EXAMINING THE BELIEFS, ACADEMIC ACHIEVEMENTS, AND BACKGROUND CHARACTERISTICS OF STUDENT'S ENROLLED IN QUANTITATIVE REASONING AND PRE-CALCULUS I AT A COMMUNITY COLLEGE

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Submitted to the Faculty of the
Graduate College of the
Oklahoma State University
in partial fulfillment of
the requirements for
the Degree of
DOCTOR OF PHILOSOPHY
July, 2020

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ACKNOWLEDGEMENTS

Completing a doctoral degree is by far one of the most difficult challenges I have taken on thus far in my life. I could not have finished this journey without an amazing support system. The support that I have received through these 4 years has driven me to complete the tasks of coursework, research, reading, writing a dissertation, and ultimately in the earning of my degree.

First I would like to thank my supportive committee members; Dr. Jennifer Cribbs, Dr. Adrienne Sanogo, and Dr. Mindy McCann. Thank you for all of your help in analyzing data, giving me constructive feedback, and encouraging me throughout the process. I want to give a special thank you to my advisor and dissertation chair, Dr. Juliana Utley. I could not have finished this without your guidance, leadership, patience, and dedication throughout this process. I can truly say that your encouragement has been a driving force in the completion of this study.

To my classmates, I will always cherish the relationships that we have built through study groups, text messages, and phone calls. Thank you Autumn, Tonya and Kristin for always encouraging me when I wanted to give up as well as continuing to push me to be a better student. A special thank you to my carpool buddy and co-worker Josh for helping me through this dissertation process, as well as answering all of my questions every time I would come into your office.

My family has played a very important role in the completion of my degree. To my mother Donna, thank you for always encouraging me to be great ever since I was a child, also for all of the help with your granddaughter throughout this process, from picking her up from school, to taking her to cheer practice. Thank you to my brother David who has always cheering me on and for pushing me to be a better sister. To my daughter, Tyjanae, you were my main reason for completing this journey, to be able to show you that you that hard work and dedication pays off. I want to thank you for being understanding through all of the times I had to go to class and all the time I spent writing. Hopefully, you will look back and realize the benefits this has given our family.

Lastly, to my husband Howard, there are no words to tell you how much I appreciate you. From the beginning, you were understanding when I told you that I wanted to leave my full time job and pursue this journey. You have encouraged me to write when I wanted to give up, you pushed me when I needed it, you were there when I cried, and you never lost faith that I could complete this journey. Thank you so much for taking care of the family and the house duties in order for me to work. Without you this journey would not have been possible.

Acknowledgements reflect the views of the author and are not endorsed by committee members or Oklahoma State University.

Name: LATOYA JOHNSON

Date of Degree: JULY, 2020

Title of Study: EXAMINING THE BELIEFS, ACADEMIC ACHIEVEMENTS, AND BACKGROUND CHARACTERSTICS OF STUDENT'S ENROLLED IN QUANTITATIVE REASONING AND PRE-CALCULUS I AT A COMMUNITY COLLEGE

Major Field: EDUCATION

Abstract: College Algebra has been the main credit bearing mathematics course for many college students, but only one in five students at the community college level were passing this course. Students that did not have a mathematics dependent major seen College Algebra as a gatekeeper for completing college. With several students struggling to complete College Algebra, new mathematical pathways were created that gave students the option to take other courses such as Quantitative Reasoning in order to fulfill their college mathematics credit.

The Midwestern College, where this study took place, chose to incorporate a new QR course for students. With the incorporation of this new course, it is important for instructors to know who are now in these classes in order to develop interesting and relatable material, thus this study examined 230 participants demographics, achievement, and belief characteristics in both QR and Pre-Calculus I (i.e., College Algebra). The study also looked at any differences in characteristics between the two groups as well as differences between students that were successful and unsuccessful in each course. Last, the study look at the combination of characteristics that could predict student's success (final curse grade) in each course.

University records provided high school GPA and ACT mathematics and composite scores, while a face-to-face self-reporting survey was used to gather data on demographics, mathematics identity, grit, mathematics attitudes, anxiety, and self-efficacy. This dissertation presents the findings from the data collected.

The findings from this study indicate that demographics for the two courses are similar, but Pre-calculus I (PC-I) students had a significantly higher ACT composite and mathematics score, identity score, and effectance motivation. Additionally, the study found that females were more successful than males in PC-I and students that successfully complete QR had a higher consistency of interest. A binary logistics regression indicated that consistency of interest and the usefulness of mathematics were predictors of success for students in the QR course. High school GPA, gender, and self-efficacy were predictors of success for the students in the PC-I course. This insight will help instructors to develop activities and curriculum to aid in the success of students.

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CHAPTER I

Introduction

The entry-level mathematics course for many higher education institutions is College Algebra. College Algebra was designed to develop students' algebraic skills and prepare them for Calculus I, although many students struggled to pass. According to Herriott and Dunbar (2009), less than half of students who complete College Algebra ever take a calculus course and only about 10 - 15% plan on majoring in fields that require higher-level mathematics.   Thus, the examination of how many students that were enrolling in College Algebra and not passing, and the fact that most students did not require a math-intensive curriculum, demonstrated that not all students needed College Algebra as their entry-level mathematics course (Gaze, 2018).

This realization has resulted in researchers (e.g., Kashyap & Mathew, 2017; Smith & Thompson, 2007; Tennant, 2014) exploring alternate courses for students to meet their college-level mathematics requirements. Fortunately, “some success has been seen with adult students in approaching mathematics from a practical, problem-solving stance, allowing students to connect to current learning with life experiences” (Tennant, 2014, p. 25).   Thus, some colleges across the United States have set the requirement for some majors as Quantitative Reasoning (QR), where content relates more to real-world applications than a typical algebra course. For example, Kashyap and Mathew (2017) suggest that QR focuses on real-world problems, critical thinking, and problem-solving skills including topics such as “logic, arguments, reasoning, and problem-solving, mathematical finance (loan, credit card, mortgage), tax, federal budget, linear, and exponential models, as well as some geometry topics” (p. 23).

When comparing the performance of students in College Algebra and a QR class, Van Peursem, Keller, Pietrzak, Wagner, and Bennett (2012) found that the QR course "proved to be a worthwhile alternative to the traditional College Algebra course for students, especially those with weaker mathematics backgrounds" (p. 113). So why do students that have not always been perceived as a mathematics person, seem to have more success in the QR course than the College Algebra course? What do educators know about QR students enrolled in their classes? With student’s having a choice between QR and College Algebra, it is important to understand who is choosing to take each of these courses as well as both the beliefs and academic characteristics, as we can no longer rely on what these were in the past. Instructors need to understand the attitudes and beliefs of their students in order to anticipate their needs and create lessons to address these needs (Cifarelli, Goodson-Epsy, & Chae, 2010). Understanding these characteristics will provide administrators and faculty support to create a curriculum that relates to student's majors and aids in student success.

Background of Problem

College Algebra was designed to prepare students for upper-level college mathematics courses, but students that do not have a math-based major see College Algebra as a gatekeeper to obtaining a degree (Ganza & Mazzariello, 2018). Many students that enter college are not prepared for college-level mathematics. Only one in five students at the community college level pass a college-level mathematics course in their first year, and there is only a 50% pass rate at four-year universities (Complete College of America, 2012).

With the number of students failing to get through college-level math courses during their first year of college, educators realized that students could excel in their major by taking an alternate mathematics course (Gaze, 2018). In 2015, the Mathematical Association of America (MAA) recommended the implementation of several mathematics pathways aligned to specific majors, with some introducing basic statistics, modeling, and calculations (Saxe & Braddy, 2015). Thus, the development of QR, as an alternative course, started to flourish across the United States.

Quantitative reasoning can be described in a variety of ways. Elrod (2014) defined QR as “the application of basic mathematics skills, such as algebra, to the analysis and interpretation of real-world quantitative information in the context of discipline or interdisciplinary problem to draw conclusions that are relevant to students in their daily lives” (p. 5). Steen (2004) suggested that QR is “sophisticated reasoning with elementary mathematics rather than elementary reasoning with sophisticated mathematics” (p. 9). QR requires students to use basic mathematical skills to solve complex problems and develop the skills needed for the decision-making process. Additionally, Smith and Thompson (2007) argued that QR would help students “bridge the gap between algebraic and arithmetic reasoning” (p. 102) as it relates to real-world problem-solving.

With the inclusion of this new QR course, it is crucial for faculty to have an understanding of who each group of students are and the differences that they may have (Bettinger, Boatman, & Long, 2013). In order for educators to be effective, they can not only focus on a student's cognitive or previous level of academic success, but they must have an understanding of the characteristics that impact student success (Higbee & Thomas, 1999). For example, instructors need to know their students' needs to develop appropriate instructional material that promotes a positive attitude towards mathematics (Cifarelli, Goodson-Epsy, & Chae, 2010).

There are several beliefs and academic achievement variables that influence the way students learn mathematics. Factors such as student ACT scores, grade point average (GPA), self-efficacy, and identity have been shown to predict student success in mathematics. For example, Arens et al. (2017) stated that "school grades and standardized test scores are the two most commonly used indicators of students' achievement" (p. 623). Schoenfeld (1989) found a strong correlation between students' grades and factors related to identity. Bong and Skaalvik (2003) found that self-efficacy relates positively to intrinsic motivation, task choice, task values, and persistence.

In order to improve student success in college-level mathematics courses, these factors (e.g., ACT scores, GPA, grit, self-efficacy, math attitudes, and identity) should be examined more closely. The community college in this study recently created a new mathematics pathway for students, based on whether they are STEM or non-STEM majors, which includes QR. With the introduction of new courses, such as QR, the curriculum must continually be redeveloped to meet students' needs. Being able to understand the characteristics of the students taking QR and College Algebra will help faculty create lessons that cater to both groups of students.

Statement of Problem

Research suggests that many first-year students entering college are not prepared to be successful in College Algebra, and institutions of higher education were experiencing high dropout and failure rates in College Algebra (e.g., Bailey et al., 2010; Conley, 2017; Royer & Bayer, 2018). Thus, educators believed there was a need to re-examine the traditional mathematics path of College Algebra for all students. Upon this re-examination, educators decided that for some degree paths, what students needed was a quantitative literacy or quantitative reasoning course. This course would support students' understanding of everyday mathematical situations such as "evaluating data in charts and understanding the importance of interest rates when it comes to making financial decisions" (Van Peuresen et al., 2012, p. 107). Thus, some colleges have changed their entry-level pathways so that students, depending on their degrees, can take a QR or College Algebra (Ganza & Mazzariello, 2018).

While there have been many studies (e.g., Goolsby, 1988; Lu, Weber, Spinath, Shi, 2011; Van Peursem et al., 2012) that have examined different achievement factors and beliefs related to student learning in College Algebra, there has been little research related to students enrolled in QR. Additionally, the lives of students are stimulated by different demographic factors such as race and parents' education. In order for teachers to be effective, there is a need to know the demographics of their students and to understand that students are influenced by these characteristic. Thus there is a need to examine the demographics of the students now enrolling in College Algebra since there could be a shift in the student population. The institution where this study took place has recently added a QR course as an option for students to take other than College Algebra, or Pre-calculus I (PC-I) as it is listed at the institution. Since this is a relatively new course for instructors, examining the characteristics of these two groups of students will provide insight into lesson presentations that relate to the students and their interests. This study will examine any differences in the demographics as well as beliefs and achievement factors between PC-I (i.e., College

Algebra) and QR students, and which of these factors predict student success in these courses.

Purpose Statement & Research Questions

Many higher education institutions are developing new mathematics pathways for students to pursue as they strive to complete their college degrees. With the introduction of these new mathematics pathways, the institution in this study took an approach of QR for students pursuing a non-STEM focused degree and Pre-Calculus I for those seeking a STEM-focused degree program. With this focus on students pursuing STEM or non-STEM related careers, instructors must have a picture of the students for whom they will be providing instructional opportunities, and it is difficult to know how the characteristics (demographics, beliefs, and achievements) of students have changed in these courses. Thus, this study will aid in providing insight and exploring any differences between these factors for students in the two courses and if these factors are predictors of success in these courses. The following research questions will guide this study:

1. What are the characteristics (i.e., demographics, achievements, and beliefs) of college students enrolled in Quantitative Reasoning and college Pre-calculus I (i.e., College Algebra) at one campus of a large Midwestern community college?
2. Are there significant differences in the characteristics (i.e., demographics, achievements, and beliefs) between students enrolled in Quantitative Reasoning and Pre-calculus I (i.e., College Algebra) at one campus of a large Midwestern community college?

3. Are there significant differences in characteristics (i.e., demographics, achievements, and beliefs) between students enrolled in Quantitative Reasoning based on whether they were successful in the course?
4. Are there significant differences in characteristics (i.e., demographics, achievements, and beliefs) between students enrolled in Pre-calculus I (i.e., College Algebra) based on whether they were successful in the course?
5. What combinations of characteristics (i.e., demographics, achievements, and beliefs) for college students enrolled in Quantitative Reasoning are predictors of success?
6. Which combination of characteristics (i.e., demographics, achievements, and beliefs) for college students enrolled in Pre-calculus I (i.e., College Algebra) are predictors of success?

Significance of Study

One goal of an educator is to develop engaging and connected curricular materials that meet students' needs. Knowing students' attitudes and beliefs about mathematics and their level of academic success allow instructors to anticipate learners' needs and develop appropriate instructional materials to address these needs and promote positive mathematical attitudes (Cifarelli, Goodson-Epsy, & Chae, 2010). Thus, to create a curriculum that students find useful and that encourages student success, this study will examine the characteristics of the students enrolled in each of these courses. This research project intends to generate knowledge that could be shared with faculty and curriculum leaders at the college level to develop engaging and relevant curriculum units and to ensure students' success rates.

Assumptions, Limitations, and Delimitations

The first assumption for this study is that there is a potential difference between the two groups of students because the STEM-focused students take College Algebra and the non-STEM students take QR. Secondly, it will be assumed that participants in the study will respond honestly to all parts of the study, and the participants will understand the questions being asked.

Limitations focus on things that are weaknesses of the study and/or things that are out of control of the researcher (Simon & Goes, 2013). The study will be limited to students enrolled in either PC-I (i.e., College Algebra) or QR courses who agree to consent to this research project. Another limitation was that the study took place during the coronavirus pandemic. All classes went online for the last six weeks of the semester, which may have affected drop rates and overall grades.

Delimitations are used for a researcher to narrow the focus of the study. One delimitation of the study is that the population of the study will only consist of students enrolled at one campus of a multi-campus community college. Also, the study did not include any students that are concurrently enrolled. All participants in this study were 18 or older and not currently high school students.

Definition of Terms

- *Achievement factors* – factors that are linked to the educational processes such as the ACT, GPA, and placement test
- *Grit* – one's capacity to dig deep and do whatever it takes-even sacrifice, struggle and suffer-to achieve their most worthy goals in the best ways (Duckworth, 2007)

- *Math anxiety* – "tension, apprehension, and fear of situations involving math" (Yang, 2014, p. 28)
- *Math confidence* – the confidence in one's ability to learn and do well on a mathematical task (Fennema & Sherman, 1976)
- *Math identity* – whether a person views themselves as a math person or not (Gonzalez, 2017)
- *Math usefulness* – an attitude that one holds about the need for math now and in their future (Reyes, 1984)
- *Self-efficacy* – an individual's perception of whether they possess the skills or ability to complete a given task (Bandura, 1977)

Summary and Organization of the Study

With the offering of an alternative mathematics course to College Algebra for students who have lower math skills than others and for students who are not pursuing an algebra-based degree, it is imperative to understand both the achievement characteristics (i.e., ACT, placement scores) and beliefs (i.e., demographics, math identity) of students enrolled in these classes. Thus, the purpose of this study is to gain a more in-depth insight into any differences between students enrolled in the PC-I (i.e., College Algebra) course and the students enrolled in the QR course. Since the composition of student characteristics in these two courses may be different, this information can aid faculty with curricular decisions that are specific to the audience they are teaching.

