematics self-efficacy. Consisting of two subscales (Mathematics Task subscale and Mathematics Courses subscale), students rate their level of confidence regarding their perceived ability to perform various mathematical tasks (Betz & Hackett, 1993).
8. *Mathematics task self-efficacy* – Mathematics task self-efficacy is one's confidence concerning one's ability to successfully solve mathematics problems. (Betz & Hackett, 1993).
9. *Math-related school subjects' self-efficacy* – Math-related school subjects' self-efficacy is one's confidence in achieving a final course grade of a B or higher in a math or math-related course (Betz & Hackett, 1993).
10. *Multiple measures* – Multiple measure policies allow colleges to use a combination of measures such as high school GPA, standardized test scores, and previous math courses taken in order to accurately place students in college level courses (Ngo & Kwon, 2015).
11. *Non-traditional students* – Using age only as a classification, students 25 and older are considered non-traditional students (Jameson & Fusco, 2014).
12. *Online courses* – Courses in which at least 80% of the content is delivered online are considered online courses (Allen et al., 2016).

13. Performance-based funding – Performance-based funding is a system "based on allocating a portion of a state's higher education budget according to specific performance measures such as course completion, credit attainment, and degree completion, instead of allocating funding based entirely on enrollment" (Miao, 2012, p. 1).

14. *Quantitative literacy* – Quantitative literacy is the "inclination and ability to make reasoned decisions using general world knowledge and fundamental mathematics in authentic, everyday circumstances" (Wiest, Higgins, & Frost, 2007, p. 48).

15. *Self-efficacy* – Self-efficacy can be defined as the perception of an individual's ability to "organize and execute the courses of action required to produce given attainments" (Bandura, 1997, p. 3).

16. *Traditional students* – Using age only as a classification, students below the age of 25 are considered traditional students (Jameson & Fusco, 2014).

CHAPTER TWO: LITERATURE REVIEW

Overview

This chapter reviews the literature related to the mathematics self-efficacy of students, the success and attrition rates of face-to-face and online courses, and the importance of graduates possessing quantitative literacy skills. Researchers have examined the mathematics self-efficacy of face-to-face students, but no research was discovered that measured the mathematics self-efficacy of students enrolled in online courses. With more educational institutions requiring a quantitative literacy course as a gateway mathematics course (Joselow, 2016; NC Community Colleges, 2017), research regarding self-efficacy of these students will add to the current body of knowledge regarding mathematics self-efficacy of college students. This chapter explores existing theoretical and empirical literature related to: (a) self-efficacy, (b) Dweck's theories of intelligence, (c) mathematics self-efficacy, (d) face-to-face and online education, (e) community college students, and (f) the importance of quantitative literacy.

Theoretical Framework

For most postsecondary academic majors, it is imperative that students have a strong mathematics foundation. Azar and Mahmoudi (2014) insisted that being mathematically literate is considered to be a factor for personal and professional success. Mathematics is also considered a major factor in students' choice of college major and attainment of college degree (Hall & Ponton, 2005). If students are unable to successfully complete their gateway mathematics course, then they are unable to obtain a college degree. Bandura (1997) posited that individuals' self-efficacy is a determinant to their level of perseverance for completing a specific task, how much effort they will expend toward the task, and whether the task will even be attempted. Rattan et al. (2015) contended, "The psychology of the student is key to academic achievement" (p. 724). If students fail to persist, then they also fail to achieve their academic goals.

Self-Efficacy

Bandura (1977) was the first to introduce the construct of self-efficacy. According to Bandura's (1997) social cognitive theory, individuals' self-efficacy beliefs determine choices made, effort exerted, and persistence level when obstacles arise. When individuals are successful in completing a particular task, their confidence in accomplishing similar tasks increases; conversely, when individuals are unsuccessful in accomplishing a particular task, their confidence diminishes (Usher & Pajares, 2008). In the educational arena, self-efficacy is a predictor of students' academic achievement (Komarraju & Nadler, 2013) and students' choices for college major and career (Lent, Ireland, Penn, Morris, & Sappington, 2017).

Bandura (1997) defined perceived self-efficacy as a judgment of one's ability to "organize and execute the courses of action required to produce given attainments" (p. 3). Individuals with high levels of self-efficacy work harder, persevere when faced with obstacles, and achieve at a higher level than those with low self-efficacy (Bandura, 1986; Ertmer & Schunk, 1997). Margolis and McCabe (2006) insisted that individuals with low-self efficacy often create negative self-fulfilling prophecies. Low self-efficacy expectations regarding a particular task or behavior may lead to avoidance behaviors and thus impede academic achievements.

When constructing self-efficacy beliefs, Bandura (1997) insisted there are four principal sources of information: enactive mastery experiences, vicarious experiences, verbal persuasion, and physiological and affective states. Enactive mastery experiences, the most prominent source of self-efficacy, provides realistic evidence as to one's capabilities. Experiencing success can strengthen one's self-efficacy while experiencing failure usually weakens it. While experiencing success is important, individuals can learn from their failures. Bandura insisted that obstacles provide opportunities for individuals to exercise control over events and turn failure into success. Individuals learn how to persevere in the face of adversity when they believe they have the capability to be successful. Failures will not greatly affect one's self-efficacy beliefs once a strong sense of self-efficacy has been established (Bandura, 1977). If students consistently perform well in math courses, then they may believe this mathematical ability will continue in the future.

The second way of constructing self-efficacy beliefs is through vicarious experiences. As individuals see their peers overcoming obstacles and experiencing success, they, too, feel confident in their ability to emulate that same success (Bandura, 1997). Not all activities have a concrete measure of proficiency; thus, instances occur in which individuals must assess their capabilities in relation to others' accomplishments. Students often look to their peers who model the abilities they wish to attain. Students then gauge their capabilities based on the capability of their peers. Depending on the comparisons, a student's self-efficacy may increase or decrease.

Verbal persuasion, the third source of self-efficacy, is used to encourage and persuade individuals that they possess the ability to successfully perform specific tasks. Individuals who receive encouragement from their peers are more likely to persevere than if their peers convey doubts about their ability (Bandura, 1997). Students may look to their parents, teachers, and peers to offer encouragement regarding their mathematical ability, and this praise could boost their mathematical self-efficacy. Teachers can capitalize on this source of self-efficacy if they continuously express their confidence in a student succeeding at a particular task and then follow up with substantive task-specific feedback (Margolis & McCabe, 2006).

The final source of self-efficacy is physiological and affective reactions. Individuals often gauge their emotional arousal in situations and the reaction can play a role in one's perceived ability (Bandura, 1997). Bandura (1986) insisted that "Perceived self-inefficacy leads people to approach intimidating situations anxiously, and experience of disruptive levels of arousal may further lower their sense that they will be able to perform well" (pp. 364-365). Negative emotions, such as anxiety and fear, usually hinder performance, while experiencing a comforting feeling elicits positive beliefs that can strengthen one's self-efficacy.

The terms self-esteem and perceived self-efficacy, are often used interchangeably although they represent two entirely different things (Bandura, 1997). Perceived self-efficacy focuses on an individual's perception of his/her personal capabilities, whereas self-esteem focuses on an individual's perception of his/her self-worth. Bandura (1997) suggested, "Individuals may judge themselves hopelessly inefficacious in a given activity without suffering any loss of self-esteem whatsoever, because they do not invest their self-worth in that activity" (p. 11). Students may doubt their ability to perform certain mathematical procedures while at the same time possess a high level of self-worth.

Just as self-efficacy can predict students' academic achievement (Komarraju & Nadler, 2013), there is also a relationship between mathematical performance and mathematics self-efficacy (Ayotolah & Adedeji, 2009; Azar & Mahmoudi, 2014; Hackett, 1985). While most research testing the theory of self-efficacy and mathematics self-efficacy involves face-to-face students (Hall & Ponton, 2005; Jameson & Fusco, 2014; Komarraju & Nadler, 2013; Peters, 2012), additional research is needed to determine the mathematics self-efficacy beliefs of online students.

Related Literature

Mathematics students, whether face-to-face or online, may enter the college classroom with varied beliefs regarding their academic ability and possess either a fixed or a growth mindset. The mindset embodied may promote or hinder their ability to be successful. Students who personify a fixed mindset feel that the intelligence they possess cannot be altered. Dweck (2000) referred to this fixed mindset as an entity theory of intelligence. Students who exemplify a growth mindset, or an incremental theory of intelligence, believe their intelligence can be developed and cultivated over time (Rattan, Savani, Chugh, & Dweck, 2015). Just as Bandura's (1977) self-efficacy theory focuses on perceptions and beliefs, Dweck's (2000) theories of intelligence and Betz and Hackett's (1993) self-efficacy expectations regarding mathematics reiterate the effect one's perceptions and beliefs have on academic performance.

Dweck's Theories of Intelligence

Students differ in how they approach academic situations and how they perceive themselves in an academic setting (Robins & Pals, 2002). In the classroom, students may personify either an entity theory of intelligence (fixed mindset) or incremental theory of intelligence (growth mindset). Students with an entity theory of intelligence value performance over learning and are discouraged with poor grades, while students with an incremental theory of intelligence relish a challenge and attribute their successes to hard work (Robins & Pals, 2002). Furthermore, students with a growth mindset have a desire to learn and respond to challenges by being persistent, and students with a fixed mindset strive to look smart but have the tendency to give up when faced with adversity (Yeager & Dweck, 2012). Yeager and Dweck insisted that students' mindsets can be altered. Paunesku et al. (2015) conducted a study of 1,594 students to determine if academic-mindset interventions (growth-mindset and sense-of-purpose) could positively influence academic outcomes. Of the 1,594 students in the study, the researchers labeled 519 as at-risk students. At-risk students were defined as students who had a "baseline first-semester GPA of 2.0 or less or failed at least one core academic course" (Paunesku et al., 2015, p. 5). Data analysis revealed the intervention-group at-risk students were significantly more likely to earn satisfactory grades in core academic classes after the intervention (M = .49) compared with the control-group at-risk students (M = .41), odds ratio (OR) = 1.58, Z = 2.68, p = .007. Altering the mindset of students has the potential to positively impact academic outcomes.

Mathematics Self-Efficacy

When entering the college classroom, students may bring varied expectations and beliefs regarding their academic ability, as some students have been unsuccessful in previous mathematics courses while others have not taken a mathematics course in several years. Hall and Ponton (2005) contended that "Exposure to mathematics with positive outcomes increases mathematics self-efficacy, whereas exposure to mathematics with negative outcomes decreases self-efficacy, provided the positive outcomes are attributed to increase in personal capability and/or effort by the student" (p. 28). The operational definition of mathematics self-efficacy includes perceptions of mathematical ability as it relates to solving math problems, performing everyday tasks that involve mathematics and successfully completing math-related collegiate coursework (Betz & Hackett, 1993). Researchers have (a) examined the relationship between mathematics self-efficacy and math performance, (b) examined if differences exist in the mathematics self-efficacy expectations of males and females, and (c) examined if differences exist in the mathematics self-efficacy expectations of students based on age.

Mathematics self-efficacy and mathematical achievement. Students attribute their lack of success in mathematics to a variety of factors. Students with an external locus of control believe that events occur in their lives due to chance, fate, or even luck, while students who personify an internal locus of control believe that the events that occur in their lives are a result of their own actions (Rotter, 1966). While students often attribute poor mathematical performance to parochial issues outside of their control such as instructor, instructional style, relevancy of course content to subsequent mathematics courses, and attendance (Wheland, Konet, & Butler, 2003), one's self-efficacy is a major factor in predicting mathematics performance (Stevens, Olivarez, Lan, & Tallent-Runnels, 2004). Research indicates that students with high mathematics self-efficacy achieve higher in mathematics classes (Peters, 2012; Usher, 2009), confirming the relationship between mathematics self-efficacy and mathematics performance (Ayotolah & Adedeji, 2009; Azar & Mahmoudi, 2014; Hackett, 1985). When examining the relationship between mathematics self-efficacy, attitude, anxiety and achievement in a statistics course, Azar and Mahmoudi (2014) found that mathematics self-efficacy had a direct, positive, and significant effect on statistics scores (direct effect = 0.37, p = 0.001).

Usher (2009) conducted a qualitative study that investigated the "rules of heuristics that students with high and low self-efficacy use to select and interpret information related to their mathematics self-efficacy" (p. 307). Interview data revealed high levels of achievement from students reporting high levels of mathematics self-efficacy and low performance from students with low self-efficacy. When compared to math anxiety and gender, mathematics self-efficacy is a stronger predictor of math performance (Pajares & Kranzler, 1995). Students' lack of success in mathematics can be attributed to low mathematics self-efficacy (Hackett, 1985; Pajares & Miller, 1994; Siegle & McCoach, 2007), thus if students' mathematics self-efficacy increases, so does their mathematical achievement, as students' mathematics self-efficacy is significantly related to mathematical achievement (γ_{10} = .08, t =3.36, p = 0.005;Peters, 2012).

Although research regarding the mathematics self-efficacy of students has been well documented (Ayotolah & Adedeji; 2009; Azar & Mahmoudi, 2014; Hackett, 1985; Pajares & Kranzler, 1995; Peters, 2012; Siegle & McCoach, 2007; Usher, 2009), there is a limited amount of research studies that investigate methods to improve students' mathematics self-efficacy (Cordero, Porter, Israel, & Brown, 2010). Cordero et al. conducted an experimental quantitative research study to compare two interventions (Performance-Accomplishment, Performance-Accomplishment plus Belief Perseverance) to increase the mathematics self-efficacy of college students. All research participants were asked to solve 18 math problems and after self-scoring the problems, were told that a passing score was correctly answering 12 out of 18. After determining if a passing score was achieved, the experimental group was then given a prompt and asked to complete a belief perseverance activity and write a justification outlining their suitability for pursuing a mathematical or science focused career. The control group was asked to write a justification for their aptness to be the winner of a travel scholarship. One-way analysis of covariance (ANCOVA) results indicated that when compared to the control group, the experimental group had statistically significantly higher mathematics self-efficacy, $F(1,95)$ = 8.82, p < .05, partial η^2 = 0.09. Research findings suggest that utilizing belief perseverance activities can increase the self-reported mathematics self-efficacy of college students.

When relying on students to self-report their perceived mathematics self-efficacy, they may be overconfident in their perceived ability to perform mathematical tasks. Research indicates that students' self-reported mathematics self-efficacy does not match actual mathematical capabilities (Pajares & Kranzler, 1995; Pajares & Miller, 1994). In a quantitative study of 329 high school students, Pajares and Kranzler (1995) utilized path analysis and determined that after completing the Mathematics Confidence Scale (MCS) and then working 18 problems that corresponded to the type of problems in which their confidence was measured by the MCS, 86% of the students overestimated their performance. Pajaras and Miller's (1994) research study focused on undergraduate students, and while college students overestimated performance by an average of 1.91 problems, high school students overestimated performance by an average of 5.5 problems (Pajares & Kranzler, 1995).

Mathematics self-efficacy and gender. Initial research on mathematics self-efficacy centered on the relationship between mathematics self-efficacy and college majors and career choices (Betz & Hackett, 1983; Hackett, 1985; Lent, Lopez, & Bieschke, 1991). Research studies indicate that although numerous courses assist students in achieving their academic goal of attaining a college degree, mathematics is critical to students' choices in determining college majors and ultimately to success in attaining a college degree (Betz & Hackett, 1983; Moreno & Muller, 1999). Hackett and Betz (1981) first applied the concept of self-efficacy expectations to career development of women. Using the Mathematics Self-Efficacy Scale with three subscales (Math Tasks, College Courses, and Math Problems), Betz and Hackett (1983) found that male self-efficacy expectations ($M = 6.7$, $SD = 1.2$) were significantly higher than female mathematics self-efficacy expectations ($M = 6.2$, $SD = 1.0$) on the total Mathematics Self-Efficacy scale, $t = -3.4$, $p < .001$. On the Math Tasks subscale, females only scored higher on the items that related to stereotypically female activities, (i.e., cooking and sewing). Overall, males tended to have a greater confidence in their mathematical ability and higher mathematics self-efficacy on all three subscales (Math Tasks, College Courses, and Math Problems). Further research is needed to determine if females only score higher on the MSES items related to stereotypical female activities.