This study is organized in a five-chapter format. This chapter provided an introduction to the study, the problem, purpose, and significance of the study, as well as the research questions and significant definitions. Chapter II will include a review of the literature related to quantitative reasoning, including the history and prior research, as well as a review of the literature over the demographics of the traditional college student and the cognitive and non-cognitive factors listed in the research questions. Chapter III will give an outline of the research design and methodology of this study for potential future replication. The section will address the study's goals and objectives, the research approach, the variables examined, the instrument used to collect data, and the research design. The analysis of the data will be presented in Chapter IV, while the findings of the study, the conclusion, implications, and recommendations for future research will be discussed in Chapter V.

CHAPTER II

Review of Literature

The overarching goal of this study is to gain a better understanding of the academic and belief factors of students now enrolling in their choice of one of two entry-level courses, Pre-Calculus I or Quantitative reasoning. Specifically, this study provides researchers with a better understanding of the characteristics of students enrolled in either a Pre-Calculus I or Quantitative reasoning course at one campus of a large Midwestern community college. Also, this study will explore differences in the characteristics of students in these two courses. Lastly, this study will attempt to determine characteristics that are predictors of the success of college students enrolled in Pre-calculus I and Quantitative Reasoning courses. Thus, research that is relevant to this study includes a brief overview of College Algebra, as well as exploring quantitative reasoning as a new course. The topics covered in this review include:

1. College Algebra: A Historical Overview
2. Quantitative Reasoning: A New Course
3. Achievement Factors That Influence Mathematics
4. Belief Factors That Influence Mathematics

College Algebra: A Historical Overview

College Algebra was introduced as a course in the middle of the 18th century at higher education institutions such as Harvard and Yale. It was an elite course designed to prepare privileged students for upper-level mathematics courses such as differential calculus (Gaze 2018; Tunstall, 2018). During the early 19th century, there was a need for secondary students to be able to apply algebraic concepts in real-world contexts such as surveying and navigation; therefore, the study of algebra made its way into secondary schools (Kilpatrick & Iszak, 2008). During the 19th and 20th centuries, public schools became more common, and college enrollment increased, no longer just for the elite. This increase in enrollment led to colleges requiring all students to have College Algebra as a requirement for admissions, which in turn pushed the teaching of algebra into secondary schools (Gordon, 2008). While students were studying algebra in secondary school and colleges were expecting them to begin their college mathematics coursework with calculus, students that were enrolling were not ready for calculus; thus, College Algebra evolved as the option for these students (Gaze, 2018).

Over the last six decades, the population of the United States has doubled, which has caused an increase in the number of students attending college by roughly ten-fold (Gordon, 2008). This increase in enrollment has also caused an increase in the number of students taking College Algebra, with over 480,000 students enrolling in the course in 2010 (Tunstall, 2018). Today College Algebra is still being required of most students and being taught as a pathway to calculus, when in reality College Algebra is their only required course (Herriott, 2006). Dunbar (2006) found that only 29% of students that take College Algebra take business calculus, with only 1% making it to the third course in the calculus sequence. Dunbar (2006) also found that 20% of students have to retake College Algebra due to failing or withdrawing from the course.

College Algebra concepts are still required for students pursuing degrees that require calculus. However, for non-STEM related majors College Algebra concepts are not necessarily what students need for their future careers. These students can benefit from developing their quantitative literacy skills that they can apply directly to their daily lives (Todd & Wagner, 2015). Gordon (2008) pointed out that over the past 15 years, there have been significant changes in student's mathematical education due to the changing demographics of students taking college-level mathematics, and the changing mathematics needs of people. Due to these changes, educators realized that College Algebra may not be beneficial to all majors and that students could take a different math course to satisfy their mathematical requirements for their degree program.

Quantitative Reasoning: A New Course

Due to the need for quantitative literacy, but not all students needing College Algebra class for their degrees, a Quantitative Reasoning course was developed. Quantitative Reasoning (QR) is a recently developed course now being offered in many higher education mathematics departments across the U.S. Because QR is a new course, it is important to explore the effectiveness and applicability of the course. In order to capture a picture of QR, it is essential to examine how and why a quantitative reasoning course evolved, topics embedded within the course, and current studies associated with students in this new course.

Defining Quantitative Literacy

The notion of quantitative literacy is the idea of applying mathematics skills to be able to problem-solve throughout life. Steen (2001) defined quantitative literacy as "an aggregate of skills, knowledge, beliefs, dispositions, habits of mind, communication capabilities, and problem-solving skills that people need in order to engage effectively in quantitative situations arising in life and work" (p. 5). This study will use Wilkins (2000) definition, which describes quantitative literacy as the ability to understand mathematics in everyday life. He later expands this definition by stating, "quantitative literacy is more of a habit of the mind characterized by a person's motivation to use quantitative information and shaped by his or her beliefs, values, and attitudes related to mathematics" (Wilkins, 2010, p. 268).

Historical Beginnings

With the continued growth of the population of the United States, combined with the change in demand for careers, the number of students attending college has drastically increased (Gordon, 2008). Historically the job market has called for more STEM graduates. However, now, corporations are seeking college graduates that are "proficient in using quantitative methods for modeling real-life business scenarios and solving complex business problems" (Agustin, Agustin, Brunkow & Thomas, 2012, p. 306). With this change, quantitative literacy must become a part of the learning process for college students.

However, most higher education institutions still offer College Algebra for all students, regardless if they are a STEM or non-STEM major (Gaze, 2008). Most students enrolled in STEM majors still require higher-level mathematics courses, but this need is not the same for non-STEM majors who would benefit more from quantitative mathematics that could be applied directly to their daily lives (Todd & Wagner, 2015).

Since the 1980s, this idea for differentiating the mathematics needs of STEM and non-STEM majors has been a topic of conversation. For example, the United States Department of Education (1983) released the Nation at Risk report calling for every student to be able to use mathematics in their everyday lives. Consequently, in 1989, the Mathematical Association of America (MAA) established a subcommittee on quantitative literacy that explored the quantitative literacy requirements students needed to obtain a degree. The subcommittee came to four conclusions: (1) all college graduates need quantitative literacy, (2) all college graduates should be able to apply mathematics strategies in order to solve real-life problems, (3) colleges and universities should have a leadership department in order to develop a quantitative literacy program, and (4) quantitative literacy programs should be assessed regularly by colleges and universities.

Quantitative literacy was not thought of as a course offering but looked at as a thinking skill that was a necessity in life. However, to make math classes more relevant to students and to improve success rates in college mathematics, various organizations and colleges developed mathematics pathways, a new model of mathematics education (Gonga & Mazzariello, 2018). This new pathway allows students to choose their mathematics course based on their major. A person with a major that is not mathematics-based, such as communication or history, might fulfill their college mathematics requirement with a quantitative reasoning course. In contrast, a mathematics and chemistry major would continue on the traditional algebra pathway.

Quantitative Reasoning as a Course

A QR course was developed to explore topics found in everyday life. The QR course at the college level is intended to help students develop the skills and tools needed to think critically about quantitative information encountered in everyday life. The course highlights solving real-world problems using open-ended exercises that include reading, analyzing, calculating, and reporting results.

Research Related to Quantitative Reasoning as a Course Offering

Recently, there have been studies of many colleges and universities re-evaluating their curriculum and offering a QR course as an alternative to a typical College Algebra course. The purpose of this change in the curriculum was to see if students found this new course more useful in everyday life and if it had a more positive effect on students that were not STEM majors. For example, Tunstall et al. (2016) conducted a study to explore if a quantitative reasoning course would affect how students used mathematics in everyday life compared to a College Algebra Course. The data showed that the course had a positive effect on students' attitudes and showed positive gains in everyday life. Tunstall et al. (2016) stated that "the course appears to be a pragmatic and realistic alternative for students alienated by College Algebra" (p. 8).

In 2005, Southern Illinois University embarked on a new general education plan that incorporated a QR course. Because QR is such a new course, there was skepticism about the effectiveness and applicability. Some of the concerns were that the course was watered-down and that students should come to college numerically literate and therefore do not need this course. Agustin et al. (2012) examined "the claim that students whose degree programs require a significant math component (e.g., calculus) will acquire adequate quantitative reasoning skills as part of their chosen major" (p. 307). The study had students that were enrolled in freshman-level mathematics courses, such as College Algebra and concepts of statistics, to complete a quantitative diagnostic test. The results from the study highlight "the need for a quantitative reasoning course that is not merely a "watered-down" or remedial traditional math course" (p. 311). Additionally, it was found that traditional mathematics courses, such as College Algebra and Pre-calculus, do not provide quantitative literacy skills because of course objective differences.

Van Peursem et al. (2012) concluded that a quantitative literacy course was a good alternative to the traditional College Algebra course for students who possessed weaker mathematics skills at the University of South Dakota. The students in the quantitative literacy course "reported higher perceptions of usefulness of mathematics and in the ability to transfer their knowledge to other situations" (p. 113).

By examining the research of this new alternative to College Algebra, it seems that students that have to take this course find it to be more useful for their everyday life. The course seems to be effective, and students can apply what they have learned in the course to their future careers.

Achievement Factors That Influence Mathematics Learning

When it comes to mathematics, high school performance and academic success are also predictors of success. As one begins to examine the factors that influence mathematics success for college students, it is important to examine the cognitive factors such as high school GPA, ACT scores and mathematics placement scores, which are common indicators of student success in their first mathematics course in college. These factors are commonly used by departments of mathematics to place students in the appropriate mathematics class.

High School GPA and ACT Scores

Two of the most common indicators of student achievement have been school grades and standardized achievement, such as ACT scores (Arens et al., 2017). Arens et al. (2017) stated that "school grades are very salient to students as they are directly communicated, easy to compare among classmates, and entail important implications for students' school careers" (p. 623). School grades not only represent student achievement but typically indicate other student characteristics such as student effort and behavior (Zimmerman, Scüutte, Taskinen & Köller, 2013).

Most colleges require transcripts showing student's grades and ACT/SAT scores during the application process, with some colleges using these items to determine whether a student gets accepted into that particular institute. These tests measure aptitude and are said to be predictors of future success in learning (Edge & Friedberg, 1984). The ACT is an exam that tests four subject areas: English, Mathematics, Reading, and Science. The test intends to measure the skills and knowledge students have developed in high school and need to be effective in college (ACT, 1997). Composite Scores are calculated by taking an arithmetic average of the four sections and are reported on a scale of 1 to 36. The ACT association conducted a study to examine the correlation between high school GPA, ACT scores, and college GPA. Data analysis determined a relationship between the two GPA's as well as between ACT scores and college GPA (ACT, 2006).

Furthermore, other studies have found a relationship between college entrance exams and college persistence (Edge & Friedberg, 1984; Houglum, Aparasu, & Delfinis 2005).

The ACT, although a respectable measure of how educated a student may be, is not the only predictor of college success (Tough, 2012). Edge and Friedberg (1984) conducted a study to discover the factors determining student achievement in calculus. The researcher concluded that the "combination of algebraic skills, as represented by the score on the algebra pre-test, and long-term perseverance and competitiveness, as measured by high school rank, play a significant role in the prediction of achievement in the first semester of calculus" (p.136). Houglum, Aparasu, and Delfinis (2005) conducted a study examining the predictors of academic success and failures of students in a pharmacy program. Predictors of success found were ACT composite scores, the average grade in Organic Chemistry courses, and gender. Armstrong (2010) found that the disposition of students and demographic variables showed higher exploratory power than test scores and other variables. By reviewing the literature, researchers found that certain factors as standardized test scores and GPA are predictors of academic success. Researchers also found that belief influences, such as mathematics identity, grit, mathematics self-efficacy, and mathematics attitudes, are just as significant.

Belief Factors That Influence Mathematics Learning

There have been many studies conducted over the years that have looked at the influences on students' academic achievement, particularly in mathematics. Researchers are always looking for ways to increase students' belief towards subjects, especially subjects that students struggle with, such as mathematics. The following section will provide a description of the belief factors found in the literature that contribute to student learning.

Mathematics Identity

The idea of identity has become a prominent topic in mathematics education research in recent years (e.g., Cobb & Hodge, 2011; Cribbs, Hazari, Sonnert, & Sadler, 2015; Gee, 2000). Content-specific identity has recently been applied to education by researchers in schools and universities to investigate the effects of students' identities (Cribbs, Hazari, Sonnert, & Sadler, 2015). According to Gee (2000), researchers in many areas of education are starting to see identity as a systematic tool to understand schools and people. "Math identity refers to a person's belief, attitudes, emotions, and disposition about mathematics and her or his resulting motivation and approach to learning and using mathematics knowledge" (Froschi & Sprung, 2016, p. 320). Additionally, Gee (2000) described identity as being a certain kind of person based on a particular context or situation. With this idea in mind, mathematics identity is viewed as being socially constructed (e.g., Sfard & Prusak, 2005; Wenger, 1998).

Teachers need to understand the significance of identity as it pertains to student interest in order to develop relatable activities. For example, Reitzes and Burke (1980) found that people were inclined to be involved in activities that were consistent with their identities. Specifically, research tells us that mathematics identity is important because it can determine students' future engagement with mathematics (Boaler & Greeno, 2000; Cribbs, Cass, Hazari, Sadler, & Sonnert, 2016).

Identity has been measured using both quantitative and qualitative approaches. Many researchers utilize observations, field notes, video recordings, and individual interviews to gather information about a student's identity (Bishop, 2012; Cobb, Gresalfi, & Hodge, 2009). The method selected by the researchers depends on the way they are positioning their work within the literature on identity. For example, research exploring student positioning in mathematics classrooms often takes a qualitative approach through discourse or storytelling (Bishop, 2012; Boaler & Greeno, 2000). However, when exploring core identity – "concerned with students' more enduring sense of who they are and who they want to become" – a survey is useful for assessing an individual's mathematics identity at that point in time based on an accumulation of prior experiences (Cobb & Hodge, 2011, p.189).

Several researchers have developed instruments to understand a student's identity better. Hazari, Sonnert, Sadler, and Shanahan (2010) wanted to investigate students' physics identity further, so they developed a quantitative measure of identity in order to explore how students' high school experiences shaped their physics' identity. The researchers surveyed first-time freshmen over four constructs: interest, performance, competence, and recognition. Following the work of Harazi et al. (2010), Cribbs et al. (2015) developed a quantitative instrument using the same factors to measure mathematics identity. The 5-point Likert type scaled instrument measures the beliefs that participants hold about their mathematics identity based on students' perceptions of their interest, recognition, competence, and performance.

Mathematics Self-Efficacy

Bandura (1977) defined self-efficacy as an individual's perception of whether they possess the skills to complete a given task. If a person believes that they can achieve a task, then it is more than likely that they will succeed. A person's thoughts or perceptions of themselves can affect their motivation. Educators believe that the way students perceive themselves affects academic achievement (Skaalvik, Federici, & Klassen, 2015). According to Peters (2013), an essential factor connected to students' failure in mathematics is a lack of self-efficacy. Self-efficacy is connected to personality in that it is "relatively stable and has important implications for coping and persistence in challenging situations" (Hackett, 1985, p. 46). If a person's self-efficacy levels are high, they will more than likely persist and finish the task, people with low self-efficacy tend not to finish, some not even starting at all.

Depending on the self-efficacy levels of an individual, the choices and courses of action that a person makes can be affected (Pajares, 1996). Bandura (1997) claims that an individual's self-efficacy can predict persistence during a task, the effort that they put forth, and their overall attempt. Collins (1982) demonstrated that students with strong self-efficacy and perform mathematical problems correctly have a higher persistence on difficult problems than students with low self-efficacy. Fast et al. (2010) found that "students with higher math self-efficacy persist longer on difficult math problems and are more accurate in math computations than are those with lower math self-efficacy" (p. 729).

Researchers have shown that self-efficacy can also be a predictor of mathematics success in students. Ayotola and Adedeji (2009) conducted a study to examine the relationship between students' mathematics self-efficacy and their academic mathematics achievement. They found no difference in self-efficacy scores between males and females; however, there was a significant difference between students' mathematics self-efficacy and their mathematics achievement.

Self-efficacy has also been known to affect other mathematics attitudes. For example, in a study of 262 undergraduate students, Hackett and Betz (1989) examined (1) the relationship of mathematical attitudes, mathematics self-efficacy, and mathematics performance and (2) whether self-efficacy along with mathematics performance was a predictor of educational choices. Analysis of the data revealed that learners who had "high scores on mathematics self-efficacy and mathematics performance and achievement, compared to those with low scores, tend to report lower levels of mathematics anxiety, higher levels of confidence and effectance motivation, and a greater tendency to see mathematics useful" (p. 268).

Klassen, Krawchuk, and Rajani (2008) state that self-efficacy affects levels of motivation for not only secondary students but for university students as well. Since motivation and self-efficacy can be affected by the way a person performed in the past, it is important to examine if self-efficacy or academic achievement is a better predictor of motivation (Skaalvik et al., 2015).

According to Pajares and Miller (1994), mathematics self-efficacy is a better predictor of how a student will perform in a mathematics class compared to mathematics anxiety or previous experiences in mathematics. When students are confident in their mathematics skills, they usually do not have a problem with the introduction of new tasks. If they do struggle in the beginning, they are prone to work harder until they figure it out. When students come in with the belief that they are bad at mathematics and tend always to struggle, their motivation to try new tasks is low (Skaalvik et al., 2005).

In their study of 823 middle school students in Norway, Skaalvik et al. (2005) explored whether a student's mathematical self-efficacy was a mediator when examining the relationship between prior mathematics achievement and student motivation. Additionally, they wanted to know if there was a relationship between motivation and mathematics. Their study revealed that self-efficacy had a positive and robust relationship to students' grades, intrinsic motivation, and persistence.

Mathematics self-efficacy has been explored qualitatively via interviews and open-ended questionnaires as well as quantitatively using predominately Likert-type questions. One common scale is the Mathematics self-efficacy scale (MSES) created by Betz and Hackett (1983). The scale was created to explore gender differences, how these differences affect career choices, and measure students' beliefs about their ability to perform mathematical tasks and behavior. Another instrument used in research is the Math Self-efficacy and Anxiety Questionnaire (MSEAQ) developed by May (2009). This 5-point Likert scale consists of 28 questions, 13 self-efficacy (MSEAQ-SE) questions, and 13 anxiety (MSEAQ-A) questions.

Attitudes Towards Mathematics

Students need to maintain a positive attitude when it comes to mathematics. Keller (2010) suggests that students are motivated by instruction related to their personal goals and when they can connect to the learning environment. For decades researchers have been interested in exploring the impact of student's dispositions. For example, Randelm Stevenson and Witruk (2000) determined that attitudes and beliefs were shown to be a strong predictor of achievement. Mcleod (1992) concluded that students with negative attitudes towards mathematics are less likely to engage with mathematics.

Furthermore, attitudes towards mathematics have been shown to be a strong predictor of whether students will participate in advanced mathematics courses (Ercikan et al., 2005). The way that students feel about mathematics does not only affect their academic success in mathematics, but it also affects students "electing to study mathematics and its learning" (Fennama & Sherman, 1976, p. 1). Therefore, in order to improve students learning of mathematics, it is important to examine students' attitudes towards mathematics.

Attitudes toward mathematics are how students think, feel, see, and act towards mathematics (Jovanovic & King, 1998). Neal (1969) states that attitudes towards mathematics are a measure of "a liking or disliking of mathematics, a tendency to engage in or avoid mathematical activities, a belief that one is good or bad at mathematics, and a belief that math is useful or useless" (p. 632). These attitudes develop as young children and carry over into adulthood. Student attitudes towards mathematics tend to decrease as they progress through the K-12 curriculum (Aiken, 1970).

Research (e.g., Mcleod, 1992; Randel, Stevenson, & Witruk, 2000) indicates that students' attitudes towards mathematics are correlated with student success. Gupta, Harris, Nellie, and Paul (2006) conducted a study to examine the characteristics that predict students' success and failure in a basic mathematics class to create interventions that promote student success. Pyzdrowski et al. (2012) examined indicators for success in a beginning college calculus course. They found that although there was a significant positive correlation between course performance and high school GPA and the Calculus Readiness Assessment, attitudes towards mathematics and course performance had the strongest positive correlation on student performance.

The usefulness of mathematics can also be associated with student success. In a world where mathematics literacy is becoming more important, students want material that will relate to their everyday lives. Meyer and Koehler (1990) found that "students' perception of the usefulness of mathematics, both immediately and in their future, is a variable shown to be strongly associated with mathematics participation and achievement" (p. 62). Additionally, Anderman et al. (2001) stated that "whether or not students developed a sense of valuing math and reading during the elementary and middle school years can have found effects on students' future plans and potential career trajectories" (p. 77).

There have been several instruments designed to measure attitudes towards mathematics. For example, Aiken (1974) created an attitude towards mathematics scale that measured two constructs, appreciation and use of mathematics. Tapiz and Marsh (2004) developed the Attitudes Toward Mathematics Inventory designed to measure the mathematics attitudes of high school students. However, the most frequently used instrument to measure attitudes towards mathematics is the Fennema-Sherman Mathematics Attitudes Scales (Fennema & Sherman, 1978) consisting of nine subscales. In each of these instruments, the authors established the reliability and validity of items in the scale and subscales.

Due to time constraints, this study will only use four of the nine subscales corresponding with the constructs of interest: The Attitudes toward Success subscale, the Confidence to learn mathematics subscale, the Effectance Motivation subscale, and the Usefulness to Learn Mathematics subscale.

Mathematics Anxiety

Mathematics anxiety, as defined by Yang (2014), is when a person "feel[s] tension, apprehension, and fear of situations involving mathematics" (p. 28). Mathematics anxiety continues to be an issue for students as they panic or have mental disorganization when it comes to solving math problems (Richardson & Suinn, 1972). Luttenberger, Wimmer, and Paechter (2018) define mathematics anxiety as "feelings of apprehension and increased physiological reactivity when individuals deal with math, such as when they have to manipulate numbers, solve mathematical problems, or when they are exposed to an evaluative situation connected to math" (p.312). According to Perry (2004), some causes for these fears are a lack of confidence, the fear of being wrong, or the uneasy feeling of solving a math problem.

There are many different levels of mathematics anxiety. Perry (2004) discusses some of the levels, with the lowest level being math test anxiety. Many students do well on homework and in-class assignments, and they possess the knowledge to answer the questions on a test review correctly. However, when the time comes to take the test, students tend to panic and forget the material they were previously confident. The most severe level of anxiety is nausea, sweaty palms, and shortness of breath. These symptoms can occur from a regular math problem or the introduction of a new topic.

Many students struggle with math anxiety. Perry (2004) states that 85% of students that have to take an introductory or developmental math class suffer from math anxiety, whether mild or severe. Math anxiety can cause low confidence in math, causing students only to take the minimum math credits to meet requirements (Vahedi & Farrokhi, 2011). Many students only take the math they need to graduate, not going any further, even though they may have the potential and ability to do higher-level mathematics. Andrews and Brown (2015) state that "with this avoidance, students feel inferior to their mathematical anxiety and are unable to move forward in their mathematical potential, which is an essential area of their education" (p. 363).

Research has been done to examine the effects that mathematics anxiety has on student's mathematics success. For example, Nunez-pina, Suarez-pellicioni, and Bono (2012) conducted a study that looked at whether negative attitudes, along with mathematics anxiety, could affect college students' educational successes in specific courses of their degree. The study found that negative attitudes towards mathematics, along with math anxiety, do affect student performance. Students that failed the course had higher levels of math anxiety and low levels of confidence, enjoyment of math, and motivation. Al Mutawah and Masooma Ali (2015) examined the relationship between math anxiety and student success and found a correlation between students' perceived achievement and math anxiety. Scheffield, David, Hunt, and Thomas (2006) found that math anxiety had a direct effect on how students perform on mathematics tasks. Ashcraft and Kirk (2011) found that individuals with increased mathematics anxiety exhibit decreased working memory periods. By using different instruments, researchers have been able to explore the effects that mathematics anxiety has on students.

The Mathematics Anxiety Rating Scale (MARS) has been one of the most cited scales used to measure mathematics anxiety for research and clinical studies (Suinn, 1972). The scale consists of 98 items, with most of the items worded to involve practical mathematics situations. This scale was deemed useful, but the time it took to administer the test was impractical. For this reason, Suinn and Winston (2003) developed a shorter 30-item version of the MARS scale. By adapting questions from the shorten MARS scale and including self-efficacy questions, May (2009) developed the Math Self-Efficacy and Anxiety Questionnaire (MSEAQ). This 5-point Likert scale consists of 28 questions, 13 self-efficacy (MSEAQ-SE) questions, and 13 anxiety (MSEAQ-A) questions.

Grit

Duckworth's (2007) definition of grit points to a person's "perseverance and passion for long-term goals" (p. 1087). Thus, grit is composed of two primary components perseverance and passion. These two components can also be seen in how Duckworth, Peterson, Matthews, and Kelly (2007) defined grit as "your capacity to dig deep and do whatever it takes-even sacrifice, struggle and suffer-to achieve your most worthy goals in the best ways" (p. 167). Perseverance is the effort to achieve a goal, no matter the difficulty or opposition. Duckworth et al. (2007) describe that a person cannot just have perseverance, but passion must also be present. During an interview, Duckworth stated, "grit is not about just having resilience in the face of failure, but also having a deep commitment that you remain loyal to over many years" (as cited by Perkins-Gough, 2013, p. 16). In order to have a passion for a long-term goal, one must maintain a deep, loyal commitment over time.

In exploring the influence of grit, Zimmerman and Brogan (2015) pointed out that research has shown that grit predicts student achievement in a variety of contexts. For example, Eskreis-Winkle, Duckworth, Shulman, and Scott (2014) found that grit could predict high school graduation rates, whether a particular army course would be completed, or whether or not salespeople can be retained, and even if males will stay in a marriage. More recent studies have looked at grit as being a factor that influences or predicts academic achievement. Students who have higher grit tend to have higher mathematics achievement scores. Research has shown that students who have more grit have a stronger determination to push through difficult problems. (Eskreis-Winkle et al., 2014)

Grit has become an emerging construct amongst educational researchers. "New research in education is encouraging considering grit as an important aspect to improve school performance" (Al-Mutawah & Fateel, 2018, p. 97). For example, Wolters and Hussain (2015) conducted a study using 213 students enrolled in undergraduate psychology to investigate the relationship between grit, self-regulated learning (SRL), and academic achievement. The study found that students who had more confidence in completing a task indicated higher diligence, less frustration from setbacks, worked harder and expressed more interest in their coursework. Furthermore, Al-Mutawah and Fateel (2018) used a descriptive approach research design to investigate the correlation between grit, attitudes, and student achievement. They found a relationship between grit and achievement in science and mathematics, as well as a positive correlation between grit and academic achievement in mathematics, but not in science achievement.

The idea of grit has evolved due to work by Angela Duckworth, who studied grit for over 12 years and its effects on achievement (Al-Mutawah & Fateel, 2018). Duckworth et al. (2007) created a 12-item grit scale; however, the scale displayed little evidence of predictive validity. As a result of this, Duckworth and Quinn (2009) started an investigation to "validate a more efficient measure of grit" (P. 166). Through rigorous testing, Duckworth and Quinn (2009) found a shorter 8-item instrument referred to as the Grit-S to be more efficient when it came to measuring grit. The 8-item instrument contains four items measuring the consistency of interest and four items measuring perseverance of effort. Researchers have found that grit may be content-specific in some areas; for example, Kruczek (2017), with permission, modified the Grit-S scale to be mathematics-specific and found it to have a good internal consistency of .80 using a Cronbach Alpha. Thus, for this study, Kruczek's (2017) modified mathematics version of the Grit-S scale will be used to measure grit in this research study.

Summary

The literature review gives an overview of the purpose of the study. Being able to gather demographics, cognitive, and non-cognitive traits of students enrolled in either a Pre-Calculus I or Quantitative reasoning course, describing the characteristics of these students, and determining the characteristics that predict success can add to the existing literature.

In order to develop a curriculum that aids in the success of students in QR or Pre-Calculus I, we first have to know the characteristics of each group of students in these courses. The next chapters, 3-5, are the research methodology, results, and discussion sections of the study. The methodology chapter includes the research design, instrumentation, participants, setting, and an outline of the data analyses. Chapter 4 discusses the results of the data analyses, and last, Chapter 5, includes a summary of the research and future implications.

CHAPTER III

Methodology

This study explored the characteristics of students enrolled in a Quantitative Reasoning or Pre-calculus I (i.e., College Algebra) course at one campus of a large multi-campus Midwestern community college. The quantitative survey design of this study, along with the methods of data collection and analysis procedure, will be addressed in this chapter. The research questions that guided this study were:

1. What are the characteristics (i.e., demographics, achievements, and beliefs) of college students enrolled in Quantitative Reasoning and college Pre-calculus I (i.e., College Algebra) at one campus of a large Midwestern community college?
2. Are there significant differences in the characteristics (i.e., demographics, achievements, and beliefs) between students enrolled in Quantitative Reasoning and Pre-calculus I (i.e., College Algebra) at one campus of a large Midwestern community college?
3. Are there significant differences in characteristics (i.e., demographics, achievements, and beliefs) between students enrolled in Quantitative Reasoning based on whether they were successful in the course?
4. Are there significant differences in characteristics (i.e., demographics, achievements, and beliefs) between students enrolled in Pre-calculus I (i.e., College Algebra) based on whether they were successful in the course?

5. What combinations of characteristics (i.e., demographics, achievements, and beliefs) for college students enrolled in Quantitative Reasoning are predictors of success?
6. Which combination of characteristics (i.e., demographics, achievements, and beliefs) for college students enrolled in Pre-calculus I (i.e., College Algebra) are predictors of success?

Research Design

A cross-sectional survey design approach guided the current study in order to explore the characteristics of students in Pre-calculus I (PC-I) and Quantitative Reasoning (QR) at a large Midwestern community college. A cross-sectional survey design gathers data about a population at one point in time that allows the researcher to produce a snapshot of the population about which they are gathering data (Lewis-Beck, Bryman, & Futing, 2004). The cross-sectional survey design was used to gather data about the participants, including general demographics, achievement, and beliefs. Cross-sectional survey designs allow the researcher to compare two groups of students "in terms of attitudes, beliefs, opinions, or practices" (Creswell, 2008, p. 378).

Since data was collected at a single point in time, no causal relationships can be derived from the analysis of the cross-sectional survey data. However, some of the advantages of this type of study are that it can be conducted in a relatively short time period and can typically be conducted inexpensively. Cross-sectional survey designs are often based on questionnaires and are easy to administer and do not require any additional follow-up with participants. However, since there is only one chance to gather participant data, there is the possibility of "non-response bias if participants who consent to take part in the study differ from those who do not, resulting in a sample that is not representative of the population" (Sedgwick, 2014, p. 1).

Research Setting

This study was conducted at one campus of a large multi-campus community college in the Midwest that offers 86 associate degree programs and 39 credit-bearing certificate programs. This multi-campus community college is one of the largest community colleges in the state serving over 22,000 college students during the 2018-2019 academic year. As of the 2018-2019 school year, 64% of the students at the college were Caucasian, 9% were Black or African American, 8% were American Indian or Alaska Native, 4% were Asian, less than 1% were Pacific Islander, 9% were two or more races, 2% were Non-resident Alien, and 4% were unknown. Eight percent of the population were Hispanic. There is a 19:1 student/faculty ratio with class sizes ranging from eight to 30 students. Courses are taught using either a face-to-face, blended (with part online and part face-to-face), or a fully online platform.

Students entering this community college are placed in a traditional college-level mathematics course if they score above a 19 on their ACT for the mathematics portion. If a student does not meet the ACT minimum requirements, or they have not taken the ACT in the past, they are required to take the colleges' ACCUPLACER® placement test.