Additional researchers (Baxter et al., 2017; Cordero et al., 2010; Junge & Dretzke, 1995; Pajares & Miller, 1994; Peters, 2012) confirmed the findings that males self-report higher mathematics self-efficacy expectations. Even when measuring the mathematics self-efficacy of gifted and talented high school students, males showed higher mathematics self-efficacy than females on over 25% of the items reported (Junge & Dretzke, 1995). Using a one-way ANOVA with random effects model, statistically significant differences were discovered in mathematics self-efficacy (γ_{10}=-11.65, t = -2.57, p = 0.022) that favored males (Peters, 2012). Males scored nearly 12 points higher in self-efficacy than females. Similarly, Cordero et al. (2010) found a significant difference between females' and males' mathematics self-efficacy, with females reporting significantly lower mathematics self-efficacy (M = 6.77, SD = 1.30) than males (M = 7.43, SD = 1.04), $t(97)$ = - 2.733, $p < .017$.

Baxter, Bates, and Al-Bataineh (2017) examined 240 Intermediate Algebra students in a midwestern four-year public university and found a statistically significant difference between the mathematics self-efficacy expectations for females (n = 158) and males (n = 70). Three Intermediate Algebra students failed to indicate their gender. An independent samples t-test was conducted and male students self-reported a higher level of mathematics self-efficacy (M = 5.977, SD = 1.174) than female students (M = 5.243, SD = 1.272), t = 4.293, p = .000. Lent, Lopez, and Bieschke (1991) contended, "The effects of gender on self-efficacy are mediated by differential efficacy-building experiences for the two sexes, particularly differences in past performance" (p. 428). When interpreting the mean scores for male and female Intermediate Algebra students, utilizing the Approximate Percentile Equivalents for Math Self-Efficacy

Scores chart provided by Betz and Hackett (1993), males and females ranked in the 30-40th percentile. Hall and Ponton (2005) also examined the mathematics self-efficacy of male and female Intermediate Algebra students, and male students fell into the 20-30th percentile, while females fell into the 30-40th percentile.

Contrary to the vast number of research studies that indicated a self-reported higher self-efficacy in males, Hall and Ponton (2005) examined freshman Calculus I and Intermediate Algebra students (N = 185) in a medium-sized, rural university in the Southeast and found that a statistically significant difference did not exist among female (n = 100) and male (n = 85) students. Results of independent t-tests showed no significant difference in the mathematics self-efficacy of Intermediate Algebra students (t = .254, p = .800) nor Calculus 1 students (t =.337, p = .737) based on gender. Given these conflicting findings in the literature, further research is needed that focuses on the mathematics self-efficacy of students based on gender.

Mathematics self-efficacy and age. While differences in mathematics self-efficacy based on gender have been investigated (Hall & Ponton, 2005; Peter, 2012), research examining the differences in mathematics self-efficacy based on age (traditional and nontraditional students) is limited. According to Jameson and Fusco (2014), nontraditional students, defined as students 25 or older, often report a lower level of mathematics self-efficacy when compared to traditional students. Nontraditional students scored significantly lower on the math self-efficacy measure (M = 29.38, SD = 0.61) than those classified as traditional students (M = 32.87, SD = 1.04), $F(1,213) = 8.34$, p =.003, η^2_p =0.05. Jameson and Fusco (2014) further disaggregated the data and divided the students into three groups: traditional age with traditional characteristics, traditional age with nontraditional characteristics, and nontraditional age with nontraditional characteristics. Nontraditional characteristics include, but are not limited to, delaying enrollment into a postsecondary institution, attends school part time, works full time, is a single parent and/or does not have a high school diploma (Ekowo & Walizer, 2015). ANOVA data analysis results revealed that nontraditional age participants with nontraditional characteristics scored significantly lower on the math self-efficacy measure (M = 27.16, SD = 9.6) than both traditional age participants with traditional (M = 32.87, SD = 7.02) and nontraditional characteristics (M = 30.12, SD = 7.06), $F(2, 217) = 6.95$, $p = .001$, $n^2_p = 0.061$. These data suggest that older students who have responsibilities outside of school personify a lower level of mathematics self-efficacy, which could then affect their academic performance.

While Baxter et al. (2017) failed to have enough participants to display statistical significance when examining the differences in the mathematics self-efficacy of nontraditional (n = 24) and traditional students (n = 207), independent t-tests were still conducted. Although data analysis revealed that nontraditional students (M = 5.832, SD = 1.4270) scored higher on the MSES when compared to their traditional peers (M = 5.494, SD = 1.286), no statistically significant difference existed between the groups. Additional research is needed to determine if a statistical difference exists in the mathematics self-efficacy of students based solely on age or if nontraditional characteristics contribute to the perceived difference.

Face-to-Face and Online Education

With overall community college enrollment decreasing (American Association of Community Colleges, 2016), enrollment in online courses continues to increase at a steady pace (Community College Research Center, 2013). Technological advancements have made it possible to provide more students with access to online courses and in an attempt to reconcile budget issues, education institutions view online courses as a cost-effective method to manage rising enrollments (Driscoll, Jicha, Hunt, Tichavsky, & Thompson, 2012). Parsad and Lewis

(2008) reported that for the 2006-2007 academic year, 92% of Title IV 2-year public institutions offered at least one online, hybrid/blended, or other distance education course. When determining the best learning environment (face-to-face or online), students' self-efficacy beliefs may play a major role. Xu and Jaggars (2011) suggested that when compared to their underprepared counterparts, academically superior students are more likely to choose the online learning environment.

Although it is believed that students who enroll in online courses are stronger academically than their peers enrolled in traditional face-to-face courses, research studies have produced conflicting results when comparing the learning equity of face-to-face and online students (Atchely, Wingenbach, & Akers, 2013; Huston & Minton, 2016; Jones & Long, 2013; Nelson, 2006; Xu & Jaggars, 2011). Some research suggested that when comparing student performance in face-to-face and online courses, face-to-face courses produced superior outcomes (Atchely et al., 2013; Huston & Minton, 2016; Xu & Jaggars, 2011), while other studies suggested that no statistically significant difference existed in the course success rates of face-to-face and online courses (Fonolahi, Khann, & Jokhan, 2014; Jones & Long, 2013). Additionally, some researchers contend that online students outperform their face-to-face counterparts (Ashby et al., 2011; Shachar & Neumann, 2003). For the current research study, online courses will be defined as courses in which at least 80% of course content is delivered online and for face-to-face courses, less than 30% of the content is delivered online (Allen et al., 2016).

A limitation to the academic achievement data provided by institutions is that the calculation of course completion rates vary by institutions (Carr, 2000). Atchley, Wingenbach, and Akers (2013) insisted, "Some universities included students who dropped during the drop/add period while other universities did not report those instances" (p. 106). Furthermore, Ashby, Sadera, and McNary (2011) argued that the superior delivery method depended on whether or not dropouts were included in the course success data. The lack of a standard rule for calculating course completion rates make it difficult to accurately compare groups of students across educational institutions.

Face-to-face delivery method superior. As online course enrollment rates continue to outpace overall community college enrollment rates, learning equity and equality have become a major concern (Huston & Minton, 2016). Several studies have shown statistically significant differences in student performance based on delivery type, with face-to-face students outperforming online students (Amro, Mundy, & Kupczynski, 2015; Atchley, Wingenbach, &Akers, 2013; Huston & Minton, 2016; Sohn & Romal, 2015; Xu & Jaggars, 2011, 2014). For gateway mathematics courses, Xu and Jaggars (2011) found that for students who completed the course, the success rate (final course grade of C or higher) for online students was 67% compared to 73% for face-to-face students. Similar results were found with gateway English courses, as 77% of face-to-face students earned a C or higher compared to 74% of the online students (Xu & Jaggars, 2011). These data suggest that for gateway courses, students are more successful in the face-to-face learning environment.

Huston and Minton (2016) conducted a quantitative study of 173 sections of Intermediate Algebra to determine if a statistically significant difference existed in course completion rates based on term/semester and delivery method. Huston and Minton (2016) utilized the same measure to define course completion as Xu and Jaggars (2011) utilized to define course success. A final course grade of C or higher was deemed success although it is uncertain whether students who dropped the course were included in Huston and Minston's (2016) data set, as information regarding attrition rates was not provided in the research study. The researchers found a statistically significant difference in the course completion rate between the face-to-face and online sections (F(1,167) = 12.982, p = .000), with face-to-face sections (M = 0.564, SD = 0.180) having a higher course success rate than the online sections (M = 0.436, SD = 0.118).

In an ex post facto design, Brown (2012) found little variation in students' averages when comparing land-based and web-based undergraduate and graduate students. While the web-based courses were more popular, land-based undergraduate students had an average .37 points higher than web-based undergraduate students and land-based graduate students had an average 1.32 points higher than web-based graduate students.

Even while controlling for demographic characteristics (gender and ethnicity), Amro, Mundy, and Kupczynski (2015) confirmed the previous studies findings regarding face-to-face students outperforming online students. Originally, age was considered a covariate but was dropped due to method and age lacking homogeneity. Using archival data in a causal-comparative research design, Amro et al. (2015) examined the effects of demographic characteristics on college algebra face-to-face and online final course grades. Demographic data indicated that for both groups, the majority of the students were Hispanic. A one-way analysis of covariance (ANCOVA) was conducted and results revealed that face-to-face students (M = 2.98, SD = 1.46) had a statistically higher overall average grade when compared to online students (M = 2.20, SD = 1.42), F (1, 8230) = 127.55, p = .00, η^2 = 0.02. The only significant interaction was between delivery method and age, F (1, 8226) = 4.86, p = 0.003, η^2 = 0.00. When focusing on those students who failed the course with a grade of F or W, 53.5% failed in the online learning environment compared to 27.5% in the face-to-face learning environment. Since this research study involved predominantly Hispanic students, further research is needed to determine if demographic characteristics account for the difference in academic achievement in face-to-face and online courses.

Additionally, Driscoll, Jicha, Hunt, Tichavsky, and Thompson (2012) conducted a quasi-experimental study to determine if a statically significant difference existed in the performance on a course exam between online (*n* = 170) and face-to-face (*n* = 198) students. The same instructor taught all sections, both face-to-face and online, of the course over three consecutive semesters in 2010. Driscoll et al. (2012) found that face-to-face students (*M* = 81.88, *SD* = 7.565) outperformed online students (*M* = 78.94, *SD* = 10.346). Further analysis revealed that students enrolled in the face-to-face courses (*M* = 4.75, *SD* = 1.044) generally had higher grade point averages (GPA) than those students enrolled in online courses (*M* = 4.37, *SD* = 1.084). This implies that students who choose to enroll in face-to-face courses are academically stronger than online students and thus perform better in the course. Once the researchers controlled for GPA, the effect was disregarded. Driscoll et al., (2012) insisted that the presence of academically stronger students in the face-to-face courses creates the appearance that the face-to-face delivery method is superior to the online learning environment, which contradicts Xu and Jaggars (2011) assertion that online students are more academically prepared than their face-to-face counterparts. Data indicated that delivery method (face-to-face or online) accounts for approximately 1.7 percent of the variation in student performance, while student GPA accounts for about 13 percent. When examining the differences in the learning outcomes of face-to-face and online students, previous academic factors such as GPA, credit hours taken, and previous online experience should be considered. Stronger academic performance may stem from previous academic factors and not necessarily the delivery method.

Low mathematics self-efficacy may also be one possible explanation for the research findings. Spence and Usher (2007) claimed that students' lower performance in the online learning environment could be linked to their lower mathematics self-efficacy. Also, Xu and Jaggars (2011) argued that the instructional strategies currently utilized in gateway online courses may not be as effective as the instructional strategies utilized in face-to-face courses at 2-year educational institutions.

Online delivery method superior. While the vast number of research studies indicate that face-to-face students outperform online students (Amro et al., 2015; Atchley et al., 2013; Huston & Minton, 2016; Xu & Jaggars, 2011, 2014) or that no statistically significant difference exists in the academic performance of face-to-face and online students (Fonolahi et al., 2014; Jones & Long, 2013), fewer research studies contend that online students outperform their face-to-face counterparts (Ashby et al., 2011; Shachar & Neumann, 2003). When examining the differences between learning environments (face-to-face, blended, and online), Ashby et al. (2011) found that for students who completed the course, face-to-face students performed the lowest with 63% of students receiving a passing grade. Sixty-nine percent of the students in the blended courses and 85% of the online students received a passing grade; thus a statistically significant difference exists between the three learning environments, $\chi^2(2, N = 134) = 6.669$; $p = 0.04$. The online students outperformed the students in the face-to-face and blended sections only when the students who had dropped the course were excluded. Ashby et al. (2011) contended that this difference exists due to the higher attrition rates in the online and blended courses. Wolff, Wood-Kustanowitz, and Ashkenazi (2014) argued that in order to boost the success rates in online courses, students with poor academic skills should be discouraged from enrolling in an online course. To aid in the self-selection process of choosing a particular delivery method, college administrators could require students to meet certain requirements prior to enrolling in an online course.

Using a meta-analytic approach, Schachar and Neumann (2003) integrated the results from 86 experimental and quasi-experimental studies to determine if the quality of learning outcomes was equitable between delivery methods (face-to-face or online) based on final course grades. The studies used for this meta-analysis were conducted during the 1990-2002 timeframe. The overall effect size from the 86 studies was 0.366 with a significant Chi-square of 397.55, indicating that online students had higher final academic performance grades than their face-to-face counterparts. Online students can perform as well, and sometimes even better, than face-to-face students.

No statistically significant difference exists. As colleges increase the number of online course offerings to meet the enrollment demand, college administrators and educators may anticipate that online courses will be as effective or more effective than face-to-face courses. Multiple research studies that contend that either the online or the face-to-face delivery method is superior (Amro et al., 2015; Ashby et al, 2011; Atchley et al., 2013; Huston & Minton, 2016; Shachar & Neumann, 2003; Xu & Jaggars, 2011, 2014). Other research studies conclude that no statistically significant difference exists in the success rates of students enrolled in online and face-to face courses (Fonolahi et al., 2014; Jones & Long, 2013), suggesting that equivalence in learning is possible when utilizing final course grades as the measure of success. In a quantitative study conducted by Fonolahi, Khann, and Jokhan (2014), data were acquired for face-to-face classes from 2006-2009 and for online classes from 2010-2013. Classes were not simultaneously offered in both the online and face-to-face format since once a course was offered in the online format, the face-to-face course was phased out. Data collected for classwork, final exam, and total marks failed to pass the assumption of normality test, thus the Mann-Whitney U non-parametric test was performed. Data analysis revealed no statistically significant difference (U = 173800.5, p = 0.884) in the overall performance of students between the two delivery methods. Although no statistically significant difference was found regarding overall performance, 15% of online students did not take the final exam, compared to 3.9% of the face-to-face students (Fonolahi et al., 2014). This research study also supports the research that suggests when compared to face-to-face courses, the attrition rates are higher for online courses (Ashby et al., 2011; Nelson, 2006; Zavarella & Ignash, 2009).

Furthermore, in a quantitative study conducted by Jones and Long (2013), final course grades were collected for the face-to-face and online sections of Quantitative Business Analysis I, a course similar to business mathematics, from fall 2005 to spring 2011. Originally, data analysis revealed a statistically significant difference existed between the mean course grade in the online (M = 73.546, SD = 14.254) and face-to-face (M = 78.655, SD = 16.271) courses (t(443) = 3.341, p = 0.001). Given the number of outliers in the data set and the large spread of the data, further investigation revealed the need to remove the first three semesters of the original data set. After the removal of the first three semesters of final course grade data, the Mann-Whitney U test indicated that no statistically significant difference existed between the mean course grade in the online and face-to-face courses (U = 9350.5, p = .000). The research findings regarding which delivery method produces superior learning outcomes are important as educational institutions strive to meet the needs of the ever-increasing population of students enrolling in online courses.