The community college offers two pathways for entry-level mathematics course work, including QR for non-STEM pathway students and PC-I for STEM pathway students. The college's QR course covers skills and tools (including technology) required to think critically about quantitative information encountered in daily life. The course emphasizes solving real-world problems utilizing open-ended exercises that involve reading, analyzing, calculating, and reporting results. Topics for the course include using numbers in the real world, financial literacy, statistics, probability, and linear and exponential modeling. College Algebra supports critical thinking skills and prepares students for STEM-related coursework such as higher-level mathematics, science, computer science, and engineering courses. Students in College Algebra cover topics such as solving systems of linear and nonlinear equations, algebraically solving equations and inequalities including linear, quadratic, polynomial, rational, radical, absolute value, exponential, and logarithmic, and performing operations on functions including compositions.

Participants

The sampling strategy for this study utilized both purposive and convenience sampling strategies. Purposive sampling is used when researchers have a particular purpose in mind, and the population meets specific criteria. For this study, participants had to be 18 years or older, could not be concurrently enrolled, and had to be enrolled in either a PC-I or QR course. Also, the sampling strategy is convenient because the participants are students at one campus where the researcher works (Creswell, 2008).

At the beginning of the spring 2020 semester, there were six QR sections with 175 students and 14 PC-I sections with 309 students. With instructor permission, five QR sections were surveyed, with 118 students agreeing to participate, and seven PC-I sections with 112 students agreeing to participate. Students were recruited by using a script describing the purpose of the study. From the 12 sections that were surveyed, a total of 230 out of 312 (73.72%) students participated in the current study.

Overall, participants in this study had a mean age of 22.8 years and included close to an equal gender distribution with 104 males (45.2%), 123 females (53.5%), and three students (1.3%) chose not to report their gender. In terms of ethnicity, nearly a quarter (*n* = 51, 22%) of the students reported that they were Hispanic. More than half (*n* =150, 65.2%) of the study participants reported their race as white. The remaining participants reported their race as 9.6% (*n* = 22) were African American, 9.6% (*n* = 22) indicated two or more races, 8.7% (*n* = 20) were American Indian/Alaska Native, and 7% (*n* = 16) were Asian.

Data Sources

Data for this study were collected from two different sources: a questionnaire and institutional data. The questionnaire included demographic questions as well as questions involving mathematics identity, grit, attitudes towards mathematics (i.e., confidence, success, usefulness, and effectance motivation), mathematics anxiety, and mathematics self-efficacy. The institutional data that was gathered consisted of mathematics placement scores and the grades that students obtained in their current mathematics course. In this section, the various data sources for the study are described.

Demographics

In order to capture a picture of who the students were enrolled in QR and PC-I, the questionnaire included ten demographic questions aimed at gathering general characteristics such as age, gender, ethnicity, major, and current mathematics course in which they were enrolled (see Appendix A). By finding out the current mathematics course they were enrolled in not only allowed for a portrait of students enrolled in each course, QR and PC-I, but also allowed for comparisons across the two courses.

Mathematics Identity Scale

The mathematics identity scale (see Appendix B; Cribbs, Hazari, Sonnert, & Sadler, 2015) was used to measure beliefs that participants hold about their math identity in terms of their perceptions of math as it relates to interest, recognition, and competence/performance. The 5-point Likert-type scale consists of 11 questions across these three subscales. Means on the identity survey can range from 1 to 5, with higher scores being more indicative that a person identifies as a math person. Illustrative items are "I see myself as a math person" and "I look forward to doing math." Survey items were adapted based on Hazari et al. (2010) instrument measuring physics identity. Statistical validity and reliability were established in prior research through an exploratory factor analysis (Cribbs et al., 2016), confirmatory factor analysis, and structural equation model (Cribbs et al., 2015). Additionally, Cribbs et al. (2015) reported a Cronbach alpha for the reliability of each subscale as 0.95 for interest, 0.63 for recognition, and 0.77 for competence/performance.

Mathematics Attitudes Scale

The Mathematics Attitudes Scale (see Appendix C), created by Fennema and Sherman (1976), was designed to measure attitudes related to mathematical learning. The instrument contains nine subscales that can be used independently. However, due to the length of the attitude scales this study chose to only utilize four of these subscales, including 1) attitudes towards success in mathematics, 2) confidence in learning mathematics, 3) effectance motivation in mathematics, and 4) usefulness of mathematics. Each subscale consists of 12 questions, six positively and six negatively worded items using a 5-point Likert-type scale ranging from 1: strongly disagree to 5: strongly agree.

Mean scores can range from 1 to 5, with higher scores indicating a more positive attitude towards mathematics. Illustrative items are "I am sure I can do advanced work in mathematics" and "I'd be happy to get top grades in mathematics". Fennema and Sherman (1976) reported a split-half alpha of 0.87 for attitudes towards mathematics success, 0.87 for effectance motivation, 0.88 for usefulness, and 0.93 for the confidence scale.

Mathematics Self-Efficacy and Anxiety Questionnaire

The Math Self-efficacy and Anxiety Questionnaire (MSEAQ) (May, 2009) was used to measure students' mathematics self-efficacy and mathematics anxiety. This 5-point Likert-type scale consists of 28 questions, 13 math self-efficacy (MSEAQ-SE) questions, and 13 math anxiety (MSEAQ-A) questions. Mean scores on the MSEAQ can range from 1 – 5 with higher scores indicating a higher level of mathematics self-efficacy or mathematics anxiety depending on the subscale. In order to explore the construct validity of the survey, May (2009) compared the students' responses to the MSEAQ to two math self-efficacy tests and two math anxiety tests that had been previously established and found significant positive correlations with both the MSEAQ-SE ($p < .05$) and MSEAQ-A ($p < .01$) subscales. Using Cronbach's alpha, the overall MSEAQ ($\alpha = 0.96$), MSEAQ-SE ($\alpha = 0.93$), and MSEAQ-A ($\alpha = 0.93$) were shown to have a strong internal consistency (May, 2009). Illustrative items are "I feel confident when taking a mathematics test" and "I believe I can understand the content of a mathematics course". A copy of this instrument is included in Appendix D.

Short Grit Scale (Grit-s)

The Short Grit Scale (Duckworth and Quinn, 2009) was modified by Kruczek (2017) specifically to measure a student's mathematics-related grit. The scale was designed in order to measure participant's "perseverance and passion for long-term goals" (Duckworth & Quinn, 2009, p. 166). This 8-item, 5-point Likert-type instrument contains four items measuring consistency of interest and four items measuring perseverance of effort. The 5-point Likert scale ranges from 1: not at all like me to 5: very much like me. To calculate a person's overall grit, the mean score across the eight items is calculated. The overall mean can range from one (not gritty at all) to a five (very gritty). The Grit-S scale has been well documented with an internal reliability, reporting a Cronbach alpha of 0.87 (Strayhorn, 2013). Additionally, Kruczek (2017) reported a Cronbach alpha of 0.80. Sample items include "I finish whatever I begin in mathematics" and "In mathematics, I am a hard worker" (see Appendix E).

Achievement Data

In order to measure students' level of success in mathematics, both baseline data, such as ACT (mathematics and overall) and high school GPA, as well as final grades in the QR and PC-I courses, were used. The achievement data for each participant were collected by making a request to the university's data management office. As typical, letter grades were assigned by the instructor of each section of each course based on a student's overall course average. The grading scale for both courses was A: 90-100, B: 80-89, C: 70-79, D: 60-69, and F: 0-59. In this study, students were considered successful if they earned a letter grade of A, B, or C. Students that received a letter grade of D, F, or was assigned a W for withdrawal were considered non-successful.

Data Collection

Before data were collected, the researcher gained approval from Oklahoma State University's Internal Revenue Board (IRB). Data was then collected in two phases. Phase I took place during weeks three and four of the 2020 spring semester. The researcher emailed all instructors that taught PC-I and QR courses at the community college. The email included the study's purpose and requested permission to administer the surveys to students in the various sections of these courses. Once the researcher was granted permission to survey the class, students were read a script that contained the purpose of the study and was provided a survey packet. The first page of the survey was a consent form with a statement informing the participants that by signing the consent form and completing the survey, they were providing consent for the researcher to use their responses. The participants were also informed that participation in the study was voluntary, and they can withdraw from the survey at any time. Students that were at least 18 and that gave consent were then asked to complete the questionnaire.

The second phase of the study consisted of collecting final grades of participants through the college's database as well as college records for all participants, including ACT scores (composite as well as math sub-scores) and overall high school GPA. A spreadsheet containing phase I data was sent to the college's data office. The college then matched the participant's grades, ACT scores and overall GPA. Once all data was matched, all identifiers were removed by the college and sent back to the researcher.

Data Analysis

The researcher used SPSS to analyze quantitative data. Descriptive statistics (e.g., means, ranges, and standard deviation) are reported for each part of the instrument and any subscales on the questionnaire. Additionally, Cronbach's alphas are reported for each instrument overall and for any subscales. Independent samples t-tests were used to make comparisons among the groups, and Pearson correlations were used to determine if there were any significant differences among the groups. Table 3.1 provides an overview of both the data sources used and data analysis techniques used to answer each research question.

For research question 1, the researcher used SPSS in order to run a descriptive statistic of both the QR group and the PC-I group. A descriptive statistic allows the researcher to describe the basic characteristics of each group. The researcher also examined the groups broken down by students who were taking an extra essentials course and students that were not taking the additional course. These statistics were run in order to get an idea of the students that are in both courses. Having an idea of the students in the class will give instructors insight into their students and the ability to gear instruction to meet students' needs.

Table 3.1

Summary of Data Sources and Analyses Used

Research Question	Data Source(s)	Data Analysis Techniques
1. What are the characteristics (i.e., demographics, achievements, and beliefs) of college students enrolled in Quantitative Reasoning and college Pre-calculus I (i.e., College Algebra) at one campus of a large Midwestern community college?	• Math Identity scale • MSEAQ • Fennema-Sherman Attitude Scales • Grit • Achievement (GPA, ACT, placement score) • Demographics	Descriptive statistics (Means, and standard deviations)
2. Are there significant differences in the characteristics (i.e., demographics, achievements, and beliefs) between students enrolled in Quantitative Reasoning and Pre-calculus I (i.e., College Algebra) at one campus of a large Midwestern community college?	• Math Identity scale • MSEAQ • Fennema-Sherman Attitude Scales • Grit • Achievement (GPA, ACT, placement score) • Demographics	Independent Samples t-test
3. Are there significant differences in characteristics (i.e., demographics, achievements, and beliefs) between students enrolled in Quantitative Reasoning based on whether they completed the course? 4. Are there significant differences in characteristics (i.e., demographics, achievements, and beliefs) between students enrolled in Pre-calculus I (i.e., College Algebra) based on whether they completed the course?	• Math Identity scale • MSEAQ • Fennema-Sherman Attitude Scales • Grit • Achievement (GPA, ACT, placement score) • Demographics	Independent Samples t-test
5. Which combination of characteristics (i.e., demographics, achievements, and beliefs) for college students enrolled in Quantitative Reasoning are predictors of success? 6. Which combination of characteristics (i.e., demographics, achievements, and beliefs) for college students enrolled in Pre-calculus I (i.e., College Algebra) are predictors of success?	• Math Identity scale • MSEAQ • Fennema-Sherman Attitude Scales • Grit • Course Grades	Logistics Regression Model

For research questions two and three, the researcher used a T-test in order to detect differences between the groups of students in both courses. Independent T-test takes two sets of data and compares the differences between those sets (Nolan & Heinzen, 2010). The assumptions for a two-sample T-test are that 1) the data sets are independent of each other, 2) the data must be normally distributed, 3) both samples are simple random samples, 4) the data should be able to be represented as scale data, and 5) there should be homogeneity of variance. The researcher made sure that these assumptions were met.

For question four, the researcher used a logistics regression model to examine if any of the characteristics surveyed are predictors of success. Linear regression models attempt to determine the relationship between two variables by finding the line of best fit between variables. This model allowed the researcher to predict if any of the characteristics examined can predict student success in the two courses.

Ethical Consideration

Research considered all ethical issues, including applying for permission from Oklahoma State University's IRB board to conduct the study. All personal information was kept confidential, and all data was stored on a password-protected computer, available only to the researcher. Student ID numbers were used to align survey data, archival data, and final grades. Only aggregate data will be reported. Any participant choosing to leave the study at any time was able to do so. Not participating in the study did not affect any of the students' grades in the course.

Summary

The purpose of this mixed-methods study was to describe students' characteristics in a PC-I and QR course at a large Midwestern community college by collecting demographic data and cognitive and non-cognitive characteristics through college records and surveys. Differences in cognitive and non-cognitive characteristics of the two groups were also calculated. Furthermore, a correlational analysis was conducted to determine the relationships between student characteristics and student success. The chapter gave a summary of the research design, setting, participants, data sources, procedures, and analysis that will be used in the study. The results of the data analysis will be presented in Chapter IV, followed by a discussion of the results in Chapter V.

CHAPTER IV

Results

This quantitative study examined the potential differences in characteristics of students enrolled in Quantitative Reasoning (QR) and those enrolled in Pre-calculus I (PC-I) at a Midwestern community college and investigated which of these characteristics might predict success in these courses. In this chapter, research data will be presented that were gleaned from questionnaires, course grades, and institutional data. The following questions guided the research study:

1. What are the characteristics (i.e., demographics, achievements, and beliefs) of college students enrolled in Quantitative Reasoning and college Pre-calculus I (i.e., College Algebra) at one campus of a large Midwestern community college?
2. Are there significant differences in the characteristics (i.e., demographics, achievements, and beliefs) between students enrolled in Quantitative Reasoning and Pre-calculus I (i.e., College Algebra) at one campus of a large Midwestern community college?
3. Are there significant differences in characteristics (i.e., demographics, achievements, and beliefs) between students enrolled in Quantitative Reasoning based on whether they were successful in the course?

4. Are there significant differences in characteristics (i.e., demographics, achievements, and beliefs) between students enrolled in Pre-calculus I (i.e., College Algebra) based on whether they were successful in the course?
5. What combinations of characteristics (i.e., demographics, achievements, and beliefs) for college students enrolled in Quantitative Reasoning are predictors of success?
6. Which combination of characteristics (i.e., demographics, achievements, and beliefs) for college students enrolled in Pre-calculus I (i.e., College Algebra) are predictors of success?

The results presented in this chapter are organized into three main sections. First, the characteristics of the students that are enrolled in QR and PC-I will be described along with any significant differences between the characteristics of the two groups. Second, quantitative data will be examined to determine any significant differences between the students that started each course and the students that successfully completed the course. The last section includes an examination of characteristics that may affect students' success in the course for which they were enrolled.

Characteristics and Differences of Students Enrolled in QR and PC-I

For instructors to provide an engaging and relevant curriculum to students enrolled in QR and PC-I, it is first essential for them to understand who these students are. To have a portrait of their students, instructors need to understand their students' demographic/ background characteristics, beliefs related to learning mathematics, and prior mathematics achievement (Tahir & Baker, 2009; Choy, 2001). From research literature, two commonly used indicators of student achievement are student grades and standardized achievement test scores (Arens et al., 2017). Therefore, student characteristics of demographics, beliefs, and achievement data were collected and analyzed. In order to determine the characteristics of students enrolled in QR and in PC-I, both questionnaires and institutional data such as grade point average and course grades were utilized. Descriptive statistics, including frequencies, measures of central tendency, and dispersions, were calculated. Since some participants in each course were also enrolled in an essentials lab that provided extra support that the remaining students did not receive, descriptive statistics were reported for each course as a whole and each subgroup. It is not only important to know the characteristics of the students in each course, but also if there are any significant differences between the students in each course. Therefore, the researcher analyzed the data for demographics, beliefs, and achievements for potential differences.

Demographics Characteristics

Descriptive statistics and frequency distribution were used to provide an overall picture of the participants enrolled in QR and PC-I (see Table 4.1), including whether they were enrolled in the essentials course. The chi-square test of independence was used to identify any association between the demographic variables. "When dealing with nominal data, the most widely used test of significance is the chi-square test" (Ary et al., 2006, p. 206). The demographic variables (gender, ethnicity/race, 1^{st} generation college graduate, parental education, and major) were analyzed for association between the PC-I and QR groups. In order to run a valid chi-square test, there must be two categorical variables, with two or more categories for each variable, the observation must be independent with no relationships between the subjects, and the sample must be relatively large with frequencies of at least 5 for the majority of the cells. All demographic data being analyzed met these criteria.