Attrition rates. When determining the superior learning environment (face-to-face or online) along with course success rate calculations, researchers often calculate course retention and attrition rates. Attrition rates denote the percentage of students who withdrew from the course, while retention rates signify the percentage of students who remained enrolled for the duration of the course (Nelson, 2006). Craig and Ward (2008) insisted that retaining students is a longstanding problem for community colleges as college-wide retention rates are often lower due to their open-door policies. Hyllegard, Deng, and Hunter (2008) suggested that community college students are often juggling their academic work along with family responsibilities and Engstrom and Tinto (2008) referred to the community colleges' open door policy as a revolving door for underprepared students. Researchers have found that attrition rates are often disconcertingly higher in online courses when compared to face-to-face courses (Fonolahi et al., 2014; Nelson, 2006; Zavarella & Ignash, 2009). In a causal comparative research study, when analyzing the course retention rates between face-to-face and online courses at Delaware Technical and Community College, Terry Campus, Nelson (2006) found that only 77% of the students completed the online courses, compared to 81% who completed the face-to-face courses.

Zavarella and Ignash (2009) further confirmed Nelson's (2006) findings when conducting a non-experimental quantitative study that examined if a relationship existed between students' learning styles and their withdrawal from a mathematics course by delivery method (lecture-based, hybrid, or distance learning). Data analysis revealed that students enrolled in the online courses had a higher attrition rate (39%) than those students enrolled in the lecture-based face-to-face course (20%). The researcher attempted to contact the students who withdrew from each course and of the students who withdrew from the online course ($n = 22$); 11 students stated that the course presented unexpected challenges (Zavarella & Ignash, 2009).

Additionally, for gatekeeper mathematics courses, Xu and Jaggars (2011) found that the mid-semester attrition rate for online courses was 25%, compared to 12% for face-to-face courses. Depending on the time in which a student withdraws from a course, GPA may not be affected but the withdrawal negatively impacts academic progression (Craig & Ward, 2008). Along with examining retention and attrition rates of face-to-face and online courses, additional research is needed to determine why students withdraw from online courses at a higher rate.

The difference in attrition and retention rates of face-to-face and online students may come from factors other than the chosen method of delivery. In a mixed-methods research study of Borough of Manhattan Community College (BMCC) students, Hyllegard et al. (2008) identified factors that may explain why students withdraw from an online course. In the fall of 2003, BMCC had 728 online students and the attrition rate for online courses was 26% compared to a 12% attrition rate for the same courses taught face-to-face. Hyllegard et al. (2008) noted that when compared to the overall student population at BMCC, online students were older, were majority female, had accrued more credit hours, had higher GPAs, and were required to complete developmental courses. For students who officially withdrew from the course, survey results indicated that 61% withdrew due to personal problems or insufficient time available to devote to the online course, citing that the course(s) required more reading and writing than expected (Hyllegard et al., 2008). For those students who unofficially withdrew (final course grade treated as an F), personal problems and lack of time were also cited as the reasons for failing to complete the course. Almost 40% cited the uneasiness of the online course format as the reason for non-completion. For the students who officially and unofficially withdrew from a course, although they failed to successfully complete the course in the online format, 60% stated they would enroll in another online course in the future at BMCC. This research suggests that online students lead busy lives and problems occur during the semester, which forces them to withdraw from an online course. This withdrawal does not always deter them from enrolling in future online courses.

Choosing a delivery method. Just as students withdraw from courses for varied reasons, students have a plethora of reasons for choosing a particular course delivery method. In a research study that focused on the effectiveness of taking a gateway English or mathematics course online, Xu and Jaggars (2011) noted that when compared to face-to-face students, online students were "older students, women, career-technical students, White students, English-fluent students, and students with lower credit loads in the current semester" (p. 368). Numerous research studies have compared the learning equity in face-to-face and online courses (Atchely, Wingenback, & Ackers, 2013; Huston & Minton, 2016; Jones & Long, 2013; Nelson, 2006; Xu & Jaggars, 2011), but research is lacking that examines why students choose or avoid a particular delivery method. As online enrollment continues to increase (Community College Research Center, 2013), Jaggars (2014) insists that in order to continuously increase online course offerings, college administrators must strive to understand why students choose a particular delivery method. Also, if a vast number of research studies indicate that there is no statistically significant difference in the learning outcomes of face-to-face and online students, can the successful face-to-face student also be a successful online student? O'Neill and Sai (2014) argued that:

> Since students who drop a course do not take final exams, it is reasonable to suspect that the discrepancy between the dropout rates of online and face-to-face courses may be distorting the findings of studies comparing learning outcomes between the two course modalities. (p. 3)

When choosing online courses, students insist that convenience and flexibility are key factors (Braun, 2008; Jaggars, 2014; Powell & Keen, 2006; Willging & Johnson, 2009) and contend that online courses require students to be more disciplined and active in the learning process (Public Agenda, 2013). Powell and Keen (2006) insisted that some college students choose the online learning environment, not attempting to substitute for "The Real Thing," but because of the convenience (p. 292). In a qualitative study drawn from the data collected at two Virginia community colleges, Jaggars (2014) found that 80% of the students reported that they decided to enroll in online courses because they were employed and 20% reported having transportation issues. Along with convenience and flexibility, students felt online courses allowed them to efficiently utilize their time, as both the instructor and other students often used in-class time inefficiently (Jaggars, 2014). Brown (2012) found that when students provided a reason for choosing an online course, the most frequent response was the idea that the course would be easier. Conversely, while some students felt an online course would be easier than the face-to-face version, some researchers contend that when compared to their face-to-face counterparts, students who enroll in online courses appear to have higher levels of motivation and academic ability (Rovai, Ponton, Wighting, & Baker, 2007; Xu & Jaggars, 2011).

Just as students have a plethora of reasons as to why they choose the online learning environment, students in Jaggars' (2014) study reported two overall reasons to take courses in the face-to-face learning environment: (a) the need to sustain a meaningful connection with their peers and the physical campus community, and (b) the importance of fostering a strong student-instructor relationship. For some college students the student-student and student-teacher interaction is important. Jaggars (2014) posited, "Unless a college works to systematically cultivate strong levels of instructor presence and guidance into its online courses, its students' demand for online learning may soon level off" (p. 35). Students may long for student-student and student-teacher interactions and if the online learning environment fails to foster those interactions, students will continue to prefer enrollment in face-to-face courses.

While online courses may provide some students with an opportunity to earn a degree that otherwise would not be an option, some courses are better suited for the face-to-face learning environment. Offering online courses may eliminate some of the barriers students face with furthering their education, yet the online learning environment introduces additional barriers for some students (Jost, Rude-Parkins, & Githens, 2012). The data analyzed by Jaggars (2014) indicate that students assert that certain courses (i.e., laboratory science and foreign language courses) were not suited for the online learning environment. Also, students realized the need to take more academically challenging courses face-to-face and courses they felt were less challenging, in which they could teach themselves, could be taken in the online learning environment. Successful online students understand the need to be active participants in the learning process, thus assuming a greater responsibility for their learning (Jaggars, 2014; Public Agenda, 2013).

Community Colleges

Community colleges serve a vital role in our nation as individuals realize the need to further their education beyond high school (Zeidenberg, 2008). Both Bailey (2004) and Zeidenberg (2008) insist that community colleges serve as the entry point for about half of U.S. undergraduate students. For fall 2013, the American Association of Community Colleges (2015) asserted that approximately 7.4 million students attended 2-year institutions. Due to the open door policy, community colleges face a variety of challenges as they strive to educate students who are often times underprepared for the level of rigor expected in the college classroom (Liao, Edlin, & Ferdenzi, 2014) along with managing the financial pressures associated with a lack of adequate funding (Zeidenberg, 2008). Given the influx of underprepared students, many may be required to complete remedial courses prior to enrolling in college-level curriculum courses. Chen (2016) suggested that among 2003-2004 postsecondary students, 68% of public 2-year institution students enrolled in at least one remedial course between 2003 and 2009. During the same timeframe, nearly 50% of incoming students at public 2-year institutions took more than one remedial course and 26% took remedial courses in multiple courses such as English, reading, and/or math.

Along with some students being underprepared when entering college, Bailey (2004) insisted that when compared to 4-year university students, community college students are:

> More likely to come from households with lower incomes, to be from a minority population, to be first-generation college students, to be older than the average college student, to have children, to delay enrollment after high school, to have had a less rigorous high school curriculum, and to have lower achievement in high school. They are also more likely to have non-traditional enrollment patters, such as attending part-time, working while enrolled, or interrupting their schooling. (p. 1)

As it relates to delaying enrollment, Craig and Ward (2008) found that the length of time between graduating from high school and enrolling in college was significantly related to student retention at the community college level. Given the unique characteristics of community college students, college administrators may need to investigate best practices to effectively educate this population of students.

Quantitative Literacy

Quantitative literacy has been defined in various ways (National Council on Education and the Disciplines, 2001; Wiest et al., 2007). Individuals are inundated with numbers in almost every facet of their lives whether it is dealing with finances, social media, or politics. Todd and Wagram (2015) defined quantitative literacy as the ability to understand how numbers are used and how data are analyzed in real life situations. Wilkins (2000) defined quantitative literacy as:

> An everyday understanding of mathematics. More explicitly, quantitative literacy includes a knowledge of mathematical content embedded in a contextual framework that promotes understanding and appreciation of the nature, development, and social impact of its applications. Furthermore, it includes a capacity for reasoning and utility and is further supported by a feeling that one is able to function in a quantitative situation. (p. 406)

Overall, quantitative literacy is more about the conceptual and contextual understanding of numbers, not just deriving the answer.

Numerous higher educational institutions note the importance of students possessing quantitative literacy skills (Bressound, 2009; Steele & Kilic-Bahi, 2010; Todd & Wagram, 2015). Tunstall et al. (2016) argued that all college graduates should possess quantitative literacy skills that are adequate to meet the needs of society. Wiest, Higgins, and Frost (2007) asserted, “Being quantitatively literate is particularly important in today’s Information Age, where technological advances have yielded a plethora of data—of widely varying credibility—that is available to the average citizen through, for example, personal computers and Internet access” (p. 49). As community colleges strive to prepare students for the workforce or to transfer to a 4-year university, it is imperative for students to be quantitatively literate.

Prior to colleges implementing a quantitative literacy curriculum, college algebra was the gateway mathematics course required by many educational institutions (Nguyen, 2015; Tunstall et al., 2016). Madison (2006) posited that courses such as college algebra are currently used ineffectively as a general education requirement and may be replaced by quantitative literacy courses. When borrowing money, calculating the amount of interest that will be paid does not require an in-depth knowledge of college algebra or calculus, but requires an individual to have a basic understanding of numbers and to be able to reason mathematically. At Michigan State University, students were required to either complete or test out of college algebra, which was the general education mathematics requirement before a quantitative literacy course was created and implemented (Tunstall et al., 2016). College algebra was designed to be a gateway for students to reach their academic goals, but instead it became a gatekeeper for many students (Reyes, 2010). The low success rates experienced by some college students in college algebra (González-Muñiz, Klingler, Moosai, & Raviv, 2012) confirm research findings (Reyes, 2010; Nguyen, 2015), indicating a large percentage of students enrolled in college algebra repeat the course multiple times. Although college algebra is still the gateway course for many students, the course is criticized for inadequately preparing students for real world experiences with numbers (Tunstall et al., 2016). The benefit to quantitative literacy being an alternative mathematics course for students is that students are introduced to a variety of mathematical topics relevant to their everyday lives and work through real-life contexts using current data.

For North Carolina community colleges, students meet the prerequisite for Quantitative Literacy via three ways: (a) meeting the North Carolina multiple measures for placement criteria, (b) appropriate North Carolina Diagnostic Assessment and Placement (NC DAP) scores, or (c) completion of required developmental sequence (Coffey Consulting, 2017; NC Community

Colleges, 2017). Approved in 2013, North Carolina's Multiple Measures for Placement policy utilizes a hierarchy of measures to assess whether a student is academically prepared for credit-bearing college-level courses. North Carolina was the first state to adopt high school GPA as a method of primary placement and as an alternative to diagnostic placement testing (Coffey Consulting, 2017). Zeidenberg (2008) contended that diagnostic placement test scores do not correctly place students, as a single high-stake test does not accurately measure a student's skill level and is unable to predict future outcomes.

In order to place into credit-bearing college-level courses and be exempt from taking the NC DAP, students are required to meet certain criteria. If students have graduated from a North Carolina-licensed high school within five years and have a "minimum 2.6 unweighted high school GPA, and completion of four specific math courses: Algebra 1, Geometry, Algebra II (or its Common Core equivalent) and one additional math course" (Coffey Consulting, 2017, p. 1), then they are deemed college-ready. A link exists between success in an intensive mathematics course (algebra 2, trigonometry, pre-calculus, and calculus) and success in college (Trusty & Niles, 2003). For students who do not meet the high school GPA and fourth math requirement, subject-area ACT and SAT scores are used to determine college math and English readiness. Finally, students who do not meet any of the criteria listed are required to take the NC DAP to determine appropriate placement (State Board of Community Colleges, 2014). The NC DAP determines if students are eligible to take credit-bearing college courses or if remediation is needed in English/reading and/or mathematics.

The NC DAP is a custom assessment, specifically created by the College Board for North Carolina Community Colleges, aligned to the developmental curricula (NC Community Colleges, 2014). The mathematics portion of the assessment matches the content in the developmental mathematical modules DMA 010, DMA 020, DMA 030, DMA 040, DMA 050, and DMA 060. In order to enroll in Quantitative Literacy, students must score seven or higher on DMA 010, DMA 020, DMA 030, DMA 040, and/or DMA 050 modules as well as place out of, or successfully complete, DRE 098. Students are required to enroll in and successfully complete the module(s) in which a score of less than seven was achieved.

Students enrolled in the Quantitative Literacy course at a North Carolina community college will be a mixture of students who have been deemed college-ready upon entrance into the college and those who needed remediation. Ngo and Kwon (2015) insisted that "Community colleges have the responsibility to place students in courses in which they are most likely to succeed given their math skills while simultaneously promoting progression towards completion and attainment" (p. 463). Hall and Ponton (2005) examined the mathematics self-efficacy of freshman Intermediate Algebra (n = 105) and Calculus 1 (n = 80) students at a Southeastern rural, medium-sized, state research institution. Using Betz and Hackett's (1993) Mathematics Self-Efficacy Scale to measure mathematics self-efficacy, data analysis revealed that a significant difference existed between the mathematics self-efficacy of Intermediate Algebra (M = 5.33, SD = 1.4464) and Calculus 1 (M = 7.08, SD = 1.1411), t = 8.902, $p < 0.001$. Hall and Ponton's (2005) research results suggest that developmental students self-report a lower level of mathematics self-efficacy when compared to college-level curriculum mathematics students. Baxter et al.'s (2017) research also focused on the mathematics self-efficacy of Intermediate Algebra students. For both studies, Intermediate Algebra is considered a developmental mathematics course and Baxter et al. (2017) insisted that developmental mathematics students enter the classroom apprehensive and with a belief that they will not be successful. An independent samples t-test determined that a significant difference exists in the mathematics self-efficacy of students who place in the lower levels of developmental mathematics courses when compared to students who place into the highest level of developmental mathematics (t = -2.154, p = .032). Students who placed into Basic Algebra (M = – 5.290, SD =1.320) prior to enrolling into the Intermediate Algebra course had a lower mathematics self-efficacy when compared to the students who placed directly into Intermediate Algebra (M = 5.655, SD = 1.253). No research studies were found that determined if differences existed in the mathematics self-efficacy of students based on method of placement into a college-level curriculum mathematics course. For some community college students, their method of placement into a mathematics course is based on previous academic performance and this research study will add to the body of knowledge regarding mathematics self-efficacy and previous academic performance.

Summary

Researchers have concluded that students with higher mathematics self-efficacy achieve higher in mathematics courses (Peters, 2012; Usher, 2009). Researchers uncovered inconsistent results when examining the differences of mathematics self-efficacy based on age (Baxter et al., 2017; Jameson & Fusco, 2014) and gender (Hall & Ponton, 2005; Peters, 2012), as well as determining if learning outcomes were equitable in the face-to-face and online learning environment (Ashby et al., 2011; Atchley et al., 2013; Fonolahi et al., 2014; Huston & Minton, 2016; Jones & Long, 2013). As the number of students enrolling in online courses increases (Community College Research Center, 2013), a large number of these students are enrolling in a community college (Bailey, 2004; Zeidenberg, 2008). Once enrolled, most students are required to successfully complete a gateway mathematics course in order to reach their academic goals (Tunstall et al., 2016). Given the increased attention to the importance of students possessing quantitative literacy skills, the mathematics self-efficacy of students enrolled in a quantitative literacy course needs to be measured. Such research is imperative, as there is a steady increase in enrollment in online courses (Community College Research Center, 2013) and a gap in the literature was discovered related to determining if differences existed in the mathematics self-efficacy of face-to-face and online students.