Participants' from the PC-I course had a mean age of 23.2 years, which was only slightly higher than the QR participants mean age of 22.5 years. For PC-I, results revealed a similar overall gender distribution (M = 50%, F = 49.1%); however, for QR, the gender distribution revealed slightly more females (57.6%) than males (40.7%). After closer analysis, using the chi-square test, there were no significant differences between the genders of the two groups (χ^2 (1) = 1.88, $p = 0.17$). This suggests that each group had a similar proportion of males and females.

As anticipated, the percentage of STEM majors (i.e., nursing, pre-med, air traffic control, biology, and engineering) were higher for PC-I (64.3%) compared to the STEM majors in QR (12.4%). In contrast, the number of non-STEM majors (i.e., business, education, theatre, art, and psychology) were higher for QR (80.5%), compared to PC-I (25%). With the percentage of non-STEM majors being significantly higher (χ^2 (2) = 74.640, $p < 0.001$) in QR, it is suggested that students are typically enrolling in the recommended course for their particular major.

Approximately one-fourth of the students in PC-I (27%) and QR (24%) were Hispanic. In terms of race, approximately two-thirds of the participants in each course identified themselves as white (64.3% in PC-I and 66.1% in QR). The remaining students identified as African American (11.6% in PC-I and 7.6% in QR), American Indian/Alaska Native (8.9% in PC-I and 8.5% in QR), and Asian (8.0% in PC-I and 5.9% in QR). When including multi-race self-reporting numbers, 9.5% of students claimed more than one race (7.1% in PC-I and 11.9 in QR). The results from the chi-square test indicated no significant differences in ethnicity (χ^2 (1) = 1.045, p = 0.307) or race (χ^2 (4) = 2.337, p = 0.674) between the two groups of students.

Table 4.1

Participant Demographic Characteristics

Characteristics	Pre-calculus I			Quantitative Reasoning		
	All (*n* = 112) *n* (%)	No essentials (*n* = 66) *n* (%)	With essentials (*n* = 46) *n* (%)	All (*n* = 118) *n* (%)	No essentials (*n* = 66) *n* (%)	With essentials (*n* = 52) *n* (%)
Gender						
Male	56 (50.0)	35 (53.0)	21 (45.7)	48 (40.7)	30 (45.5)	18 (34.6)
Female	55 (49.1)	30 (45.4)	25 (54.4)	68 (57.6)	35 (53.0)	33 (63.5)
Other	1 (0.9)	1 (1.5)	0 (0.0)	2 (1.7)	1 (1.5)	1 (1.9)
Ethnicity/Race						
American Indian/Alaska Native	10 (8.9)	5 (7.6)	5 (10.9)	10 (8.5)	3 (4.6)	7 (13.5)
Asian	9 (8.0)	5 (7.6)	4 (8.7)	7 (5.9)	5 (7.6)	2 (3.9)
African American	13 (11.6)	8 (12.1)	5 (10.9)	9 (7.6)	3 (4.6)	6 (11.5)
White	72 (64.3)	45 (68.2)	27 (58.7)	78 (66.1)	47 (71.2)	31 (59.6)
Two or more races	8 (7.1)	3 (4.6)	5 (10.9)	14 (11.9)	8 (12.1)	6 (11.6)
Hispanic	27 (24.1)	11 (16.7)	6 (13.0)	24 (20.3)	12 (18.2)	12 (23.1)
1st gen college graduate	22 (19.6)	12 (18.2)	10 (21.7)	31 (26.3)	17 (25.8)	14 (26.9)
Father's education level						
Did not finish HS	25 (22.3)	14 (21.2)	11 (23.9)	22 (18.6)	12 (18.2)	10 (19.2)
High school	24 (21.4)	11 (16.7)	13 (28.3)	27 (22.9)	11 (16.7)	16 (30.8)
Some college	28 (25.0)	15 (22.7)	13 (28.3)	32 (27.1)	21 (31.8)	11 (21.2)
Four years of college	25 (22.3)	19 (28.8)	6 (13.0)	25 (21.2)	17 (25.8)	8 (15.4)
Graduate school	10 (8.9)	7 (10.6)	3 (6.5)	12 (10.2)	5 (7.6)	7 (13.5)
Mother's education level						
Did not finish HS	18 (16.1)	9 (13.6)	9 (19.6)	19 (16.1)	10 (15.2)	9 (17.3)
High school	25 (22.3)	14 (21.2)	11 (23.9)	26 (22.0)	14 (21.2)	12 (23.1)
Some college	38 (33.9)	23 (34.9)	15 (32.6)	29 (24.6)	11 (16.7)	18 (34.6)
Four years of college	24 (21.4)	13 (19.7)	11 (23.9)	29 (24.6)	23 (34.9)	6 (11.5)
Graduate school	7 (6.3)	7 (10.6)	0 (0.0)	15 (12.7)	8 (12.1)	7 (13.5)
Majors						
STEM	72 (64.3)	45 (68.2)	27 (58.7)	17 (14.4)	13 (19.7)	4 (7.7)
non-STEM	28 (25.0)	13 (19.7)	15 (32.6)	95 (80.5)	49 (74.2)	46 (88.5)
Undecided	12 (10.7)	8 (12.1)	4 (8.7)	6 (5.1)	4 (6.1)	2 (3.9)

Examining general demographic characteristics are important, but it is also important to consider other components, such as whether students were first-generation college students as well as the highest educational level for each parent or guardian, as they may influence a student's success outside of the classroom (Choy, 2001). Almost one-fourth of the student participants reported being a first-generation college student. The numbers for PC-I (19.6%) were slightly lower than QR (26.3%). At a closer analysis of the data, there was no significant difference in the number of first-generation graduates between the two groups (χ^2 (1) = 3.92, p = 0.14). In other words, there is an equal amount of first-generation graduate students enrolling in both QR and PC-I. Teachers should be aware of the number of first-generation college students, as they may not have as much support at home since their parents do not have college experiences (Nelson, 2009).

Another demographic factor outside of the classroom was the participant's parental level of education. For students enrolled in PC-I, 22.3% reported that their father did not finish college, compared to 18.6% of the fathers of the students in the QR class. Likewise, 21.4% of fathers for PC-I student's highest education was high school, compared to 22.9% of the fathers for the QR students. The chi-square test revealed that there were no significant differences (χ^2 (5) = 1.81, p = 0.88) in father's education between the two groups of students. As for the mother's education level, results revealed a similar overall mean for the mothers that did not finish college (PC-I = 16.1%; QR = 16.1%); however, the means for the mothers that had some college were slightly higher (PC-I = 33.9%; QR = 24.6%). Although the percent of mothers with some college and that went to graduate school seemed higher for the PC-I course, there were no significant differences found between the students in each of the two courses based on the educational level of the mother (χ^2 (4) = 4.48, p = 0.35).

Achievement

Student's grades in high school, as well as standardized achievement such as ACT scores, are two of the most common indicators of student success (Arens et al., 2017). Participants' high school GPA and ACT composite and mathematics scores were collected using college records to gain a better understanding of a student's prior mathematics achievement. The following tables (4.2) list the academic descriptive statistics for all participants in QR and PC-I. After examining the means of participant's high school GPA, it appears that both the PC-I and QR groups were similar (PC-I = 3.09, QR = 3.10). Conversely, when looking at the mean scores of the students ACT composite and ACT math scores it appears that the students in PC-I were slightly higher than the QR students' in both the overall ACT score (PC-I = 19.62, QR = 18.48) and the ACT math score (PC-I = 18.62, QR = 17.36). This could indicate that the PC-I students have a better mathematics understanding than QR students.

Table 4.2

Participants Academic Characteristics

Group	*n*	HS GPA M (SD)	*n*	Overall ACT M (SD)	Math ACT M (SD)
Pre-Calculus I					
All	96	3.09 (0.53)	76	19.62 (3.48)	18.62 (3.33)
No Essentials	56	3.26 (0.49)	52	20.44 (3.38)	19.37 (3.38)
With Essentials	40	2.85 (0.47)	24	17.85 (3.08)	16.98 (2.58)
Quantitative Reasoning					
All	102	3.10 (0.45)	82	18.48 (0.95)	17.36 (2.71)
No Essentials	58	3.27 (0.39)	47	19.26 (2.84)	18.30 (2.92)
With Essentials	44	2.89 (0.43)	35	17.46 (2.65)	16.10 (1.76)

After noting these descriptive similarities, an independent samples t-test was used to determine if the mean difference was insignificant, indicating a similarity (see Table 4.3). A 95% confidence level was calculated for the mean difference. Results indicate no significant difference ($t(196) = -0.21$, $p = 0.83$, $d = 0.02$) in students overall high school. However, there was a significant difference between the two groups' ACT composite scores ($t(156) = 2.23$, $p = 0.03$, $d = 0.45$). The effect size for this analysis ($d = 0.45$) is considered a medium effect size, according to Cohen (1988). There was also a significant difference when it came to the students' ACT math scores ($t(156) = 2.61$, $p = 0.01$, $d = 0.42$). The effect size for this analysis was also considered a medium effect size (Cohen, 1988). These results suggest that the overall background achievement, as measured by the ACT overall score as well as the mathematics subscale, were significantly higher for the PC-I students than the QR students.

Table 4.3

Group Comparison of Achievement Variables

Academic Variable	PC-I M (SD)	QR M (SD)	*df*	*t*	*p*	*d*
HS GPA	3.09 (0.53)	3.10 (0.45)	196	-0.214	0.83	0.02
ACT Composite	19.62 (3.48)	18.48 (0.95)	156	2.227	0.03*	0.45
ACT Math	18.62 (3.33)	17.36 (2.71)	156	2.607	0.01*	0.42

*Significant at $p < 0.05$

Beliefs

Cognitive characteristics are not the only variable related to student success, non-cognitive characteristics play a role in students' academic achievement as well. For example, Dweck et al. (2011) found that "[t]wo students with equal academic abilities can respond in remarkably different ways to frustration, with one relishing the opportunity to learn and the other becoming demoralized and giving up" (p. 5). Thus, knowing students' beliefs about mathematics allows teachers to anticipate students' needs and develop a curriculum that supports students while acknowledging their belief system (Cifarelli, Goodson-Epsy, & Chae, 2010). In order to explore participants' beliefs, survey data were collected and analyzed relate to grit, identity, mathematics attitudes, anxiety, and self-efficacy beliefs.

Identity. Participant identity was measured using Cribbs, Hazari, Sonnert, and Sadler's (2015) mathematics identity scale. Mean scores were calculated based on the participant's responses to statements related to interest, recognition, and competence/performance. The higher the mean, the more someone identifies as a math person. For this study, the internal reliability for the overall mathematics identity scale was a Cronbach alpha of 0.91, the interest subscale had a Cronbach alpha of 0.89, the recognition subscale had a Cronbach alpha of 0.92, and the competence/performance subscale had a Cronbach alpha of 0.72, indicating a high level of internal consistency, and is in line with reliability reported by researchers (Cribbs et al., 2015). The means and standard deviations for identity and its three subscales are displayed in table 4.4. The overall group identity mean scores seemed similar and slightly weak for the PC-I (*M* = 2.82) and the QR groups (*M* = 2.63). However, at a glance, there may be a difference between the two groups when it comes to looking at the scale's subgroups.

Table 4.4

Descriptive Statistics for Identity

	Pre-calculus I			Quantitative Reasoning		
Construct	All (*n* = 112) *M (SD)*	No essentials (*n* = 66) *M (SD)*	With essentials (*n* = 46) *M (SD)*	All (*n* = 118) *M (SD)*	No essentials (*n* = 66) *M (SD)*	With essentials (*n* = 52) *M (SD)*
Identity	2.82 (0.90)	2.81 (0.92)	2.84 (0.87)	2.53 (0.81)	2.63 (0.85)	2.40 (0.74)
Interest	3.03 (1.12)	2.99 (1.15)	3.09 (1.09)	2.72 (0.95)	2.75 (1.00)	2.69 (1.05)
Recognition	2.58 (1.08)	2.58 (1.12)	2.58 (1.04)	2.07 (0.99)	2.17 (1.08)	1.92 (0.87)
Competence/ Performance	2.91 (0.93)	2.90 (0.97)	2.93 (0.87)	2.85 (0.93)	2.99 (0.94)	2.66 (0.90)

Since neither the PC-I nor QR groups met the normality assumptions, a nonparametric test was conducted. A Mann-Whitney U test (Table 4.5) was run and determined that there are significant differences in median identity scores between the PC-I and the QR group, $U = 5176$, $Z = -2.84$, $p = 0.01$, $r = -0.18$. When looking at the subgroups, there were also some significant differences between the groups. Interest medians for PC-I (*Mdn* = 3.00) and QR (*Mdn* = 2.67) were significantly different, $U = 5466.50$, $Z = -2.27$, $p = 0.02$, $r = -0.15$. Additionally recognition medians for PC-I (Mdn = 2.75) and QR (*Mdn* = 1.88) were also significantly different, $U = 4769$, $Z = -3.66$, $p < 0.001$, r = -0.24. Although there was a significant difference between the three characteristics, the effect size for all of these was small, indicating that there is not a large relative significance. This indicates that although both groups are on the low side, students in PC-I identify more as a math person, find math more interesting, and have higher recognition than the students in QR.

Table 4.5

Group Comparison of Median Identity Scores

Belief	PC-I	QR				
	Median	Median	*U*	*Z*	*p*	*r*
Identity	2.93	2.58	5176.00	-2.84	0.01*	-0.18
Interest	3.00	2.67	5466.50	-2.27	0.02*	-0.15
Recognition	2.75	1.88	4769.00	-3.66	0.00*	-0.24
Competence/ Performance	3.25	3.25	6498.00	-0.22	0.83	-0.01

*Significant at $p < 0.05$

Grit. In order to determine the level of perseverance and passion that a person has to complete a mathematics goal (Duckworth, 2007) amongst the participants, the mean scores from the eight-item Grit scale were calculated. Recall that a participant's mean score could range from 1 (not gritty at all) to 5 (very gritty). For this study, the Grit Scale's internal reliability was a Cronbach alpha of 0.74, indicating an acceptable level of internal consistency and is comparable to the reliability reported by researchers

(Duckworth, 2007; Kruczek, 2017). The means and standard deviations for the identity for each group are displayed in Table 4.6. From these descriptive results, it appears that a student's mean mathematical grit (PC-I = 3.14, QR = 3.16) is similar regardless of the course in which they are enrolled. This suggests that both groups finish tasks, strive to meet goals that have been set, as well as continue to maintain interest.

Table 4.6

Descriptive Statistics for Grit

	Pre-calculus I			Quantitative Reasoning		
Construct	All (n = 112) *M (SD)*	No essentials (n = 66) *M (SD)*	With essentials (n = 46) *M (SD)*	All (n = 118) *M (SD)*	No essentials (n = 66) *M (SD)*	With essentials (n = 52) *M (SD)*
Grit	3.14 (0.69)	3.12 (0.71)	3.18 (0.68)	3.16 (0.60)	3.17 (0.60)	3.14 (0.60)
Consistency of Interest	3.10 (0.80)	3.07 (0.87)	3.14 (0.69)	3.08 (0.76)	3.06 (0.74)	3.11 (0.79)
Perseverance of Effort	3.20 (0.88)	3.18 (0.84)	3.23 (0.93)	3.23 (0.75)	3.29 (0.77)	3.16 (0.77)

After noting these descriptive similarities, an independent samples t-test was used to determine if the mean difference was, in fact, not significant, thus indicating a similarity (see Table 4.7). A 95% confidence level as calculated for the mean difference. Results indicate no significant difference in students' overall mathematics grit nor their consistency of interest. However, there was a significant difference between the two groups' level of perseverance of effort ($t(228) = -0.32$, $p = 0.04$, $d = 0.04$). The effect size was small ($d = 0.04$), according to Cohen (1988), which could suggest that even though there may be a significant difference between the two groups, the difference may be trivial. These results suggest that both groups have a similar general overall grittiness when it comes to learning mathematics; however, the QR (*M* = 3.20) students tenacity required to complete a task to the end was significantly higher than that of the PC-I (*M* = 3.10) students.