CHAPTER THREE: METHODS

Overview

The literature review reveals numerous studies examining the mathematics self-efficacy of face-to-face students (Baxter et al., 2017; Hall & Ponton, 2005; Jameson & Fusco, 2014); however, there is a lack of studies focusing on the mathematics self-efficacy of online students. More students are enrolling in online courses, as evidenced by the continuous online course enrollment increase (Community College Research Center, 2013). As online enrollment increases, the overall community college enrollment decreased nearly 10% from 2013 to 2016 (American Association of Community Colleges, 2017b). Along with the increase in online enrollment, the majority of research studies indicate that students in face-to-face courses outperform their online counterparts (Amro et al., 2015; Atchley et al., 2013; Huston & Minton, 2016; Xu & Jaggars, 2011, 2014), although Xu and Jaggars (2011) insisted that students who choose the online learning environment are more academically prepared. This quantitative ex-post facto causal-comparative research study compared the mathematics task self-efficacy and math-related school subjects' self-efficacy, as measured by the Mathematics Self-Efficacy Scale (Betz & Hackett, 1993), of students who enroll in a face-to-face or online Quantitative Literacy course. Chapter Three outlines the details of the design, participants and setting, instrumentation, procedures, and data analysis.

Design

To determine if differences exist in the mathematics task self-efficacy and math-related school subjects' self-efficacy of students enrolled in a face-to-face or online Quantitative Literacy course, an ex-post facto causal-comparative design was used. Gall, Gall, and Borg (2007) asserted that a causal-comparative research design is used when "researchers seek to identify cause-and-effect relationships by forming groups of individuals in whom the independent variable is present or absent- or present at several levels- and then determining whether the groups differ on the dependent variable" (p. 306). The research study was conducted ex-post facto since the groups of students are naturally occurring and the researcher did not manually assign students to the face-to-face and online sections of the Quantitative Literacy course. The study's dependent variables were the students' mathematics task self-efficacy and math-related school subjects' self-efficacy as measured by the Mathematics Self-Efficacy Scale. Betz and Hackett (1993) defined mathematics task self-efficacy as an individual's confidence in his/her ability to solve mathematical problems, and math-related school subjects' self-efficacy as an individual's confidence in his/her ability to achieve a final course grade of B or higher in a math-related or mathematics course. The study's independent variable was the delivery method (face-to-face or online). Face-to-face courses are defined as courses in which no more than 20% of the course content is delivered online, while online courses have at least 80% of the course content delivered online (Allen et al., 2016).

Research Questions

The research questions for this study are:

RQ1: Is there a difference in mathematics task self-efficacy and math-related school subjects' self-efficacy, as measured by the Mathematics Self-Efficacy Scale, between students enrolled in a face-to-face or online Quantitative Literacy course?

RQ2: Is there a difference in mathematics self-efficacy, as measured by the Mathematics Self-Efficacy Scale, between male and female Quantitative Literacy students?

RQ3: Is there a difference in mathematics self-efficacy, as measured by the Mathematics Self-Efficacy Scale, of Quantitative Literacy students based on method of placement (high school multiple measures, placement test scores, or completion of developmental mathematics courses)?

Hypotheses

The null hypotheses for this research study are:

$H_0$1: There is no significant difference in mathematics task self-efficacy and math-related school subjects' self-efficacy, as measured by the Mathematics Self-Efficacy Scale, between students enrolled in a face-to-face or online Quantitative Literacy course.

$H_0$2: There is no significant difference in mathematics self-efficacy, as measured by the Mathematics Self-Efficacy Scale, between male and female Quantitative Literacy students.

$H_0$3: There is no significant difference in mathematics self-efficacy, as measured by the Mathematics Self-Efficacy Scale, based on method of placement (high school multiple measures, placement test scores, completion of developmental mathematics courses) of Quantitative Literacy students.

Participants and Setting

The participants for this study were drawn from a convenience sample of select community colleges in North Carolina during the 2018 spring semester. The North Carolina Community College System is comprised of 58 community colleges, and seven community colleges were chosen for the study. The seven community colleges were chosen using a convenience sample, as the researcher has former colleagues who work at each of the colleges. The seven community colleges chosen for the study are labeled with pseudonyms A, B, C, D, E, F, and G. For each community college that offers more than one face-to-face and online course, each Quantitative Literacy course was assigned a number and a random number generator was utilized to choose the section(s) of Quantitative Literacy that were invited to participate in the study. Class sizes vary among institutions based on enrollment demands. Although a convenience sample was used for the study, the researcher's goal was to acquire a sample that is representative of all North Carolina community colleges.

Community College A, located in eastern North Carolina, had a curriculum enrollment of 2,674 for the fall 2016 semester. The college was comprised of a student population that was 39% male and 61% female. Fifty-six percent of the students were White, 32% Black, 1% American Indian/Alaska Native, 1% Asian, 9% Hispanic, and 2% Other/Multiple. Thirty-nine percent of students were enrolled full-time and 70% were enrolled in at least one distance education course.

Community College B, located in eastern North Carolina, had a curriculum enrollment of 3,050 for the fall 2016 semester. The college was comprised of a student population that was 41% male and 59% female. Fifty-two percent of the students were White, 35% Black, 2% American Indian/Alaska Native, 1% Asian, 5% Hispanic, and 4% Other/Multiple. Forty-three percent of students were enrolled full-time and 58% were enrolled in at least one distance education course.

Community College C, located in central North Carolina, had a curriculum enrollment of 1,779 for the fall 2016 semester. The college was comprised of a student population that was 41% male and 59% female. Seventy-one percent of the students were White, 16% Black, 1% Asian, 7% Hispanic, and 5% Other/Multiple. Seventy-three percent of the students were younger than 25. Thirty-eight percent of students were enrolled full-time and 41% were enrolled in at least one distance education course.

Community College D, located in central North Carolina, had a curriculum enrollment of 21,747 for the fall 2016 semester. The college was comprised of a student population that was

45% male and 55% female. Forty-nine percent of the students were White, 23% Black, 3% Asian, 10% Hispanic, and 14% Other/Multiple. Thirty-six percent of students were enrolled full-time and 42% were enrolled in at least one distance education course.

Community College E, located in central North Carolina, had a curriculum enrollment of 1,248 for the fall 2016 semester. The college was comprised of a student population that was 30% male and 70% female. Forty-six of the students were White, 30% Black, 13% American Indian/Alaska Native, 1% Asian, 6% Hispanic, and 4% Other/Multiple. Forty-three percent of students were enrolled full-time and 65% were enrolled in at least one distance education course.

Community College F, located in western North Carolina, had a curriculum enrollment of 3,819 for the fall 2016 semester. The college was comprised of a student population that was 36% male and 64% female. Seventy percent of the students were White, 16% Black, 1% American Indian/Alaska Native, 2% Asian, 8% Hispanic, and 3% Other/Multiple. Forty percent of students were enrolled full-time and 49% were enrolled in at least one distance education course.

Community College G, located in western North Carolina, had a curriculum enrollment of 2,514 for the fall 2016 semester. The college was comprised of a student population that was 32% male and 68% female. Sixty-seven percent of the students were White, 16% Black, 1% American Indian/Alaska Native, 3% Asian, 3% Hispanic, and 9% Other/Multiple. Thirty-six percent of students were enrolled full-time and 79% were enrolled in at least one distance education course.

The number of participants sampled was 185, which exceeds the required minimum for a medium effect size. According to Statistics Solutions (2017), for a multivariate analysis of variance (MANOVA) with two levels and two dependent variables, 66 students per group is the required minimum sample size for a medium effect size with statistical power of 0.8 at the .05 alpha level. The sample consisted of 97 face-to-face and 88 online students. Thirty-two percent of the participants were male and 68% female. Fifty-seven percent of the students were White, 21% Black, 4% American Indian/Alaska Native, 3% Asian, 8% Hispanic, and 6% Other/Multiple. The average age of students was 26. The survey response rate for face-to-face students was 39% and 27% for online students. For online surveys, a 30% response rate is considered acceptable (The University of Texas at Austin, n.d.).

The course chosen for this study was Quantitative Literacy. The North Carolina Community College System utilizes a common course library, which includes a course description, number of credit hours, contact hours, and student learning outcomes for every course offered. Quantitative Literacy is a three credit, four contact hour course (NC Community Colleges, 2017) and all seven community colleges offer the course in the face-to-face and online setting. For the face-to-face courses, students meet with the instructor at a fixed time for at least 60% of the scheduled class time. In the online setting, students may be required to take proctored exams, but no more than 20% of the scheduled class time is face-to-face. A mixture of full-time and adjunct instructors teach the face-to-face and online courses. For Quantitative Literacy, regardless of the delivery method, all instructors must possess the required credentials as outlined by the Southern Association of Colleges and Schools Commission on Colleges (SACSCOC). To teach a general education course at the undergraduate level, faculty must possess a “doctorate or master’s degree in the teaching discipline or master’s degree with a concentration in the teaching discipline (a minimum of 18 graduate semester hours in the teaching discipline)” (SACSCOC, 2006, para. 2).

Instrumentation

Betz and Hackett (1983) developed the Mathematics Self-Efficacy Scale (MSES; see Appendix A) to address the need to measure mathematical self-efficacy expectations. The purpose of the MSES is to measure students' beliefs regarding their ability to complete various mathematical tasks. The original MSES consisted of 75 items and three subscales (Betz & Hackett, 1983). For the original MSES, Betz and Hackett (1993) reported that the reliability coefficient Cronbach's alpha of the overall scale was .96. The reliability coefficient Cronbach's alpha of the Math Tasks and Math-Related Course subscales was .92, while the reliability coefficient Cronbach's alpha of the Math Problems subscale was .96. A research study conducted by Lent et al. (1991) confirmed that the coefficient alpha of the Math-Related Course subscale was 0.92 and a two-week test-retest correlation of 0.94 for self-efficacy.

Through multiple revisions, the MSES now consists of 34 items and two subscales. Item analysis was conducted after the MSES was administered to 114 undergraduate students and the 75-item scale was shortened to 54 items (Betz & Hackett, 1983). In 1993, the Mathematics Problems subscale was removed from the MSES, thus leaving a more concise 34-item scale. The current version of the MSES consists of two subscales, the Mathematics Tasks subscale and the Math-Related School Subjects' subscale, and students should be able to answer all 34 items in approximately 15 minutes (Betz & Hackett, 1993). The Mathematics Tasks subscale, which contains 18 items, measures students' self-confidence in their aptitude to complete daily mathematical tasks. The Math-Related School Subjects' subscale, which contains 16 items, measures students' self-confidence in their ability to earn an A or B in a mathematics or math related college level course.

The MSES was used in numerous studies (e.g., Clutts, 2010; Junge & Dretzke, 1995; Hall & Ponton, 2005). Through research that validated the instrument, Betz and Hackett (1993) noted that statistically significant correlations exist between MSES and other mathematics scales. Betz and Hackett (1993) indicated that “Total MSES scores were related as follows: math anxiety (r = .56), confidence in doing math (r = .66), perceived usefulness of math (r = .47) and effectance motivation in math (r = .46)” (p. 8).

The MSES uses a 10-point Likert scale that ranges from No Confidence at All to Complete Confidence. Responses are as follows: Complete Confidence = 8 – 9, Much Confidence = 6 – 7, Some Confidence = 4 – 5, Very Little Confidence = 1 – 3, and No Confidence at All = 0. The combined possible score on the MSES ranges from 0 to 306 points. The range of scores for the Mathematics Tasks subscale is 0 to 162 and the range of scores for the Math-Related School Subjects’ subscale is 0 to 144. To determine the mean score, the total score for the MSES or the score for each subscale is divided by the corresponding number of items. To interpret the score as it relates to gender, Betz and Hackett (1993) provide approximate percentile equivalents for male and female MSES scores since research showed statistically significant gender differences.

In order to use the Mathematics Self-Efficacy Scale, the researcher purchased a Remote Online Survey License from Mind Garden in order to retype and reformat the MSES for online administration via SurveyMonkey © (Mind Garden Inc., n.d.). The Remote Online Survey License also included permission to use the MSES and the scoring key.

Along with completing the MSES, students were prompted to provide demographic data. Students were required to self-report their age, gender, ethnicity, and method of placement into Quantitative Literacy.

Procedures

Prior to submitting the Liberty University Institutional Review Board (IRB) application, the researcher contacted a number of community colleges to determine which six community colleges would be willing to participate in the study. Upon IRB application submission and approval, the Mathematics Self-Efficacy Scale was purchased and placed in SurveyMonkey© and a separate link to the survey was created for each community college's online and face-to-face sections. The survey links, along with detailed directions, were sent from a representative of the college to select Quantitative Literacy students within the first month of the official course start date.

In an effort to ensure confidentiality and safekeeping of data, survey results were stored on a password-protected computer. Although student responses were anonymous, if students included an email address, they were entered into a drawing for one of four $25 Visa gift cards. Bosjnak and Tuten (2003) posited that when participates are entered into a prize drawing for completing a survey, completion rates increase and the number of incomplete surveys are reduced.

When Quantitative Literacy students clicked on the survey link, the first page of the survey contained the informed consent form outlining the purpose of the survey, information that participation in the study was voluntary, along with the instructions for completing the survey. Once students clicked "Next" to provide consent and acknowledge they were 18 years of age or older, they were forwarded to the MSES. Prior to beginning the 34-item MSES, students were asked to provide demographic information such as age, gender, ethnicity, and method of placement into the Quantitative Literacy course (i.e., high school multiple measures, placement test scores, completion of developmental mathematics courses). After submitting the survey, participants were redirected to a page thanking them for their time and if the participants wanted to be entered into the prize drawing, they could enter a valid email address. Face-to-face and online students received the same instructions for completing the survey. Initially six community colleges were chosen for participation in the research study but due to a low response rate within the first few weeks of the study, a seventh community college was invited to participate in the study. A change of protocol was sent to the IRB requesting permission to include an additional school in the research study. Approval was granted to add the additional community college.

Data Analysis

In order to perform data analysis, survey results with three or fewer unanswered items were exported from SurveyMonkey© and imported into SPSS version 24.0. Betz and Hackett (1993) asserted that the scale is invalid if more than three items are left unanswered. Ninety-seven face-to-face students and 88 online students completed the survey. Descriptive statistics regarding age, gender, and ethnicity of participants were calculated and provided for informational purposes. To analyze the data for research hypothesis one and determine if a statistically significant difference exists in the mathematics task self-efficacy and math-related school subjects' self-efficacy of students who enroll in a face-to-face or online course, a one-way multivariate analysis of variance (MANOVA) was conducted. Since the researcher was attempting to determine if two groups' mean scores differ on multiple dependent variables, MANOVA was most appropriate and the effect size was reported using η^2 (Warner, 2013). Analyses of variances (ANOVA) on the dependent variables were conducted as follow-up tests to the MANOVA. Using the Bonferroni method, each ANOVA was tested at the .025 alpha level.

An independent samples *t*-test was also conducted to test hypothesis two that focused on determining if a statistically significant difference existed in the mathematics self-efficacy between male and female Quantitative literacy students. Since the researcher was attempting to determine if a significant difference existed in the mean scores of male and female Quantitative Literacy students, an independent *t*-test was most appropriate, and the effect size was reported using η^2 (Warner, 2013). Finally, to determine if a statistically significant difference existed in the mathematics self-efficacy of Quantitative Literacy students based on method of placement (high school multiple measures, placement test scores, or completion of developmental courses), an ANOVA was conducted to test hypothesis three. Warner (2013) posited that an ANOVA should be used when a researcher seeks to compare mean scores on a dependent variable across multiple groups.

For all three statistical tests, prior to running the data analyses, data were screened to identify possible issues. Data screening was conducted on each group's dependent variables (mathematics task self-efficacy and math-related school subjects' self-efficacy scores, mathematics self-efficacy) regarding data inconsistencies and outliers. Data were sorted and transformed into *z*-scores to identify any unusual entries and boxplots were used to identify possible outliers.

For hypothesis one, the dependent variables were measured on the interval level and the observations within each variable were independent as each participant was assigned to just one of the groups. Random sampling was used to choose the participants for the study. Normality was examined using histograms and the Kolmogrov-Smirnov test, as more than 50 participants were in each group. A scatterplot matrix was utilized to test the assumption of multivariate normal distribution and the researcher looked for a classic "cigar shape," which would imply a linear relationship existed between the dependent variables. The assumption of homogeneity of variance-covariance matrices was tested using Box's M test of equality of covariance. Warner (2013) insisted that when the Box's M test is significant, Pillai's traces can be reported instead of Wilk's lambda (Λ) as the overall test statistic; "Pillai's trace is more robust to violations of the homogeneity of variances and covariances" (p. 786). Finally, to test for absence of multicollinearity, a Pearson product moment correlation coefficient, *r*, was calculated to determine if the dependent variables, mathematics task self-efficacy and math-related school subjects' self-efficacy, were correlated.

For hypotheses two and three, the dependent variable was measured on the interval level and the observations within each variable were independent as each participant was assigned to just one of the groups. Random sampling was used to choose the participants for the study. Normality was examined using histograms and the Kolmogrov-Smirnov test, as more than 50 participants were in each group. Levene's Test of Equality of Error Variance was used to test the assumption of equal variance.

CHAPTER FOUR: FINDINGS

Overview

The purpose of this study was to determine if there was a statistically significant difference in the mathematics task self-efficacy and math-related school subjects' self-efficacy of North Carolina community college Quantitative Literacy students who enroll in a face-to-face course versus an online course. The study also sought to determine if there was a difference in the mathematics self-efficacy of Quantitative Literacy students based on gender and method of placement. A multivariate analysis of variance (MANOVA) was the primary statistical test conducted utilizing SPSS Version 24.0.0.0 statistical software. Each research question will be discussed separately.

Research Questions

The research questions for this study are:

RQ1: Is there a difference in mathematics task self-efficacy and math-related school subjects' self-efficacy, as measured by the Mathematics Self-Efficacy Scale, between students enrolled in a face-to-face or online Quantitative Literacy course?

RQ2: Is there a difference in mathematics self-efficacy, as measured by the Mathematics Self-Efficacy Scale, between male and female Quantitative Literacy students?

RQ3: Is there a difference in mathematics self-efficacy, as measured by the Mathematics Self-Efficacy Scale, of Quantitative Literacy students based on method of placement (high school multiple measures, placement test scores, or completion of developmental mathematics courses)?

Null Hypotheses

The null hypotheses for this research study are:

$H_0$1: There is no significant difference in mathematics task self-efficacy and math-related school subjects' self-efficacy, as measured by the Mathematics Self-Efficacy Scale, between students enrolled in a face-to-face or online Quantitative Literacy course.

$H_0$2: There is no significant difference in mathematics self-efficacy, as measured by the Mathematics Self-Efficacy Scale, between male and female Quantitative Literacy students.

$H_0$3: There is no significant difference in mathematics self-efficacy, as measured by the Mathematics Self-Efficacy Scale, based on method of placement (high school multiple measures, placement test scores, completion of developmental mathematics courses) of Quantitative Literacy students.

Descriptive Statistics

The final participants in this study consisted of 182 community college Quantitative Literacy students. One hundred eighty-five students completed the survey but only 182 were used for the final data analysis. Of the 182 participants, 32% were male and 68% female. Fifty-seven percent of the students were White, 21% Black, 4% American Indian/Alaska Native, 3% Asian, 8% Hispanic, and 7% Other/Multiple. The average age of students was 26. Data obtained for the dependent variables mathematics task self-efficacy and math -related school subjects' self-efficacy for face-to-face and online Quantitative Literacy students can be found in Table 1.

Table 1

Descriptive Statistics for Research Question 1

	Delivery Method	Mean	Std. Deviation	*N*
MathTask	Online	7.0318	1.58149	87
	Face-to-Face	6.4945	1.53603	95
	Total	6.7514	1.57674	182
MathRelated	Online	5.5960	1.86666	87
	Face-to-Face	4.9060	1.84810	95
	Total	5.2358	1.88383	182

Results

Data Screening

Data screening was conducted on each group's dependent variables (mathematics task self-efficacy and math-related school subjects' self-efficacy). In preparation for use in SPSS, the data file was scanned for missing data, data inconsistencies, abnormalities, and outliers. No data errors were found but one data inconsistency was detected. Student 84 answered the first question on the math related school subjects' subscale with a value greater than 0, skipped one question, and answered 0 for the remaining 14 questions for an average score of .20. Also, the Mathematics Self-Efficacy Scale (MSES) subscale score as well as the total MSES score were transformed into *z* scores. For the total MSES score, one *z*-score value (Student 141) was greater than three standard deviations from the mean. The researcher made the decision to delete these responses from the data set.

Results for Null Hypothesis One

Assumptions. A one-way between groups multivariate analysis of variance (MANOVA) was used to test null hypothesis one that examined the difference in mathematics task self-efficacy and math-related school subjects' self-efficacy between face-to-face and online Quantitative Literacy students. Original data included 185 participants. Box and whiskers plots were utilized to detect outliers for each dependent variable. Preliminary data screening using box plots indicate that outliers existed for the mathematics task self-efficacy scale. Mahalnobis distance statistics were then calculated and one value was higher than the critical value of 13.82. The researcher made the decision to remove this survey response as well (Student 90). A MANOVA was performed with and without the three surveys responses and statistical significance was unaffected. See Figure 1 for the box and whisker plot representing this data set. Additional outliers were present but were not considered to be extreme outliers.

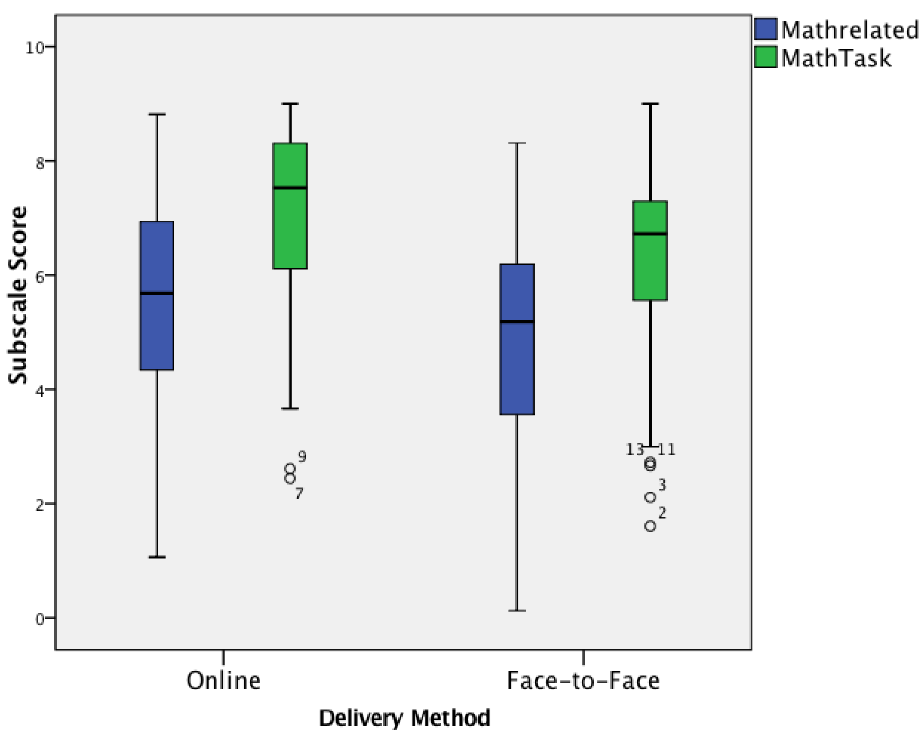

Figure 1. Box and whisker plot for subscales.

Normality was examined using a Kolmogorov-Smirnov test since the sample size was greater than 50. The assumption of normality was violated as each *p* value was less than .05. See Table 2 for the results of the Kolmogorov-Smirnov test. Except in the case of outliers, Pallant

(2007) insists that the MANOVA is fairly robust to modest violations of normality. The outliers present in Figure 1 are not extreme outliers and no observation was an outlier on both dependent variables.

Table 2

Tests of Normality for Research Question 1

		Kolmogorov-Smirnov[a]		
	Delivery Method	Statistic	df	Sig.
MathTask	Online	.134	87	.001
	Face-to-Face	.092	95	.046
MathRelated	Online	.099	87	.034
	Face-to-Face	.095	95	.034

Note. a. Lilliefors Significance Correction

Histograms and Q-Q plots were also used to determine if there was a violation of the assumption of normality. Figure 2 illustrates the histogram and Figure 4 illustrates the Q-Q plot for the online students' mathematics task self-efficacy. Figure 2 indicates the distribution, which is negatively skewed.

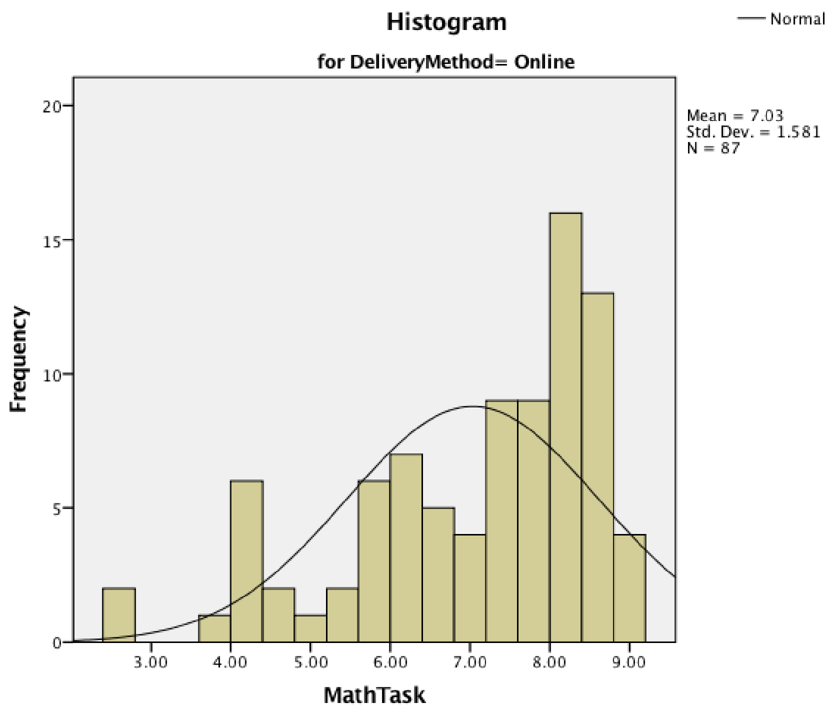

Figure 2. Histogram of online students' mathematics task self-efficacy.

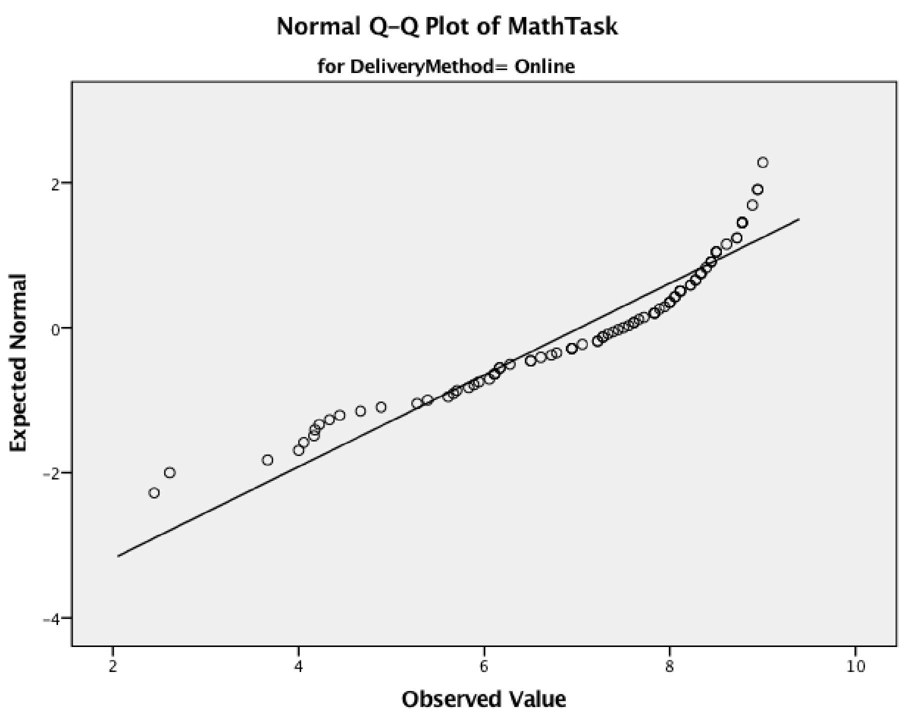

Figure 3. Normal Q-Q Plot of online students' mathematics task self-efficacy.

In Figure 4 the histogram for face-to-face students' mathematics task self-efficacy is illustrated and Figure 5 represents the Q-Q plot for the same data set. Figure 4 indicates a distribution that is slightly negatively skewed.

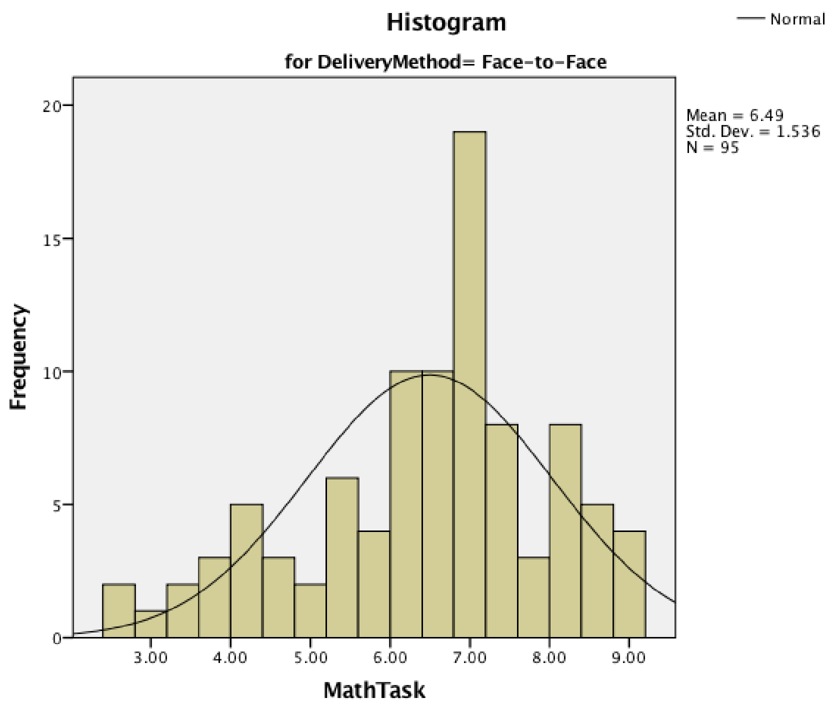

Figure 4. Histogram of face-to-face students' mathematics task self-efficacy.

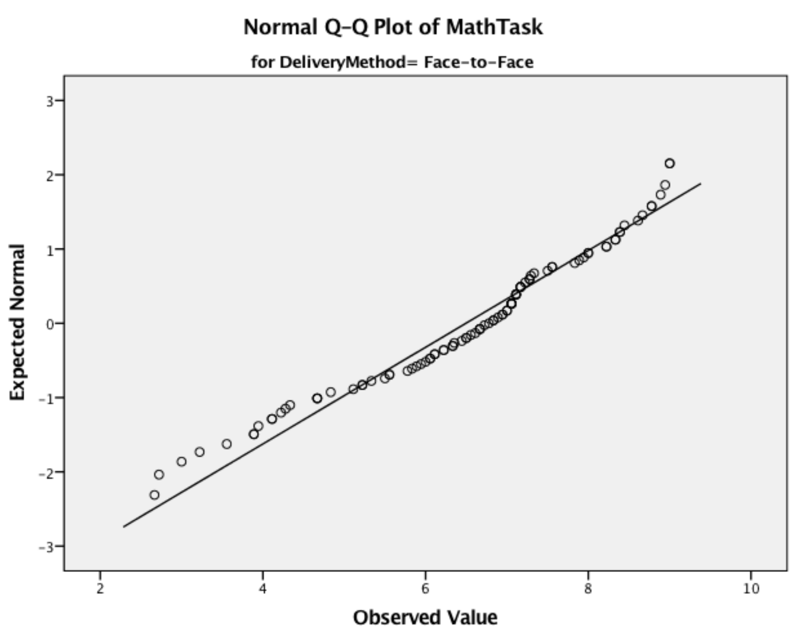

Figure 5. Normal Q-Q Plot of face-to-face students' mathematics task self-efficacy.