Table 4.7

Group Comparisons of Mean Grit Scores

Belief	PC-I *M (SD)*	QR *M (SD)*	*df*	*t*	*p*	*d*
Grit	3.14 (0.69)	3.16 (0.60)	228	-0.11	0.91	0.03
Consistency of Interest	3.10 (0.80)	3.08 (0.76)	228	0.15	0.88	0.03
Perseverance of Effort	3.20 (0.88)	3.23 (0.75)	228	-0.32	0.75	0.04

Mathematics Attitudes. Attitudes towards mathematics is a measure of "a liking or disliking of mathematics, a tendency to engage in or avoid mathematical activities, a belief that one is good or bad at mathematics, and a belief that math is useful or useless" (Neal, 1969, p. 632). Fennema and Sherman's Mathematics Attitude Scale (1976) was created to measure attitudes related to mathematics. Mean scores can range from 1 to 5, with higher scores indicating a more positive attitude towards mathematics. Aligning with previous research (Fennema & Sherman, 1976; Hodges & Kim, 2013), the internal reliability Cronbach alpha scores for this research study all indicated a high level of internal consistency - usefulness (0.93), effectance motivation (0.89), attitudes toward success (0.84), and confidence (0.92). Based on observations of means and standard deviations in Table 4.8, PC-I appears to have a total higher mean (*M* = 3.42), than QR (*M*

= 3.22), as well as a higher mean in each category. This would suggest that the students in PC-I feel that they will use math more in their everyday life, they are confident when it comes to working math problems, they are motivated, and that they will succeed in math courses that they may have to take.

Table 4.8

Descriptive Statistics for Mathematics Attitudes

	Pre-calculus I			**Quantitative Reasoning**		
Construct	All (n = 112) *M (SD)*	No essentials (n = 66) *M (SD)*	With essentials (n = 46) *M (SD)*	All (n = 118) *M (SD)*	No essentials (n = 66) *M (SD)*	With essentials (n = 52) *M (SD)*
Attitudes Towards Mathematics	3.42 (0.60)	3.44 (0.62)	3.39 (0.57)	3.22 (0.56)	3.28 (0.59)	3.14 (0.52)
Usefulness	3.54 (0.85)	3.59 (0.86)	3.48 (0.85)	3.37 (0.79)	3.44 (0.75)	3.29 (0.84)
Confidence	3.15 (0.91)	3.15 (0.95)	3.16 (0.87)	2.92 (0.85)	3.06 (0.89)	2.75 (0.78)
Effectance Motivation	3.14 (0.74)	3.16 (0.76)	3.12 (0.72)	2.91 (0.78)	2.91 (0.78)	2.91 (0.79)
Attitudes toward success	3.85 (0.60)	3.88 (0.61)	3.81 (0.60)	3.68 (0.56)	3.70 (0.54)	3.65 (0.60)

The mathematics attitude scores met the homogeneity of variance assumptions, but two of the subgroups, confidence and success, did not meet normality assumptions. An independent samples t-test (Table 4.9) was used to determine that there was significant differences in Effectance motivation ($t(228) = 2.32$, $p = 0.02$, $d = 0.30$) between the two groups of students. The effect size ($d = 0.30$) according to Cohen (1988) is a medium effect size. A Mann-Whitney U test was run to determine if there were differences in confidence and success between the two groups of students. Median scores were significantly higher in confidence of mathematics for PC-I (*Mdn* = 3.13) students than QR (*Mdn* = 2.83) students, $U = 6287$, $Z = -2.07$, p = 0.04, $r = -0.14$. Additionally, medians scores were also significantly higher in success of mathematics for PC-I (*Mdn* = 3.83) students than QR (*Mdn* = 3.67) students, $U = 5610$, $Z = -1.98$, $p = 0.05$, $r = -0.13$. These differences suggest that PC-I students are more motivated to do things related to mathematics, more confident when it comes to mathematics, and feel like they will be more successful in their current and future mathematics courses than QR students.

Table 4.9

Group Comparison of Mean Mathematics Attitude Scores

Belief	PC-I	QR	*df*	*t*	*p*	*d*
	M (SD)	M (SD)				
Overall Attitudes	3.42 (0.60)	3.22 (0.56)	228	2.61	0.14	0.35
Usefulness	3.54 (0.85)	3.37 (0.79)	228	1.61	0.30	0.21
Effect Mot[1]	3.14 (0.74)	2.91 (0.78)	228	2.32	0.02*	0.30

[1]Eff Mot = Effectance Motivation *Significant at $p < 0.05$

Mathematics Self-efficacy and Anxiety. Lastly, the researcher wanted to examine if students had the abilities needed to complete a mathematics assignment and if they had any fears or feelings of nervousness when completing these tasks. May (2009) created the Math Self-efficacy and Anxiety Questionnaire (MSEAQ) to determine students' levels of self-efficacy and mathematics anxiety. Mean scores on the MSEAQ-SE range from 1 (low self-efficacy) to a 5 (high self-efficacy). Mean scores on the MSEAQ-A range from 1 (low anxiety) to a 5 (high anxiety). For the sample of students in this study, the internal reliability of the MSEAQ had a Cronbach alpha 0.95, the MSEAQ –SE had a Cronbach alpha of 0.92, and MSEAQ-A Cronbach alpha was 0.93, which indicates a high level of internal consistency. The mean self-efficacy scores for the PC-I group (*M* = 3.21) appears to be slightly higher than the mean score for the QR group (*M* = 3.18). Additionally, the mathematics anxiety scores appear to be similar, with the PC-I class mean (*M* = 2.86) being slightly lower than the QR class mean (*M* = 2.91).

Table 4.10

Descriptive Statistics for Self-efficacy and Anxiety

	Pre-calculus I			**Quantitative Reasoning**		
Construct	All (*n* = 112) *M (SD)*	No essentials (*n* = 66) *M (SD)*	With essentials (*n* = 46) *M (SD)*	All (*n* = 118) *M (SD)*	No essentials (*n* = 66) *M (SD)*	With essentials (*n* = 52) *M (SD)*
Mathematics Self-efficacy	3.21 (0.82)	3.19 (0.90)	3.24 (0.71)	3.18 (0.77)	3.28 (0.81)	3.06 (0.70)
Mathematics Anxiety	2.86 (0.97)	2.88 (1.01)	2.83 (0.93)	2.91 (0.96)	3.05 (0.93)	2.73 (0.97)

After performing an independent samples t-test (Table 4.10), it was determined that there were no significant differences between the two groups and that the two groups were similar when it came to math self-efficacy $t(228) = 0.221$, $p = 0.24$, $d = 0.04$ and math anxiety $t(228) = -0.39$, $p = 0.91$, $d = 0.05$. The effect size for both analyses was considered small, according to Cohen's (1988) convention for small effect size ($d = .20$). These results suggest that both groups believe that they can complete a mathematics task. However, they also have the same levels of anxiety when it comes to completing mathematics assignments.

Table 4.11

Group Comparisons of Self-efficacy and Anxiety

Belief	PC-I *M (SD)*	QR *M (SD)*	*df*	*t*	*p*	*d*
Self-efficacy	3.21 (0.82)	3.18 (0.77)	228	0.22	0.83	0.04
Anxiety	2.86 (0.97)	2.91 (0.96)	228	-0.39	0.70	0.05

Differences in Characteristics Based on Successful Completion of QR or PC-I

The second goal of this research was to examine whether there were any differences in characteristics between the students that were successful and those that were unsuccessful in each of the courses. Students were considered successful in the course if they received an A, B, or C. Students were considered unsuccessful if they received a D, F, or W. Having this knowledge may help the instructor develop lessons that will help students that would typically be unsuccessful in this class to succeed. Thus, demographics, achievement factors, and belief factors for each course were explored.

Demographics. The researcher only chose to examine race and gender when it came to demographics based on the small sample size of students that were categorized as unsuccessful. When looking at gender between the successful and unsuccessful students in PC-I, there was a significant difference (χ^2 (1) = 4.43, p = 0.04). A larger percentage of males were unsuccessful (14.29%) than females (6.25%). When examining a difference in gender for the students in QR, there were no significant differences (χ^2 (1)

= 2.15, $p = 0.14$) in gender between the students that were successful and the unsuccessful students.

With regards to race, there were initially seven groups: American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian/Other Pacific Islander, White, Other, and multi-racial. Since some of the categories had low or no representation once separated between successful students and students that were not successful, race was collapsed into two groups: the majority (White and Asian) and the minority (all others). The reason for dividing race between these two groups was that even though demographics are changing due to the increase in college enrollment, Whites and Asians continue to make up higher percentages of higher education institutions enrollment numbers in the United States when compared to other races (NCES, 2015).

Results of the Chi-square test of independence indicated that there were no significant differences based on race between students that were successful and those that were unsuccessful in PC-I. Similarly, there were also no significant differences based on race between students that were successful and those that were unsuccessful in the QR course. This suggests that an individual's race is not a factor when exploring students' level of success in these courses.

Achievements. In order to examine if there were any differences in achievement factors (high school GPA, Act Composite and Act mathematics scores) between the groups that were successful and unsuccessful in both PC-I and QR, an independent samples t-test (see Table 4.12) was conducted. The independent samples t-test indicated no significant differences in high school GPA or ACT composite and math scores between the successful and unsuccessful students in QR and PC-I.

High school GPA was found to be significantly different ($t(94) = -2.48$, $p = 0.02$, $d = 0.60$) between the successful and unsuccessful group of student in PC-I but not in QR. The PC-I successful group had a higher mean high school GPA ($M = 3.15$) then the unsuccessful group ($M = 2.83$). The effect size ($d = 0.60$) suggests a medium practical significance. These findings indicate that a student's prior mathematics achievement as indicated by their high school GPA may be a better predictor of success for the students enrolled in PC-I than their ACT composite score.

Table 4.12

Achievement Statistics for Successful and Unsuccessful Students

Achievements	Successful *M (SD)*	Unsuccessful *M (SD)*	*df*	*t*	*p*	*d*
Quantitative Reasoning						
ACT Composite	18.45 (2.85)	18.64 (3.13)	80	-0.247	0.81	0.06
ACT Mathematics Score	17.22 (2.83)	17.91 (2.15)	80	-0.941	0.35	0.27
High School GPA	3.12 (0.44)	3.03 (0.48)	100	0.845	0.40	0.20
Pre-calculus I						
ACT Composite	19.33 (3.09)	21.53 (5.23)	74	1.89	0.06	0.51
ACT Mathematics	18.40 (3.16)	20.03 (4.19)	74	1.46	0.15	0.44
High School GPA	3.15 (0.50)	2.83 (0.56)	94	-2.48	0.02*	0.60

*Significant at $p < 0.05$

Belief Factors. Due to the majority of the belief factors failing to meet the assumption of normality, a Mann-Whitney U test (See Table 4.13) was conducted to examine any differences in beliefs between the successful and unsuccessful groups of students enrolled in either QR or PC-I. When examining the belief factors between successful and unsuccessful students in QR, consistency of interest was found to be significantly different between the two groups ($U = 876.50$, $Z = -2.09$, $p = 0.04$, $r = -0.19$). The median for the successful group (*Mdn* = 3.25) was higher than that for the unsuccessful group (*Mdn* = 2.75). This difference could indicate that the successful group has a higher tendency to continue to pursue their goals than the unsuccessful group.

Table 4.13

Belief Statistics for Successful and Unsuccessful Students

Belief	Successful *Median*	Unsuccessful *Median*	*U*	*Z*	*p*	*r*
Quantitative Reasoning						
Grit	2.88	2.88	1118.50	-0.51	0.61	-0.05
Consistency of Interest	3.25	2.75	876.50	-2.09	0.04*	-0.19
Perseverance of Effort	2.75	3.00	1013.50	-1.19	0.23	-0.08
Identity	2.61	2.54	1102.00	-0.61	0.54	-0.04
Interest	2.67	2.50	1076.50	-0.78	0.44	-0.05
Recognition	2.00	1.75	1116.59	-0.52	0.60	-0.03
Competence/Performance	3.25	3.00	1026.00	-1.11	0.27	-0.07
Attitudes Towards Math	3.00	2.94	916.50	-1.82	0.07	-0.12
Usefulness	2.92	2.79	1007.50	-1.23	0.22	-0.08
Confidence	3.17	3.13	1172.00	-0.16	0.88	-0.01
Effectance Motivation	3.00	2.92	1057.50	-0.91	0.37	-0.06
Success	3.00	2.92	957.50	-1.56	0.12	-0.10
Self-Efficacy	3.14	3.25	1053.50	-0.93	0.36	-0.06
Math Anxiety	3.10	2.67	1060.50	-0.88	0.38	-0.06
Pre-calculus I						
Grit	2.88	3.00	924.50	-0.41	0.69	-0.03
Consistency of Interest	3.00	3.13	931.50	-0.35	0.72	-0.02
Perseverance of Effort	2.75	3.00	888.50	-0.67	0.50	-0.04
Identity	2.92	2.94	965.00	-0.10	0.92	-0.01
Interest	3.00	3.33	939.50	-0.29	0.77	-0.02
Recognition	2.75	2.50	949.50	-0.22	0.83	-0.01
Competence/Performance	3.25	3.25	966.00	-0.10	0.92	-0.01
Attitudes Towards Math	3.04	2.96	719.50	-1.92	0.06	-0.13
Usefulness	2.92	2.79	937.00	-0.31	0.76	-0.20
Confidence	3.08	3.00	751.50	-1.69	0.09	-0.11
Effectance Motivation	3.00	2.92	689.00	-2.16	0.03*	-0.14
Success	3.08	3.04	933.50	-0.34	0.74	-0.02
Self-Efficacy	3.21	2.86	697.00	-2.09	0.04*	-0.14
Math Anxiety	3.13	3.07	943.00	-0.27	0.79	-0.02

*Significant at $p < 0.05$

When it came to the PC-I course, there was a significant difference in effectance Motivation ($U = 689.00$, $Z = -2.16$, $p = 0.03$, $r = -0.14$) between the two groups of students. The effectance motivation median was slightly higher for the successful group (*Mdn* = 3.00) than the unsuccessful group (*Mdn = 2.92)*. Additionally, there was also a significant difference in students' mathematics self-efficacy (U = 697.00, Z = -2.09, p = 0.04, r = -0.14) with the successful group (*Mdn* = 3.21) having a higher median score than the unsuccessful group (*Mdn* =2.86). These findings indicate that students that are more motivated to do mathematics, and believe in their skills, may be more successful in PC-I than other students in the same course.

Predictors of Academic Success of Students Enrolled in PC-I and QR

After looking at the differences in characteristics between successful and unsuccessful students, the final goal was to determine if any grouping of characteristics examined in the study could predict success. Success was determined by receiving an A, B, or C in the current mathematics course. Students that failed to succeed received a D, F, or W in the course. A binary logistics regression was performed for each course to determine the best combination of independent variables that could predict academic success, as measured by successful completion of the course. All achievement and belief factors were originally included in the model, as well as key demographics (gender, 1st generation graduate, race (minority/majority), and parent's education).

Factors in each category were regressed based on whether a student succeeded or failed to succeed in the course. Success rates were coded as a dichotomous variable, with failure to succeed coded as a 0 and success coded as a 1. Table 4.14 presents the results when pass rates were regressed on demographic variables.

Table 4.14

Logistics Regression Statistics for Demographics

Demographics	*n*	β	*SE*	*Sig*	*Odds Ratio*
Quantitative Reasoning	118				
Gender (1 = male, 2 = female)		0.80	0.48	0.10	2.22
Race (1 = majority, 2 = minority)		-0.74	0.49	0.15	0.50
First Generation Student (1 = yes, 2= no)		-0.39	0.67	0.57	0.68
Fathers Education		0.53	0.24	0.03*	1.69
Mothers Education		-0.40	0.23	0.08	0.67
Pre-calculus I	112				
Gender (1 = male, 2 = female)		1.12	0.53	0.04*	3.05
Race (1 = majority, 2 = minority)		0.13	0.59	0.82	1.14
First Generation Student (1 = yes, 2= no)		0.82	0.71	0.25	2.27
Fathers Education		-0.36	0.27	0.19	0.70
Mothers Education		0.23	0.34	0.49	1.26

*Significant at $p < 0.05$

For the QR course the only significant demographic variable was Father's education ($p = 0.03$). This result indicates that the higher the father's education, the more successful students were in the QR course. Students that had educated fathers' were 1.69 times more successful than students that had uneducated fathers. When considering demographics for the PC-I course, gender was positively related ($p = 0.04$) to students success rates. Based on the odds ratio, females had 3.05 times higher odds of success than males.