Figure 6 and Figure 7 represent the histogram and Q-Q plot for the online students' math-related school subjects' self-efficacy.

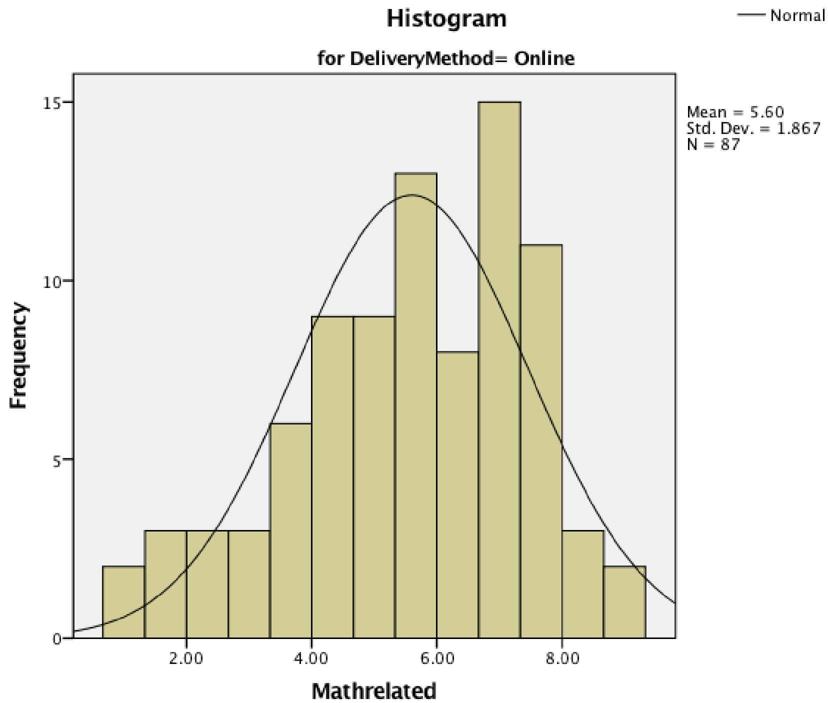

Figure 6. Histogram of online students' math-related school subjects' self-efficacy.

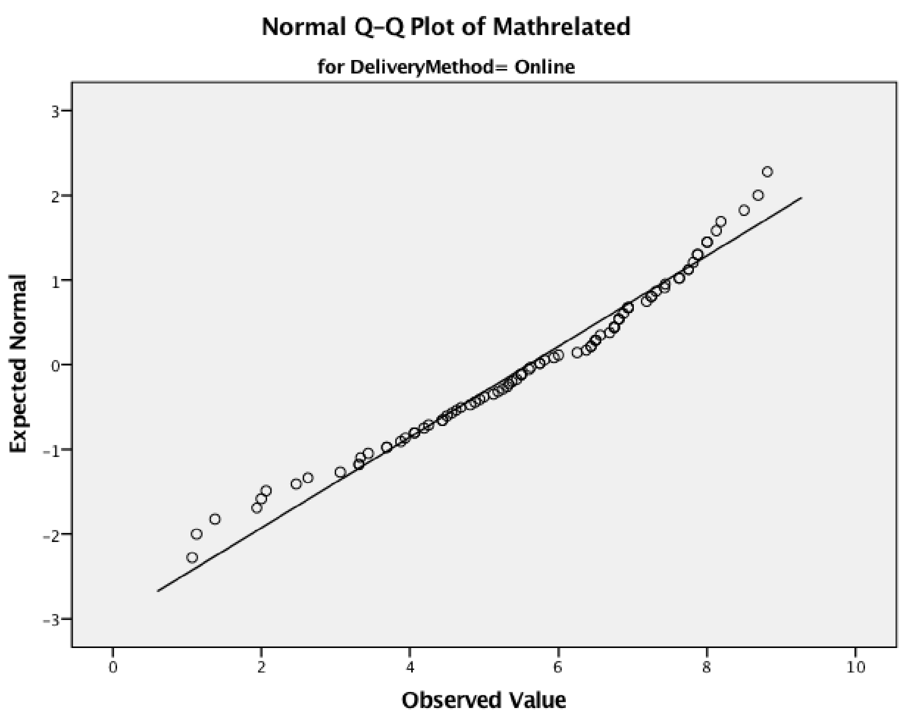

Figure 7. Normal Q-Q Plot of online students' math-related school subjects' self-efficacy.

Figure 8 and Figure 9 illustrate the histogram and Q-Q plot for the face-to-face students' math related school subjects' self-efficacy. After review of the box and whisker plots, histograms, and Q-Q plots, the researcher made the decision to continue with the data as presented.

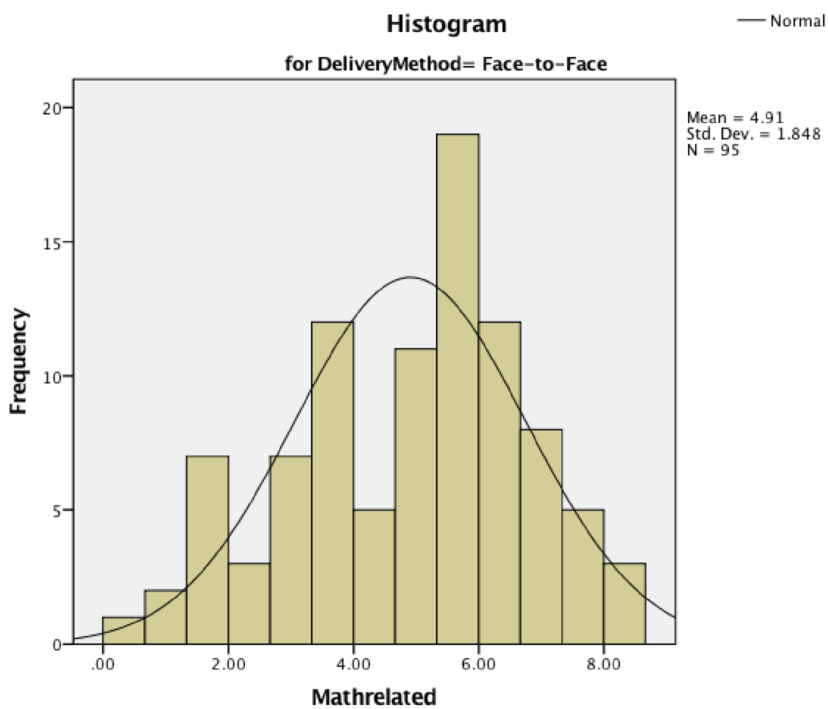

Figure 8. Histogram of face-to-face students' math-related school subjects' self-efficacy.

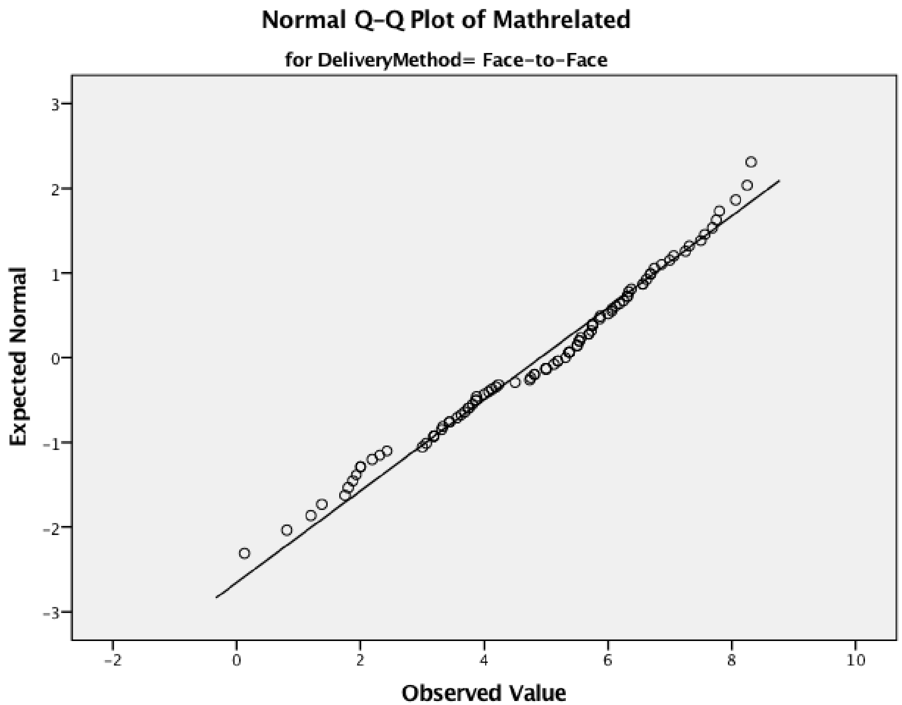

Figure 9. Normal Q-Q Plot of face-to-face students' math-related school subjects' self-efficacy.

A scatterplot was used to test the assumption of multivariate normal distribution. The classic "cigar shape" of the scatterplot implies that a linear relationship exists between the dependent variables. See Figure 10 for the scatterplot matrix.

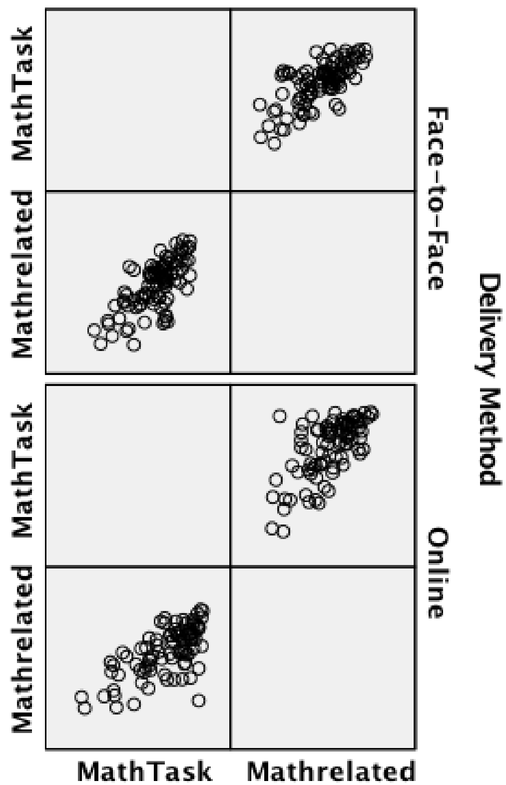

Figure 10. Scatterplot matrix for delivery method and subscales.

The assumption of homogeneity of variance-covariance matrices was tested using Box's M test of equality of covariance. The assumption of homogeneity of variance-covariance matrices was met (p = .941), thus Wilk's lambda (Λ) will be used as the overall test statistic. See Table 3 for Box's test of equality of covariance matrices.

Table 3

Box's M Test of Equality of Covariance Matrices

Box's M	.324
F	.107
df1	3
df2	7759336.34
Sig.	.956

Note. Tests the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups.

To test for absence of multicollinearity, a Pearson product moment correlation coefficient, *r*, was calculated to determine if the dependent variables, mathematics task self-efficacy and math-related school subjects' self-efficacy were correlated. A correlation of .698 was found. A correlational value of .698 implies the two dependent variables are slightly correlated. Correlational values in excess of .8 indicate that the dependent variables are highly correlated and may actually measure the same construct, thus the need to remove one of the dependent variables or combine them to form a single index (Pallant, 2007). Since the correlational value is below the threshold, the researcher made the decision to continue with the MANOVA. See Table 4 for the Pearson Correlation.

Table 4

Correlations

		Part I Average	Part II Average
MathTask	Pearson Correlation	1	.700**
	Sig. (2-tailed)		.000
	N	182	182
MathRelated	Pearson Correlation	.700**	1
	Sig. (2-tailed)	.000	
	N	182	182

Note. **. Correlation is significant at the 0.01 level (2-tailed).

Results. A one-way between groups multivariate analysis of variance (MANOVA) was performed to determine whether significant differences existed between face-to-face and online Quantitative Literacy students on the mathematics task self-efficacy scale and math-related school subjects' self-efficacy scale. Two dependent variables were used: mathematics task self-efficacy and math-related school subjects' self-efficacy. The independent variable was delivery method. For the mathematics task self-efficacy scale, data revealed face-to-face students (*M* = 6.50, *SD* = 1.54) scored lower when compared to online students (*M* = 7.03, *SD* = 1.58). For the math-related school subjects' scale, data revealed that face-to-face students (*M* = 4.91, *SD* = 1.85) scored lower than the online students (*M* = 5.60, *SD* = 1.87). There was a statistically significant difference between face-to-face and online Quantitative Literacy students on the dependent measures, Wilks' Lambda = 0.963, $F(2, 179) = 3.454$, $p = .034$. The multivariate η^2_{part} based on Wilks' Lambda indicated a medium effect size, $\eta^2_{part} = .037$ (Warner, 2013, p. 208). The null hypothesis was rejected at a 95% confidence level. See Table 5 for the Multivariate Tests.

Table 5

Multivariate Tests[a]

Effect		Value	*F*	Hypothesis *df*	Error *df*	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[c]
Delivery Method	Pillai's Trace	.037	3.454[b]	2.000	179.000	.034	.037	6.908	.531
	Wilks' Lambda	.963	3.454[b]	2.000	179.000	.034	.037	6.908	.531

Note. a. Design: Intercept + Delivery Method; b. Exact statistic.

Analyses of variances (ANOVA) on the dependent variables were performed as follow-up tests to the MANOVA. Using the Bonferroni method, each ANOVA was tested at the .025 alpha level. An ANOVA for mathematics task self-efficacy scores showed a significant difference between face-to-face (*M* = 6.50, *SD* = 1.54) and online (*M* = 7.03, *SD* = 1.58) Quantitative Literacy students, where $F(1, 180) = 5.401$, $p = .021$, $\eta^2_{part} = .029$. An ANOVA for math-related school subjects self-efficacy scores also showed a significant difference between face-to-face (*M* = 4.91, *SD* = 1.85) and online (*M* = 5.60, *SD* = 1.87) Quantitative Literacy students, where $F(1,180) = 6.271$, $p = .013$, $\eta^2_{part} = .034$. See Table 6 for Tests Between-Subjects Effect. These results indicate that online students have both a higher mathematics task self-efficacy and math-related school subject's self-efficacy.

Table 6

Tests of Between-Subjects Effects for Research Question 1

Source	Dependent Variable	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[c]
Delivery Method	MathTask	13.109	1	13.109	5.401	.021	.029	5.401	.526
	MathRelated	21.623	1	21.623	6.271	.013	.034	6.271	.597

a. R Squared = .029 (Adjusted R Squared = .024); b. R Squared = .034 (Adjusted R Squared = .028); c. Computed using alpha = .025

Results for Null Hypothesis Two

Data obtained for the dependent variable mathematics self-efficacy for male and female Quantitative Literacy students can be found in Table 7.

Table 7

Descriptive Statistics for Research Question 2

	Gender	*N*	Mean	Std. Deviation	Std. Error Mean
MSES	Male	58	6.3538	1.48710	.19527
	Female	122	5.8855	1.62582	.14719

Data Screening. Review of the data on each group’s dependent variable (mathematics self-efficacy) indicated no data errors or inconsistencies. An independent samples *t*-test was used to test null hypothesis two that examined the difference in the mathematics self-efficacy among male and female Quantitative Literacy students. Box and whiskers plots were utilized to detect outliers for the dependent variable and no extreme outliers were detected in the data set. See Figure 11 for the box and whisker plot.

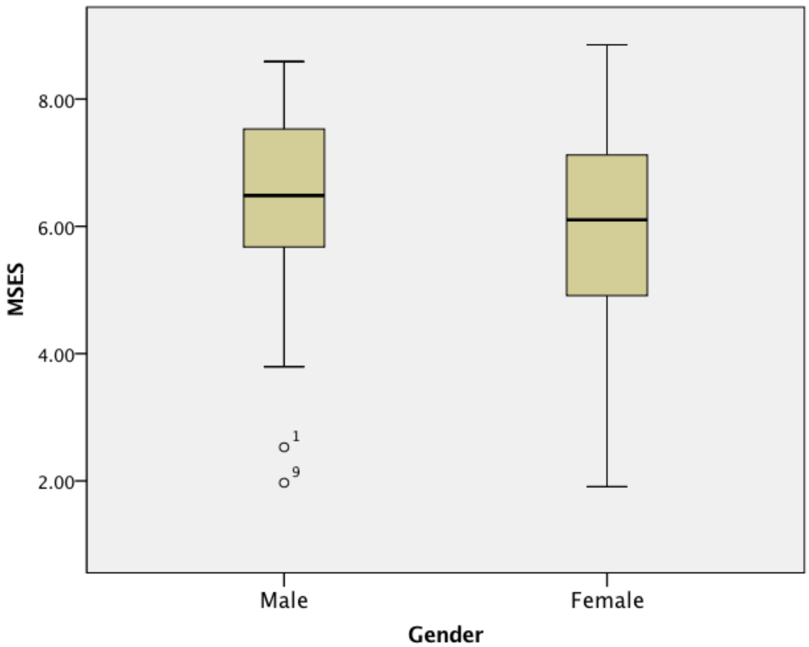

Figure 11. Box and whisker plot for mathematics self-efficacy scale based on gender.

Assumptions. Normality was examined using a Kolmogorov-Smirnov test since the sample size was greater than 50. The assumption of normality was met as each *p* value was greater than .05. See Table 8 for the Kolmogorov-Smirnov test.

Table 8

Tests of Normality for Research Question 2

		Kolmogorov-Smirnov[a]		
	Gender	Statistic	*df*	Sig.
MSES	Male	.109	58	.082
	Female	.069	122	.200*

*. This is a lower bound of the true significance.
a. Lilliefors Significance Correction

Homogeneity of variances was examined using Levene's test for equality of variances. The assumption of homogeneity of variances was met as $p = .366$. See Table 9 for Levene's test for equality of variances.

Table 9

Test of Homogeneity of Variances for Research Question 2

Levene's Test for Equality of Variances

		F	Sig.
MSES	Equal variances assumed	.822	.366

Results. An independent samples *t*-test was conducted to test null hypothesis two that examined the difference in the mathematics self-efficacy of male and female Quantitative Literacy students. For the mathematics self-efficacy scale, data revealed that male students (*M* = 6.35, *SD* = 1.49) scored higher when compared to female students (*M* = 5.89, *SD* = 1.63). Green and Salkind (2014) suggested that if sample sizes are unequal then the *t* value that corresponds to equal variances not assumed should be utilized. Although male students scored higher, no statistically significant differences were found among male and female Quantitative Literacy students on the mathematics self-efficacy scale, $t(121.677) = 1.915$, $p = .058$. The magnitude of the differences in the means (mean difference = .47, 95% CI: -0.02 to 0.95) was small (eta squared = .020). Eta squared was calculated using the following formula:

$$\text{Eta squared} = \frac{t^2}{t^2 + (N12 + N2 - 2)}$$

$$\text{Eta squared} = \frac{1.915^2}{1.915^2 + (58 + 122 - 2)}$$

Eta squared = .020 (Pallant, 2007).

The researcher failed to reject the null hypothesis at a 95% confidence level. See Table 10 for the Independent Samples Tests.

Table 10

t-test for Equality of Means

							95% Confidence Interval of the Difference	
		t	*df*	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
MSES	Equal variances assumed	1.855	178	.065	.46827	.25243	-.02988	.96642
	Equal variances not assumed	1.915	121.677	.058	.46827	.24453	-.01581	.95235

Results for Null Hypothesis Three

Data obtained for the dependent variable mathematics self-efficacy for Quantitative Literacy students based on method of placement (high school multiple measures, placement test scores, or completion of developmental mathematics courses) can be found in Table 11.

Table 11

Descriptive Statistics for Research Question 3

Dependent Variable: MSES

Method of Placement	Mean	Std. Deviation	*N*
Dev Math	5.8215	1.65016	78
Placement Test	6.3125	1.46400	39
HS MM	6.1449	1.56512	65
Total	6.0422	1.58589	182

Data Screening. Review of the data on each on each group's dependent variable (mathematics self-efficacy) indicated no data errors or inconsistencies. A one-way analysis of variance (ANOVA) was used to test null hypothesis three that stated there is no significant difference in mathematics self-efficacy of Quantitative Literacy students based on method of placement (completion of developmental mathematics courses, appropriate placement test scores, or high school multiple measures). Box and whiskers plots were utilized to detect outliers for the dependent variable and no extreme outliers were detected in the data set. See Figure 12 for the box and whisker plot.

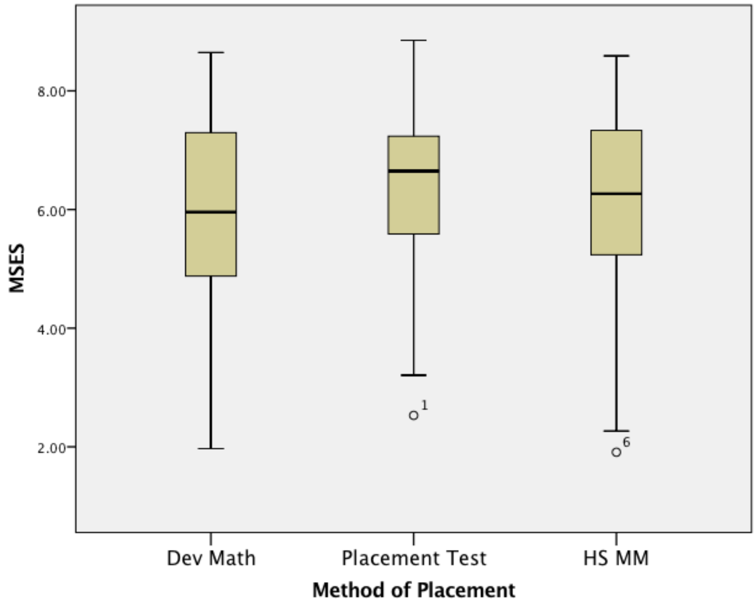

Figure 12. Box and whisker plot for math self-efficacy scale based on placement.

Assumptions. Normality was examined using a Kolmogorov-Smirnov test for the students who completed developmental mathematics courses and those selected based on high school multiple measures since their sample size was greater than 50. The assumption of normality was met in both cases as each *p* value was greater than .05. Normality was examined using a Shapiro-Wilk test for the students who placed in Quantitative Literacy via appropriate placement test scores since the sample size was less than 50. The assumption of normality was met as $p = .068$. See Table 12 for the Kolmogorov-Smirnov and Shapiro-Wilk tests.

Table 12

Tests of Normality for Research Question 3

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Method of Placement	Statistic	df	Sig.	Statistic	df	Sig.
MSES	Dev Math	.078	78	.200*	.974	78	.115
	Placement Test	.124	39	.138	.948	39	.068
	HS MM	.086	65	.200*	.953	65	.015

*. This is a lower bound of the true significance. a. Lilliefors Significance Correction

Homogeneity of variances was examined using Levene's test for equality of variances. The assumption of homogeneity of variances was met as $p = .347$. See Table 13 for Levene's test for equality of variances.

Table 13

Test of Homogeneity of variances for Research Question 3

MSES

Levene Statistic	*df1*	*df2*	Sig.
1.064	2	179	.347

Results. A one-way analysis of variance (ANOVA) was conducted to determine whether significant differences existed on the mathematics self-efficacy scale for Quantitative Literacy students based on method of placement (high school multiple measures $n = 65$, placement test scores $n = 39$, or completion of developmental mathematics courses $n = 78$). For the mathematics self-efficacy scale, data revealed students who completed developmental mathematics courses had lower mathematics self-efficacy ($M = 5.82$, $SD = 1.65$) when compared to students with appropriate placement exam scores ($M = 6.31$, $SD = 1.46$), and high school multiple measure students ($M = 6.15$, $SD = 1.57$). No statistically significant differences were found among Quantitative Literacy students on the mathematics self-efficacy scale based on method of placement, $F(2, 179) = 1.466$, $p = .234$. The researcher failed to reject the null hypothesis at a 95% confidence level. See Table 14 for the Tests of Between-Subjects Effects.

Table 14

Tests of Between-Subjects Effects for Research Question 3

Dependent Variable: MSES

Source	Type III Sum of Squares	*df*	Mean Square	*F*	Sig.	Partial Eta Squared
Corrected Model	7.334[a]	2	3.667	1.466	.234	.016
Intercept	6205.034	1	6205.034	2479.842	.000	.933
Method of placement	7.334	2	3.667	1.466	.234	.016
Error	447.892	179	2.697			
Total	7099.724	182				
Corrected Total	455.226	181				

a. R Squared = .016 (Adjusted R Squared = .005)

CHAPTER FIVE: CONCLUSIONS

Overview

This quantitative, ex-post facto causal comparative study was designed to determine if a statistically significant difference exists in the mathematics task self-efficacy and math-related school subjects' self-efficacy, as measured by the Mathematics Self-Efficacy Scale, of North Carolina community college Quantitative Literacy students who enroll in a face-to-face course versus an online course. Select Quantitative Literacy students from seven of the 58 North Carolina community colleges were asked to participate in the study. No research studies were found that compared the mathematics self-efficacy of face-to-face and online students, and this research study sought to fill that gap. This study also examined if there was a statistically significant difference in the mathematics self-efficacy of Quantitative Literacy students based on gender and method of placement. Chapter Five provides a summary of the research study results, implications and limitations of the study, as well as recommendations for future research.

Discussion

A multivariate analysis of variance (MANOVA) was conducted to determine if statistically significant differences existed in the mathematics task self-efficacy and math-related school subjects' self-efficacy between online and face-to-face Quantitative Literacy students. Bandura (1997) defined perceived self-efficacy as the judgement of an individual's ability to "organize and execute the courses of action required to produce given attainments" (p. 3). This suggests that students with high self-efficacy should achieve at a higher level than students with a perceived low self-efficacy. Individuals who possess a high level of self-efficacy persevere when faced with obstacles and achieve at a higher level than those with low self-efficacy (Bandura, 1986; Ertmer & Schunk, 1997). Just as students with a high self-efficacy persevere in the face of challenges, students with an incremental theory of intelligence (growth mindset) thrive when faced with obstacles (Dweck, 2000).

Research Question One

Is there a difference in mathematics task self-efficacy and math-related school subjects' self-efficacy, as measured by the Mathematics Self-Efficacy Scale, between students enrolled in a face-to-face or online Quantitative Literacy course?

Null Hypothesis One

There is no significant difference in mathematics task self-efficacy and math-related school subjects' self-efficacy, as measured by the Mathematics Self-Efficacy Scale, between students enrolled in a face-to-face or online Quantitative Literacy course.

The primary research question for this study was to determine if there exists a difference in the mathematics task self-efficacy and math-related school subjects' self-efficacy between students enrolled in a face-to-face or online Quantitative Literacy course. This research study showed a statistically significant difference in the mathematics task and math-related school subjects' self-efficacy of face-to-face ($M = 6.49$, $SD = 1.54$; $M = 4.91$, $SD = 1.85$) and online ($M = 7.03$, $SD = 1.58$; $M = 5.60$, $SD = 1.87$) North Carolina community college Quantitative Literacy students, with online students self-reporting both a higher mathematics task and math-related school subjects' self-efficacy. Komarraju and Nadler (2013) suggested that self-efficacy is a predictor of students' academic achievement. Furthermore, research indicates a relationship between mathematical achievement and mathematics self-efficacy (Ayotolah & Adedeji, 2009; Azar & Mahmoudi, 2014; Hackett, 1985), with students possessing high levels of mathematics self-efficacy achieving higher in mathematics courses (Peters, 2012; Ushers, 2009). Bandura (1997) insisted that "outcomes arise from actions" and these outcomes largely depend on individuals' judgement of their ability to perform in specified situations (p. 21). Given the statistically significant difference in the mathematics task and math-related school subjects' self-efficacy of face-to-face and online students, this would suggest that online students are more academically prepared than their face-to-face counterparts. This is consistent with Xu and Jaggars' (2011) assertion that academically superior students are more likely to choose the online learning environment.

Research Question Two

Is there a difference in the mathematics self-efficacy, as measured by the Mathematics Self-Efficacy Scale, between male and female Quantitative Literacy students?

Null Hypothesis Two

There is no significant difference in mathematics self-efficacy, as measured by the Mathematics Self-Efficacy Scale, between male and female Quantitative Literacy students.

The concept of self-efficacy expectations was first applied by Hackett and Betz (1981) in regards to the career development of woman. For this study, on the mathematics self-efficacy scale, males self-reported a higher mathematics self-efficacy than females. These results support the numerous research studies (Baxter et al., 2017; Betz & Hackett, 1983; Cordero et al., 2010; Junge & Dretzke, 1995; Parjares & Miller, 1994; Peters, 2012) that indicate that males self-report higher mathematics self-efficacy expectations than females. In a research study conducted by Junge and Dretzke (1995), males reported a higher mathematics self-efficacy on over 25% of the items when compared to their female counterparts, and Peters (2012) insisted that females scored nearly 12 points lower than males when comparing self-efficacy scores. Junge and Dretzke (1995) insisted that females typically judge their mathematics self-efficacy lower than males for tasks that require quantitative skills, but these differences disappear when judging their mathematics self-efficacy for tasks that are stereotypically feminine tasks. Perceived self-efficacy greatly affects one's career options (Bandura, 1997). In the current study, although males self-reported a higher mathematics self-efficacy, no statistically significant differences were found based on gender. These findings also confirm Hall and Ponton's (2005) research, which showed no statistically significant difference in the mathematics self-efficacy of Intermediate Algebra nor Calculus I students based on gender.

When utilizing the Approximate Percentile Equivalents for Math Self-Efficacy Scores chart provided by Betz and Hackett (1993), the current study indicated that the mean MSES score for male Quantitative Literacy students was 6.35 (*SD* = 1.49), which falls in the 40 – 50th percentile. The Approximate Percentile Equivalence for Math Self-Efficacy Scores can be found in Table 15. This indicates that male Quantitative Literacy students exhibit a higher level of mathematics confidence than nearly 50% of the male population. The findings differ from previous research studies focusing on the mathematics self-efficacy of students based on gender. In Hall and Ponton's (2005) study of Intermediate Algebra and Calculus students, male Intermediate Algebra students self-reported a mean MSES score of 5.39 (*SD* = 1.30), which would fall into the 20-30th percentile. Similarly, the male students in a research study conducted by Baxter et al. (2017) self-reported a mean MSES score of 5.98 (*SD* = 1.17), and this mean score falls into the 30- 40th percentile. Conversely, the male Calculus students in Hall and Ponton's (2005) study self-reported a mean MSES score of 7.11 (*SD* = 1.05), which falls into the 70-80th percentile. When comparing the mean MSES of each group, male Quantitative Literacy and Calculus students appear to possess a higher level of confidence in their mathematical ability.

Analyzing the mean MSES score of female students using the Approximate Percentile Equivalents for Math Self-Efficacy Scores produces similar results. The mean MSES score of female Quantitative Literacy students' (M = 5.89; SD = 1.63) results are contrary to previous findings, as they fall into the 50-60th percentile. The findings for Hall and Ponton's (2005) Intermediate Algebra female students along with the results for the female students in Baxter et al.'s study (2017) indicated that the female students in their respective studies fell into the 30th-40th percentile (*M* = 5.29, *SD* = 1.54; *M* = 5.24, *SD* = 1.27). The female Calculus students self-reported a higher MSES (*M* = 7.05, *SD* = 1.26) and were in the 80-90th percentile. Overall, similar to male students, female Quantitative Literacy and Calculus students appear to possess a higher level of confidence in their mathematical ability.