Similarly, achievement data was regressed on success rate (See Table 4.15) indicating no significant correlations between any of the variables for QR students. However when it came to PC-I students, there was a significant positive correlation (*p* =

0.01) between success rates and students high school GPA scores. These results suggest that the higher a students' High School GPA, the more successful they were in their current mathematics course. Students with a higher GPA was 3.94 times more successful in the course.

Table 4.15

Logistics Regression Statistics for Achievements

Achievements	*n*	β	*SE*	*Sig*	*Odds Ratio*
Quantitative Reasoning	81				
ACT Composite		0.02	0.13	0.86	1.02
ACT Mathematics Score		0.02	0.13	0.86	1.02
High School GPA		0.48	0.56	0.39	1.62
Pre-calculus I	72				
ACT Composite		-0.18	0.12	0.15	0.84
ACT Mathematics		-0.02	0.12	0.89	0.98
High School GPA		1.37	0.51	0.01*	3.94

*Significant at $p < 0.05$

Next, belief characteristics were regressed on success rates (See Table 4.16) indicating a positive correlation between consistency of Interest ($p = 0.03$) and success rates for the students in the QR course. Students with a higher consistency of interest was 2.17 times more successful in the course. Additionally, usefulness of mathematics was positively correlated with success of QR students ($p = 0.02$). Students who found math more useful were 12.66 times more successful in the course than students' who did not feel that they would use math outside of the course.

These belief results show that the more interested a student is in mathematics, as well as how much they feel that they will use the information when it comes to their career, the more successful they were in the course. When examining PC-I students, the one positive relationship found was with self-efficacy. Students with a higher self-efficacy was 5.59 times more successful in the course. The more a student believes in their ability to complete a mathematics problem, the more successful they were in the PC-I course.

Table 4.16

Logistics Regression Statistics for Beliefs

Belief	*n*	β	*SE*	*Sig*	*Odds Ratio*
Quantitative reasoning	118				
Grit					
Consistency of Interest		0.77	0.35	0.03*	2.17
Perseverance of Effort		-0.47	0.36	0.19	0.63
Identity					
Interest		0.54	0.40	0.17	1.72
Recognition		-0.23	0.37	0.53	0.80
Competence/Performance		0.82	0.53	0.12	2.28
Attitudes Towards Math					
Usefulness		2.54	1.11	0.02*	12.66
Confidence		0.35	0.97	0.72	1.42
Effectance Motivation		-0.12	0.93	0.90	0.89
Success		1.76	0.96	0.07	5.82
Self-Efficacy		-1.10	0.64	0.09	0.33
Math Anxiety		0.04	0.43	0.93	1.04
Pre-Calculus I	112				
Grit					
Consistency of Interest		-0.04	0.35	0.91	0.96
Perseverance of Effort		-0.18	0.32	0.58	0.84
Identity					
Interest		-0.47	0.38	0.22	0.63
Recognition		-0.01	0.41	0.98	0.99
Competence/Performance		-0.61	0.55	0.27	0.54
Attitudes Towards Math					
Usefulness		-1.44	1.27	0.26	0.24
Confidence		2.05	1.29	0.11	7.73
Effectance Motivation		2.40	1.30	0.07	11.04
Success		-0.01	0.90	0.99	0.99
Self-Efficacy		1.72	0.70	0.01*	5.59
Math Anxiety		0.43	0.49	0.38	1.54

*Significant at $p < 0.05$

Once all characteristics were analyzed for each category, a final model for each course (See Table 4.17) was created with characteristics that had a significant correlation with success and all insignificant characteristics were removed. Initially fathers' education was included in the final model for QR, but was removed due to being non-significance. Consistency of interest (p = 0.01) and usefulness of mathematics ($p = 0.05$) were the two significant characteristics for the QR class, with both being positively correlated with success. Students that found math more useful were 6.99 times more successful and students' that were more interested were 2.19 more successful than other students. When it comes to the QR course, students that were more interested in the material and found the material to be useful in their future careers were more successful.

Table 4.17

Final Model Logistics Regression

Final Model	*n*	β	*SE*	*Sig*	*Odds Ratio*
Quantitative Reasoning					
Consistency of Interest	118	0.78	0.32	0.01*	2.19
Usefulness	118	1.94	0.98	0.05*	6.99
Pre-calculus I					
High school GPA	72	1.69	0.57	< 0.01*	5.43
Gender	112	1.81	0.66	0.01*	6.10
Self-efficacy	112	1.09	0.43	0.01*	2.98

*Significant at $p < 0.05$

For students in the PC-I course high school GPA ($p < 0.01$) was significant, with students with higher GPA's being 5.43 times more successful. Gender ($p = 0.01$) was significant with females being 6.10 times more successful than males. Last self-efficacy ($p = 0.01$) was also significant with students with higher self-efficacy 2.98 times more likely to succeed than other students. Students that have a higher high school GPA, believe in their ability to complete mathematics problems, depending on gender, were more successful when it came to PC-I.

CHAPTER V

Discussion

Historically, College Algebra has been the recommended mathematics course for nearly all degree plans. However, recently colleges have re-evaluated their mathematics course curriculum offerings and have begun offering alternate pathways where students could take courses such as Quantitative Reasoning to fulfill their degree programs' mathematics needs. The primary emphasis for any new pathway course is to ensure that these courses are beneficial to students' success in their future careers and lives.

There has been research conducted over the years that have examined demographic factors, such as gender, race, and ethnicity and have found that student populations are becoming more diverse than in the past (NCES, 2015). Research has also examined other topics that may be indicators of students' success, such as achievement data (high school GPA and ACT scores) and belief factors (identity, grit, mathematics attitudes, self-efficacy, and mathematics anxiety) (Easton, 2013). This study adds to this collection of research as it examines the demographics of students that are now taking College Algebra and QR as well as the impact that demographics, achievement, and beliefs have on student success in mathematics courses.

Participants in this study included 118 students enrolled in Quantitative Reasoning, and 112 students enrolled in Pre-calculus I. The study used self-reported questionnaire responses and institutional records to gather demographic, achievement and belief data for each participant. Quantitative data analysis, including inferential statistics and regression analyses, were used to answer the research questions.

This chapter includes a discussion of the findings for each goal and its specific research questions and how these findings relate and add to the literature related to understanding the students' instructors are working within entry-level mathematics courses. This chapter will begin with a discussion of the conclusions that can be gleaned from each goal of the study, followed by limitations of the study and suggestions for future research.

Conclusions

Goal 1

The first goal of this study was to describe important characteristics of students enrolled in PC-I and QR at a large Midwestern community college and explore any significant differences between those characteristics. To address this goal, the specific research questions were:

R1. What are the characteristics (i.e., demographics, achievements, and beliefs) of college students enrolled in Quantitative Reasoning and college Pre-calculus I (i.e., College Algebra) at one campus of a large Midwestern community college?

R2. Are there significant differences in the characteristics (i.e., demographics, achievements, and beliefs) between students enrolled in Quantitative Reasoning and Pre-calculus I (i.e., College Algebra) at one campus of a large Midwestern community college?

Summary of Results. A chi-square test indicated no differences in the examined demographic characteristics between the two groups of students. An independent samples t-test was used to suggest that PC-I students had significantly higher ACT composite and math scores than QR students. Additionally, when it came to beliefs, PC-I students had a significantly higher overall Identity, including interest and recognition subscales, as well as a higher effectance motivation mean.

Discussion. Regardless of the fact that the majority of students that were pursuing STEM-related degrees were taking Pre-calculus I and those pursuing non-STEM related degrees were taking Quantitative Reasoning, both groups tended to have similar demographic characteristics. In terms of race and ethnicity, no significant differences were found between the two groups of students. Additionally, with the majority of students in both groups being white, suggest that there is a lack of minorities that are enrolling in these courses. These findings align with Pryor et al. (2006), who stated that racial minority students are "still lagging behind their Asian and White peers with respect to academic preparedness in mathematics upon college entry" (p. 21). Although there is a lack of diversity in the classroom, teachers must still support this diversity as it has a positive effect in the classroom and students learn a lot when they are able to interact and get diverse perspectives in the curriculum (Hurtado, 2001). With there being no differences in demographics between the courses, instructors of both QR and PC-I must incorporate curriculum that connects to students of all demographic backgrounds.

There were findings in this study that showed significant achievement differences between the two groups of students. Arens et al. (2017) discussed that GPA and standardized achievement, such as ACT scores, are two of the most common indicators of students' success. In this study, students' GPAs were similar; however, there was a significant difference between the mean ACT composite scores and the mean ACT math scores between the two groups. With students in PC-I having significantly higher mean ACT composite and mathematics subscale scores than students in QR, findings suggest that students with higher mathematics skills are enrolled in the course with more computational mathematics, and the students with lower mathematics skills are enrolled in the course focused on critical thinking and real-world problem-solving. It is important for instructors to examine the ACT scores of their students coming in so that they have insight on the student's that may struggle and student's that are perceived to have stronger mathematics skills based on their mathematics ACT score. This insight will help to develop curriculum that not only allows students to gain stronger mathematics skills, but also to challenge the student's that come in with stronger skills.

Additionally, it is important to know about students' beliefs as these beliefs can enable students to learn and be successful (Garcia, 2014; Tough, 2012). The belief factors in this study measure participants levels of anxiety when it comes to mathematics, their level of perseverance, whether they view themselves as a mathematics person, and their attitudes about mathematics, including how confident they are when it comes to mathematics and how useful they may see math in their future endeavors.

When examining identity, it was found that students in PC-I had a higher median score for overall identity, as well as two of the identity sub-scores, interest and recognition. Reitzes and Burke (1980) found that people were inclined to be involved in activities that were consistent with their identities. The findings on identity are important because it shows that students that identify more as a math person tend to enroll in PC-I, which is a more computational math course and are geared toward careers such as engineering and nursing. These findings also suggest that students that are enrolling in QR and do not have a strong mathematics identity are in a course that focuses more on real-world mathematics such as interest rates and logic that can be applied to careers such as teaching and social work.

When examining mathematics attitudes, a significant difference was found in students' effectance motivation, mathematics confidence, and mathematics success. Scores for PC-I students were higher than those for QR students. These findings suggest that PC-I students are more confident, have more motivation to perform mathematical tasks, and see themselves as being successful in mathematical assignments and courses. Ercikan et al. (2005) discussed how students with higher mathematics attitudes would be more likely to participate in an advanced mathematics course. With PC-I being a course that prepares students for higher mathematics, it is good for instructors to know that students with higher mathematics attitudes are enrolling in courses that prepare them to move on to higher mathematics. Additionally, instructors need to consider the interests of their students as they develop their curriculum for QR students ensuring that students find it relatable and potentially serving to build their confidence in mathematics. When students are more confident in themselves, they are more motivated to succeed in the classroom (Furinghetti & Pehkonen, 2000).

Goal 2

The second goal was to determine any significant differences in characteristics between the students that were successful or failed to succeed within each course. To address this goal, the specific research questions were:

R3. Are there significant differences in characteristics (i.e., demographics, achievements, and beliefs) between students enrolled in Quantitative Reasoning based on whether they were successful in the course?

R4. Are there significant differences in the characteristics (i.e., demographics, achievements, and beliefs) between students enrolled in Quantitative Reasoning and Pre-calculus I (i.e., College Algebra) based on whether they were successful in the course?

Summary of Results. A chi-square test revealed that females were more successful than males in the PC-I course. An independent samples t-test indicated significant differences in GPA, effectance motivation, and self-efficacy between students that succeeded and failed to succeed in the PC-I course. Additionally, there was a significant difference in consistency of interest between students that succeeded and failed to succeed in the QR course.

Discussion. Due to a low value of unsuccessful students, the researcher only chose to examine the gender and race of the students that were successful and unsuccessful in QR and PC-I. There was a significant difference in the success rates for students in the PC-I when it came to gender. There was a higher percentage of males that were unsuccessful than females. These results contradict Lesik's (2006) claims that there were no differences between males and females in the classroom. Instructors need to be aware of the number of male and female students in their classes and make sure the curriculum is relatable to both genders. The researcher found no significant differences when it came to race between the students that were successful or unsuccessful in either of the courses.

When it comes to previous academic achievements such as students' high school GPA and ACT composite and mathematics scores, there were no significant differences in any of the factors when it came to the students' in QR. However, there was a significant difference when it came to students' ACT composite scores. Interestingly, the unsuccessful students had a higher mean than the students' that were successful. Conversely, students that were successful in the course had a higher high school GPA than unsuccessful students. These results align with research that suggests grades are more significant to students' because they can be directly communicated and easily compared amongst other students (Arens et al., 2017). By examining student's grades before the start of the course, instructors can anticipate the needs of student's. Curriculum needs to not only challenge students with stronger mathematics skills, but it also needs to improve students with weaker mathematics skills. By examining student's high school GPA instructors will have an idea of the range of mathematics skills that incoming students will have coming into to the class. Instructors also need to know that it is important to update student's grades on a regular basis and to give immediate feedback to aid student's in successfully completing the course.

Research (e.g., Bandura, 1997; Duckworth et al., 2007; Fennama & Sherman, 1976) indicates that belief factors such as grit, attitudes towards mathematics, and self-efficacy can contribute to student success. There were no differences found in overall grit in examining the two groups of students in the QR course. However, there was a significant difference in the consistency of interest factor of the grit subscale. The students that were successful in the QR course had more of a commitment and passion for finishing the course. Additionally, there was a significant difference found between students' attitudes for mathematics in the QR course. The successful students had a more positive attitude towards mathematics than the unsuccessful students. When creating curriculum, instructors need to ask themselves what problems can help students to maintain and develop a positive mathematics attitude, as well as keep students interest. Just randomly assigning students work, without taking attitudes and interest into consideration does not aid in the success of student’s that may have a negative outlook when it comes to mathematics.

In examining belief factors between successful and unsuccessful students in PC-I, there was also a significant difference in attitudes towards overall mathematics scale, as well as the subscales of confidence and effectance motivation, between the successful and unsuccessful students, with successful students having a higher median score than the unsuccessful students for all categories. This finding aligns with research (e.g., Mcleod, 1992; Randel, Stevenson, & Witruk, 2000) that indicates that students' attitudes towards mathematics are correlated with student success. Additionally, there was a significant difference found in self-efficacy between students that were successful and unsuccessful in the PC-I course, with successful students having a higher median score than unsuccessful students. Researchers Ayotola and Adedeji (2009) found that there were significant differences between students' mathematics self-efficacy and mathematics achievements. These findings also give instructors the insight that attitudes do play a role in student’s outcomes when it comes to mathematics learning. Finding a way to boost student’s confidence whether it is immediate feedback, words of encouragement, or a more thought out curriculum, is worth the time and effort in order to aid in student success.

Goal 3

The study's last goal was to determine relationships between the academic success of the participants and their demographic, prior achievement, and belief factors. To address this goal, the specific research questions were:

R5. What combination of characteristics (i.e., demographics, achievements, and beliefs) for college students enrolled in Quantitative Reasoning are predictors of academic success?

R6. What combination of characteristics (i.e., demographics, achievements, and beliefs) for college students enrolled in Pre-calculus I (i.e., College Algebra) are predictors of academic success?

Summary of Results. A binary logistics regression indicated that consistency of interest and the usefulness of mathematics were predictors of success for students in the QR course. High school GPA, gender, and self-efficacy were predictors of success for the students in the PC-I course.

Discussion. Students were divided into two groups within each course, successful and failure to succeed. The successful group consisted of students that earned an A, B, or C, where students that failed to succeed earned a D, F, or W for their current mathematics course. To determine if any of the characteristics being examined in the study were predictors of success, a binomial logistics regression was performed.