Table 15

Approximate[a] *Percentile Equivalents for Math Self-Efficacy Scores*

Percentile	Total Score[b]	
	Females	Males
95	7.9	8.5
90	7.5	8.1
80	6.9	7.5
70	6.5	7.1
60	6.1	6.7
50	5.8	6.4
40	5.5	6.1
30	5.1	5.7
20	4.7	5.3
10	4.1	4.7
05	3.7	4.3

Note. Percentiles other than those listed could be interpolated from the data provided here; however, these values are approximate rather than exact.

[a]Based on normal curve equivalents.

[b]Average of scores on Math Tasks and College Courses Subscales.

Research Question Three

Is there a difference in the mathematics self-efficacy, as measured by the Mathematics Self-Efficacy Scale, of Quantitative Literacy students based on method of placement (high school multiple measures, placement test scores, or completion of developmental mathematics courses)?

Null Hypothesis Three

There is no significant difference in mathematics self-efficacy, as measured by the Mathematics Self-Efficacy Scale, based on method of placement (high school multiple measures, placement test scores, completion of developmental mathematics courses) of Quantitative Literacy students.

No previous research studies were found that examined the differences in the mathematics self-efficacy of students based on method of placement. Students enrolled in the Quantitative Literacy course were previous developmental mathematics students or students deemed college-ready via college placement exam or meeting the multiple measure criteria as outlined by the North Carolina Community College System. Hall and Ponton (2005) conducted a research study comparing the mathematics self-efficacy of developmental and college-level curriculum mathematics students and found a statistically difference between the two groups. The current research study differs from Hall and Ponton's (2005) study in that for the current study, students who needed developmental mathematics courses prior to enrolling in the Quantitative Literacy course had already successfully completed them and thus were no longer considered developmental students. All students in the Quantitative Literacy course were deemed college-ready at the time of survey completion.

Baxter et al. (2007) suggested that developmental students may enter the classroom apprehensive and with a belief that they will not be successful. This apprehension and low self-confidence may contribute to a lower self-reported mathematics self-efficacy. For this research study, although no significant differences were found based on method of placement into the Quantitative Literacy course, students who had to complete a developmental mathematics course in order to meet the prerequisite for the Quantitative Literacy course self-reported a lower mathematics self-efficacy (M = 5.82, SD = 1.65) when compared to students who met the pre-requisite via appropriate placement exam scores (M = 6.31, SD = 1.46) or high school multiple measures criteria (M = 6.15, SD = 1.57). To meet the criteria to be deemed college ready upon entrance into the college implies that the students experienced some form of academic success during their educational journey. Bandura (1997) suggested that experiencing success can strengthen one's self-efficacy, while experiencing failure usually weakens it.

Additional Findings (MSES and Age)

Research study participants self-reported their age as part of the demographic information collected. Jameson and Fusco (2014) defined traditional aged students as students younger than 25 years old. The current research study results indicate that no statistically significant difference exists in the mathematics self-efficacy of students based on their status of traditional or non-traditional aged students, $t(176) = -1.823$, $p = .070$. Traditional aged students (n = 100) self-reported a mean MSES score of 5.85 (SD = 1.51) and non-traditional aged students (n = 78) self-reported a mean MSES score of 6.28 (SD = 1.65). Research results support the findings of Baxter et al. (2017). Although Baxter et al. were unable to display statistical significance due to a low sample size, data analysis revealed that nontraditional students scored higher on the MSES when compared to their traditional peers. These findings contradict a study conducted by

Jameson and Fusco (2014), which indicated that non-traditional students reported a lower level of mathematics self-efficacy when compared to traditional students. Regardless of how students met the prerequisites for Quantitative Literacy, all students should possess the necessary background knowledge required for the course. Hall and Ponton (2005) posited that the older students are, the less familiar they become with mathematical concepts and thus their perceived mathematics self-efficacy declines.

Implications

No previous research studies were found that compared the mathematics self-efficacy of face-to-face and online students. Research findings add to the body of knowledge regarding mathematics self-efficacy and delivery method, gender, method of placement, as well as age. The present study may assist instructors and administrators as they analyze institutional data comparing success and attrition rates of online and face-to-face mathematics students. When determining the superior delivery method, research results are mixed as a majority of studies suggest that the face-to-face learning environment produces the more favorable results (Amro, Mundy, & Kupczynski, 2015; Atchley, Wingenbach, & Akers, 2013; Huston & Minton, 2016; Sohn & Romal, 2015; Xu & Jaggars, 2011, 2014). The results of the current study indicate that online students possess a higher mathematics task self-efficacy and math-related school subjects' self-efficacy than their face-to-face counterparts, thus should achieve at a higher level. If higher mathematics self-efficacy equates to higher mathematical achievement, then for mathematics courses, the online environment should produce the more favorable results, as previous research has recognized the vital connection between mathematics self-efficacy and academic performance (Peters, 2012; Usher, 2009).

Along with lower success rates (Atchely et al., 2013; Huston & Minton, 2016; Xu & Jaggars, 2011), research studies also suggest that online courses often have higher attrition rates (Fonolahi et al., 2014; Nelson, 2006; Zavarella & Ignash, 2009). Students enroll in online courses for a plethora of reasons, and employment, convenience, and flexibility appear to be the major ones (Jaggars, 2014). The current research study found online students possessed a high level of mathematics self-efficacy, and this level of mathematics self-efficacy implies that students are confident in their mathematical ability. Dweck (2000) argued that confidence can be an accurate predictor of academic achievement, as long as difficulties are nonexistent. Administrators and instructors must seek to determine if certain aspects of the online learning environment or reasons for students choosing the online learning environment contribute to the overall lack of success for online students.

Limitations

The research study had limitations in terms of threats to validity. Select Quantitative Literacy courses were chosen from seven of the 58 North Carolina community colleges. While all students invited to participate in the study received the same recruitment email, approximately 51% of the online students who completed the survey were enrolled in a Quantitative Literacy course at Community College D. Community College D, located in central North Carolina, was the largest community college in the study with a curriculum enrollment of 21,747 for fall 2016. Community College A, located in eastern North Carolina had zero online students complete the survey. With half of the data for online students stemming from one community college, it is difficult to imply that the research study results are representative of all North Carolina community college students.

Due to a low response rate, a seventh community college was invited to participate in the study seven weeks into the semester and the survey was open to all students longer than anticipated. Some students completed the survey within the first four weeks of the semester, while Community College G students entered the study around week eight of the semester. For this study, the researcher wanted to measure the level of mathematics self-efficacy a student possessed when entering the course, before a large amount of course content was covered. Depending on the topics covered in the Quantitative Literacy course, a students' mathematics self-efficacy could have increased or decreased from the time the course started and the time they had completed the survey. This change in mathematics self-efficacy could have resulted from the course content and does not accurately represent the mathematics self-efficacy possessed prior to classes starting.

Recommendations for Future Research

No previous research study was found that compared the mathematics self-efficacy of face-to-face and online students. Given the results of this study, the researcher suggests the following areas for future research:

- Replicate the current research study using a different gateway mathematics course.
- Expand the research study to include final course grades to determine if final course grades correlate with the reported mathematics self-efficacy.
- Conduct a study to determine if including growth mindset activities in a college level mathematics courses increases students' mathematics self-efficacy.
- Further investigate the mathematics self-efficacy of students based on the method of placement.

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APPENDIX A

IRB APPROVAL

LIBERTY UNIVERSITY.
INSTITUTIONAL REVIEW BOARD

January 19, 2018

LaRonda Lowery
IRB Exemption 3097.011918: A Causal Comparative Analysis of Mathematics Self-Efficacy of Face-to-Face and Online Quantitative Literacy Students

Dear LaRonda Lowery,

The Liberty University Institutional Review Board has reviewed your application in accordance with the Office for Human Research Protections (OHRP) and Food and Drug Administration (FDA) regulations and finds your study to be exempt from further IRB review. This means you may begin your research with the data safeguarding methods mentioned in your approved application, and no further IRB oversight is required.

Your study falls under exemption category 46.101(b)(2), which identifies specific situations in which human participants research is exempt from the policy set forth in 45 CFR 46:101(b):

(2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless:
(i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

Please note that this exemption only applies to your current research application, and any changes to your protocol must be reported to the Liberty IRB for verification of continued exemption status. You may report these changes by submitting a change in protocol form or a new application to the IRB and referencing the above IRB Exemption number.

If you have any questions about this exemption or need assistance in determining whether possible changes to your protocol would change your exemption status, please email us at [redacted]

Sincerely,

[redacted]

Administrative Chair of Institutional Research
The Graduate School

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APPENDIX B

CHANGE IN PROTOCOL APPROVAL

IRB Change in Protocol Approval: IRB Exemption 3097.011918: A Causal Comparative Analysis of Mathematics Self-Efficacy of Face-to-Face and Online Quantitative Literacy Students

IRB, IRB

Mon 2/19/2018 11:26 AM

To Lowery, LaRonda

Good Morning LaRonda,

This email is to inform you that your request to utilize ɛ as a study site for your research has been approved. Thank you for submitting documentation of permission from

Thank you for complying with the IRB's requirements for making changes to your approved study. Please do not hesitate to contact us with any questions.

We wish you well as you continue with your research.

Best,

Administrative Chair of Institutional Research
The Graduate School

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APPENDIX C

CONSENT FORM

The Liberty University Institutional
Review Board has approved
this document for use from
1/19/2018 to --
Protocol # 3097.011918

CONSENT FORM

A Causal Comparative Analysis of Mathematics Self-Efficacy of Face-to-Face and Online Quantitative Literacy Students

LaRonda Lowery
Liberty University
School of Education

You are invited to be in a research study that seeks to examine the mathematics self-efficacy of face-to-face and online community college quantitative literacy students in North Carolina. You were selected as a possible participant because you are enrolled in one of the selected Quantitative Literacy courses at your Community College. Please read this form and ask any questions you may have before agreeing to be in the study.

LaRonda Lowery, a doctoral candidate in the School of Education at Liberty University, is conducting this study.

Background Information: The purpose of this study is to determine if a difference exists in the mathematics self-efficacy of North Carolina community college quantitative literacy students when choosing to enroll in a face-to-face course versus an online course.

Procedures: If you agree to be in this study, I would ask you to do the following things:

1. Complete an anonymous survey that contains demographic questions and the Mathematics Self-Efficacy Scale. The survey should take no more than 15 minutes to complete.

Risks: The risks involved in this study are minimal, which means they are equal to the risks you would encounter in everyday life.

Benefits: Participants should not expect to receive a direct benefit from taking part in this study.

Benefits to society include an increase in the body of knowledge regarding the mathematics self-efficacy of face-to-face and online community college students. Given that no research studies that examined the mathematics self-efficacy of online students were found, this research study will add significant results to the current empirical research on mathematics self-efficacy.

Compensation: Participants will be given the opportunity to enter their email address at the end of the survey to be entered into a drawing for one of four $25 Visa gift cards. Email addresses entered at the end of the survey will be separated from the survey data and will not link to your survey responses.

Confidentiality: The records of this study will be kept private. In any sort of report I might publish, I will not include any information that will make it possible to identify a subject. Research records will be stored securely, and only the researcher will have access to the records.

- No identifying information will link participants to survey responses.

The Liberty University Institutional
Review Board has approved
this document for use from
1/19/2018 to --
Protocol # 3097.011918

- Data will be stored on a password locked computer and may be used in future presentations. After three years, all electronic records will be deleted.

Voluntary Nature of the Study: Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with Liberty University or your Community College. If you decide to participate, you are free to not answer any question or withdraw at any time prior to submitting the survey without affecting those relationships.

How to Withdraw from the Study: If you choose to withdraw from the study, please exit the survey and close your internet browser. Your responses will not be recorded or included in the study.

Contacts and Questions: The researcher conducting this study is LaRonda Lowery. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact her a[redacted] You may also contact the researcher's faculty advisor, [redacted]

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the Institutional Review Board, 1971 University Blvd., Green Hall Ste. 1887, Lynchburg, VA 24515 or email a[redacted]

Please notify the researcher if you would like a copy of this information for your records.

APPENDIX D

SAMPLE ITEMS FROM THE MSES

Name or I.D.____

Part I

No Confidence at all	Very little Confidence			Some Confidence		Much Confidence		Complete Confidence	
0	1	2	3	4	5	6	7	8	9

How much confidence do you have that you could successfully:

1. Add two large numbers (e.g., 5379 + 62543) in your head....................................	0	1	2	3	4	5	6	7	8	9
2. Determine the amount of sales tax on a clothing purchase.	0	1	2	3	4	5	6	7	8	9
3. Figure out how much material to buy in order to make curtains.........................	0	1	2	3	4	5	6	7	8	9
4. Determine how much interest you will end up paying on a $675 loan over 2 years at 14 3/4% interest.	0	1	2	3	4	5	6	7	8	9
5. Multiply and divide using a calculator.	0	1	2	3	4	5	6	7	8	9

APPENDIX E

PERMISSION LETTER FROM COLLEGE

10/24/17

LaRonda Lowery
Doctoral Student, Liberty University
[redacted]

Dear LaRonda Lowery:

After careful review of your research proposal entitled A Casual Comparative Analysis of Mathematics Self-Efficacy of Face-To-Face and Online Quantitative Literacy Students, we have decided to grant you permission to conduct your study at [redacted]

Check the following boxes, as applicable:

☑ Data will be provided to the researcher stripped of any identifying information.

☑ I/We are requesting a copy of the results upon study completion and/or publication.

Sincerely,

[redacted]

[redacted]
Director of Institutional Effectiveness/Planning
[redacted]

APPENDIX F

RECRUITMENT EMAIL

Dear Quantitative Literacy Student:

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for a Doctor of Education degree in Educational Leadership. The purpose of my research is to determine if there is a significant difference in the mathematics self-efficacy of North Carolina community college quantitative literacy students when choosing to enroll in a face-to-face course versus an online course, and I am writing to invite you to participate in my study.

If you are 18 years of age or older, are enrolled in a college quantitative literacy course, and are willing to participate, you will be asked to complete a survey. It should take approximately 15 minutes for you to complete this procedure. Your participation will be completely anonymous, and no personal, identifying information will be collected.

To participate, click here and complete the survey.

A consent document is provided as the first page you will see after you click on the survey link. The consent document contains additional information about my research. Please click on the "Next" button at the end of the consent information to indicate that you have read the consent information and would like to take part in the survey.

If you choose to participate, you will have an opportunity at the end of the survey to enter your email address in a raffle for a chance to receive one of four $25 Visa gift cards. Email addresses entered at the end of the survey will be separated from the survey data and will not link to your survey responses.

Sincerely,

LaRonda Lowery
Doctoral Student, Liberty University

APPENDIX G

FOLLOW-UP EMAIL

Dear Quantitative Literacy Student:

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for a Doctor of Education degree in Educational Leadership. Last week, an email was sent to you with an invitation to participate in a research study. This follow-up email is being sent to remind you to complete the survey if you would like to participate and have not already done so. The deadline for participation is March 8, 2018.

If you choose to participate, you will be asked to complete a survey. It should take approximately 15 minutes for you to complete this procedure. Your participation will be completely anonymous, and no personal, identifying information will be collected while completing the survey.

To participate, click here and complete the survey.

A consent document is provided as the first page you will see after you click on the survey link. The consent document contains additional information about my research. Please click on the "Next" button at the end of the consent information to indicate that you have read the consent information and would like to take part in the survey.

If you choose to participate, you will have an opportunity at the end of the survey to enter your email address in a raffle for a chance to receive one of four $25 Visa gift cards. Email addresses entered at the end of the survey will be separated from the survey data and will not link to your survey responses.

Sincerely,

LaRonda Lowery
Doctoral Student, Liberty University

APPENDIX H

PERMISSION TO INCLUDE COPYRIGHT MATERIAL

For use by LaRonda Lowery only. Received from Mind Garden, Inc. on January 20, 2018

mind garden

www.mindgarden.com

To whom it may concern,

This letter is to grant permission for the above named person to use the following copyright material;

Instrument: ***Mathematics Self-Efficacy Scale***

Authors: ***Nancy E. Betz & Gail Hackett***

Copyright: ***1993 by Nancy E. Betz and Gail Hackett***

for his/her thesis research.

Five sample items from this instrument may be reproduced for inclusion in a proposal, thesis, or dissertation.

The entire instrument may not be included or reproduced at any time in any other published material.

Sincerely,

[redacted], Inc.
www.mindgarden.com