The binomial regression found that consistency of interest and usefulness of mathematics were predictors of success for the students in the QR course. Meyer and Koehler (1990) found that "students' perception of the usefulness of mathematics, both immediately and in their future, is a variable shown to be strongly associated with mathematics participation and achievement" (p. 62). This finding is beneficial and lets instructors know that students see the QR course information as something they will use in the future, which is one of the reasons for the course. Additionally, Wolters and Hussain (2015) found that students who had more confidence in completing a task indicated higher diligence, less frustration from setbacks, worked harder and expressed more interest in their coursework. It is important for instructors to present material that students find interesting and relatable in order to increase student success in the QR course

High school GPA, gender, and self-efficacy were found to be predictors of success for the PC-I group. It was interesting that self-efficacy was the only belief predictor for PC-I students, but according to Pajares and Miller (1994), mathematics self-efficacy is a better predictor of how a student will perform in a mathematics class compared to mathematics anxiety or previous experiences in mathematics. Furthermore, other studies have found a relationship between students GPA and college persistence (Edge & Friedberg, 1984; Houglum, Aparasu, & Delfinis 2005). Students that have higher high school GPA's were more successful in PC-I. This shows that students that worked hard in high school brought these same efforts into their college experience, Additionally, the study found that females were more successful than males in PC-I, this contradicts findings that male students are more prepared for college-level mathematics than female students (Lesik, 2006; Nook, 2013).

Limitations of the Study

The limitations of the study will be discussed in terms of study participants, the instruments used to measure belief characteristics, and unplanned pandemics.

One limitation of this study was in how the sample of the study was chosen. The study utilized a convenience sampling method in which students that enrolled in QR or PC-I were invited to participate. Students participated in the study voluntarily. Because participation was voluntary, students that choose to participate could have had higher mathematics attitude, lower mathematics anxiety, identified as a mathematics person, and could be grittier than the students that did not participate. This could cause a limit in the range of scores. This is likely since many students come to college, having previously had a negative experience with mathematics. Also, the sample consisted of students at one campus of a Midwestern community college, so the results may not represent the overall population of the college.

Another limitation of the study may be an unplanned pandemic. The coronavirus emerged in the middle of the semester and ultimately shut down the state. This shut down forced the college to move all classes online. This shift could have affected students that need a classroom environment and a face to face teaching environment to succeed in the course. Some students may not have had computer or internet access, making it difficult to attend class or complete the course. Both of these reasons could have affected students' overall grade, the number of students' that were successful in the course, and the number of students that withdrew from the course.

Suggestions for Future Research

The purpose of this study was to investigate demographics, achievement, and belief factors to gain information about the students in QR and PC-I, as well as to examine the effects these characteristics had on students' success. The results of the study revealed differences between students in QR and PC-I. The students were demographically similar, but the two groups were different when it came to pre-college achievements. The two groups were different when it came to belief factors, and the predictors of success for both groups were also different. Further research is needed to help students improve their belief characteristics and provide information on students that are now taking QR and PC-I.

First, since the study took place at only one campus of a Midwestern community college, including all students of the community college, it may help describe these students more accurately and find other characteristics that may predict success. Since there were no significant differences found in demographics between the two students, and minority enrollment seemed low, future research should explore if having a larger sample size can affect these findings.

Another area of research would be to conduct this study in the fall semester. There tends to be higher enrollment during the spring compared to the fall, which could allow teachers to know who the students are enrolling in their courses during the spring semester. This future research idea could also give insight on any differences between the students that enroll in the fall compared to the spring.

Conclusion

This study explored the characteristics of demographics, achievement, and beliefs of students in QR and PC-I to give instructors insight into the students enrolling in their course. This insight will help instructors to develop activities and curriculum to aid in the success of students'. Boylan (1999) suggests that good education starts with "an institutional commitment to the concept of educational development" (p.4). Understanding student demographics, as well as their previous academic information, helps instructors to complete the picture of who their students are. Research has indicated that belief factors, such as mathematics attitudes and self-efficacy, play a role in student success, so instructors must encourage these concepts to make students are aware of the impact. With this new mathematics pathway being offered at the current college and universities across the country, time should be spent on knowing the types of students going into these new courses to ensure that students are succeeding.

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APPENDICES

Appendix A: MCC IRB Approval

Human Subjects Review
Proposal Title: Cognitive and non-cognitive characteristics of student's enrolled in quantitative reasoning and pre-calculus I at a community college
IRB #: 19-020

Dear Researcher:

Your research proposal has been approved by the Institutional Review Board at [redacted] Community College. You are authorized to begin your research and implement this study as of the date of this email. This authorization is valid for one year from today. After this authorization runs out, you are required to submit a continuation or renewal request for IRB approval.

This approval is granted with the understanding that the research will be conducted within the published guidelines of the [redacted] Institutional Review Board and as described in your application. Any changes or modifications to the approved protocols should be submitted to the IRB for approval. Please use the IRB number provided above in all your communications regarding this study.

Thank you for sending us your application for research involving human subjects. By doing so, you safeguard the welfare of our students and federal funding of our college

Best,

Allison E. Tifft, Ph.D.

IRB Intake Coordinator

Institutional Research & Assessment

Appendix B: OSU IRB Approval

Oklahoma State University Institutional Review Board

Date:	01/15/2020
Application Number:	ED-19-170
Proposal Title:	Cognitive and non-cognitive characteristics of student's enrolled in quantitative reasoning and pre-calculus I at a community college
Principal Investigator:	Latoya Johnson
Co-Investigator(s):	
Faculty Adviser:	Juliana Utley
Project Coordinator:	
Research Assistant(s):	
Processed as:	Exempt
Exempt Category:	

Status Recommended by Reviewer(s): Approved

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in 45CFR46.

This study meets criteria in the Revised Common Rule, as well as, one or more of the circumstances for which continuing review is not required. As Principal Investigator of this research, you will be required to submit a status report to the IRB triennially.

The final versions of any recruitment, consent and assent documents bearing the IRB approval stamp are available for download from IRBManager. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be approved by the IRB. Protocol modifications requiring approval may include changes to the title, PI, adviser, other research personnel, funding status or sponsor, subject population composition or size, recruitment, inclusion/exclusion criteria, research site, research procedures and consent/assent process or forms.
2. Submit a request for continuation if the study extends beyond the approval period. This continuation must receive IRB review and approval before the research can continue.
3. Report any unanticipated and/or adverse events to the IRB Office promptly.
4. Notify the IRB office when your research project is complete or when you are no longer affiliated with Oklahoma State University.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact the IRB Office at 405-744-3377 or irb@okstate.edu.

Sincerely,
Oklahoma State University IRB

Appendix C: Adult Consent Form

CONSENT FORM

Cognitive and non-cognitive characteristics of student's enrolled in quantitative reasoning and pre-calculus I at a community college.

Purpose:
The purpose of this quantitative study is to examine the characteristics of students that are enrolled in quantitative reasoning and pre-calculus I courses. This study will also identity characteristics of the students enrolled in these two courses and if any of the characteristics can predict success in the course. The researcher will investigate the demographic characteristics, mathematics identity, levels of grit, self-efficacy, mathematics attitudes, and academic success of students enrolled in quantitative reasoning and pre-calculus I courses at Tulsa Community College.

This study is being conducted by:
Latoya Johnson, Doctoral Student, Oklahoma State University
Under the direction of Juliana Utley, Ph.D., Oklahoma State University

Procedures
If you agree to be in this study, we would ask you to do the following things: You will complete a questionnaire that includes demographic information, an identity scale, a mathematics attitudes scales, a mathematics self-efficacy and anxiety scale, and a grit scale. The demographics survey will ask questions such as age, gender, race/ethnicity, and mathematics classes completed in the past. The other surveys will ask questions about your perseverance with math, your attitude towards mathematics, and how you handle difficult mathematics situations.

Participation in the study involves the following time commitment: 20 – 30 Minutes

Compensation
You will receive no payment for participating in this study.

Risks and Benefits of being in the Study
There are no known risks associated with this project, which are greater than those ordinarily encountered in daily life.

The benefits to participation are: There are no direct benefits to you. More broadly, this study may help the researchers learn more about characteristics of students enrolled in a college-level mathematics course and may help inform instructors in order to develop engaging lessons and activities that support student learning and success.

Confidentiality
The information that you give in the study will be handled confidentially. After your survey data has been matched with the academic score, your information will be assigned a code number/pseudonym. The list connecting your id number to this code will be kept in a locked file. When the study is completed and the data have been analyzed, this list will be destroyed. Your id number will not be used in any report

Voluntary Nature of the Study
Your participation in this research is voluntary. There is no penalty for refusal to participate, and you are free to withdraw your consent and participation in this project at any time. The alternative is to not participate. .

Contacts and Questions
The Institutional Review Board (IRB) for the protection of human research participants at Oklahoma State University has reviewed and approved this study. If you have questions about the research study itself, please contact the Principal Investigator at:

Latoya Johnson
(918) 521-0767
Latoya.ragsdale@okstate.edu

Or

Dr. Juliana Utley
(405) 744-7476
Juliana.utley@okstate.edu

If you have questions about your rights as a research volunteer or would simply like to speak with someone other than the research team about concerns regarding this study, please contact the IRB at (405) 744-3377 or irb@okstate.edu. All reports or correspondence will be kept confidential.

You will be given a copy of this information to keep for your records.

Statement of Consent
If you agree to participate in this research, please sign the consent form. Part of what you are giving consent for is also to obtain your high school GPA, ACT, Mathematics Placement Scores, and course grades for the college. By signing the consent form, you are indicating that you freely and voluntarily agree to participate in this study and you also acknowledge that you are at least 18 years of age.

We will collect your information through paper surveys, high school GPA, ACT scores, Mathematics Placement scores, and course grades. This data will be stored on a locked computer. When the study is completed and the data have been analyzed, the code list linking names to student ID numbers will be destroyed. This is expected to occur no later than the summer semester of 2020.

Statement of Consent
I have read the above information. I have had the opportunity to ask questions and have my questions answered. I consent to participate in the study.

Signature:____ Date: _________

Signature of Investigator:___________________________________ Date: __________

Appendix D:

Demographic Survey

Student ID#: ____________________________

1. Gender: __________
2. Age:______________
3. Ethnicity: Choose the category that best fits you
    __________Hispanic or Latino
    __________not Hispanic or Latino
4. Race: Please indicate the category that best fits you or choose other and explain
    ______ American Indian or Alaska Native
    ______Asian
    ______Black or African American
    ______Native Hawaiian or other Pacific Islander
    ______White
    ______Other ____
5. What is your major? __________________________
6. Please indicate the mathematics course you are in while completing this survey (circle one)
    Pre-calculus I   Quantitative Reasoning

7. What math classes did you complete in high school? (circle all that apply)
    Algebra I   Algebra II   Geometry   Pre-calculus

    Algebra III   Trigonometry   Calculus   Statistics

    Other: ___________________________________

8. Are you the first in your family to attend college? (circle one) Yes No

9. What was the highest level of education for your male parent or guardian? (circle only one)
    Did not finish high school   high school   some college

    Four years of college   graduate school

10. What was the highest level of education for your female parent or guardian? (circle only one)

    Did not finish high school   high school   some college

    Four years of college   graduate school

Appendix E:

Identity Scale

To what extent do you disagree or agree with the following statements?
Scale is (1 = strongly disagree, 5 = Strongly agree)

1. I enjoy learning math	1	2	3	4	5
2. I see myself as a math person	1	2	3	4	5
3. My family sees me as a math person.	1	2	3	4	5
4. My friends/colleagues see me as a math person	1	2	3	4	5
5. My professors saw me as a math person	1	2	3	4	5
6. Math is interesting.	1	2	3	4	5
7. I look forward to doing math.	1	2	3	4	5
8. I understand the math I have studied.	1	2	3	4	5
9. Math makes me nervous.	1	2	3	4	5
10. Setbacks in math do not discourage me.	1	2	3	4	5
11. I can do well on math exams.	1	2	3	4	5

Appendix F:

Grit Scale

To what extent do you disagree or agree with the following statements?
Scale is (1=very much like me, 3=somewhat like me, 5=Not like me at all)

1. New mathematical ideas and concepts sometimes distract me from previous ones.	1	2	3	4	5
2. When solving mathematical problems, setbacks do not discourage me. I bounce back from disappointments faster than most people.	1	2	3	4	5
3. I have been obsessed with a certain mathematics idea for a short time but later lost interest.	1	2	3	4	5
4. In mathematics I am a hard worker.	1	2	3	4	5
5. In mathematics, I often set a goal but later choose to pursue a different one.	1	2	3	4	5
6. I have difficulty maintaining my focus on mathematics concept that take more than a few months to complete.	1	2	3	4	5
7. I finish whatever I begin in mathematics.	1	2	3	4	5
8. I am diligent (hardworking and careful) with my mathematics.	1	2	3	4	5

Appendix G:

Fennema-Sherman Mathematics Attitudes Scales

For the following statements, circle your level of agreement with each of the following
SD - if you strongly disagree D - if you disagree N - if your feeling is neutral
A - if you agree SA - if you strongly agree

1. Generally I have felt secure about attempting mathematics	SD D N A SA
2. I'm no good in math.	SD D N A SA
3. I'll need mathematics for my future work.	SD D N A SA
4. I see mathematics as a subject I will rarely use in my daily life as an adult	SD D N A SA
5. I am sure I could do advanced work in mathematics.	SD D N A SA
6. I am not the type to do well in mathematics.	SD D N A SA
7. I study mathematics because I know how useful it is.	SD D N A SA
8. In terms of my adult life it is not important for me to do well in mathematics.	SD D N A SA
9. I am sure that I can learn mathematics.	SD D N A SA
10. I don't think I could do advanced mathematics.	SD D N A SA
11. Knowing mathematics will help me earn a living.	SD D N A SA
12. Mathematics is of no relevance to my life.	SD D N A SA
13. I think I could handle more difficult mathematics.	SD D N A SA
14. For some reason even though I study, math seems unusually hard for me.	SD D N A SA
15. Mathematics is a worthwhile and necessary subject.	SD D N A SA
16. Mathematics will not be important to me in my life's work.	SD D N A SA
17. I can get good grades in mathematics.	SD D N A SA
18. Math has been my worst subject.	SD D N A SA
19. I'll need a firm mastery of mathematics for my future work	SD D N A SA
20. Taking mathematics is a waste of time.	SD D N A SA
21. I have a lot of self-confidence when it comes to math.	SD D N A SA
22. Most subjects I can handle O.K., but I have a knack for flubbing up math.	SD D N A SA

23. I will use mathematics in many ways as an adult.	SD	D	N	A	SA
24. I expect to have little use for mathematics when I get out of school.	SD	D	N	A	SA
25. I like math puzzles.	SD	D	N	A	SA
26. Mathematics is enjoyable and stimulating to me.	SD	D	N	A	SA
27. When a math problem arises that I can't immediately solve, I stick with it until I have the solution.	SD	D	N	A	SA
28. Once I start trying to work on a math puzzle, I find it hard to stop.	SD	D	N	A	SA
29. When a question is left unanswered in math class, I continue to think about it afterward.	SD	D	N	A	SA
30. I am challenged by math problems I can't understand immediately.	SD	D	N	A	SA
31. Figuring out mathematical problems does not appeal to me.	SD	D	N	A	SA
32. The challenge of math problems does not appeal to me.	SD	D	N	A	SA
33. Math puzzles are boring.	SD	D	N	A	SA
34. I don't understand how some people can spend so much time on math and seem to enjoy it.	SD	D	N	A	SA
35. I would rather have someone give me the solution to a difficult math problem than to have to work it out for myself.	SD	D	N	A	SA
36. I do as little work in math as possible.	SD	D	N	A	SA
37. It would make me happy to be recognized as an excellent student in mathematics.	SD	D	N	A	SA
38. I don't like people to think I'm smart in math.	SD	D	N	A	SA
39. I'd be proud to be the outstanding student in math.	SD	D	N	A	SA
40. It would make people like me less if I were a really good math student.	SD	D	N	A	SA
41. I'd be happy to get top grades in mathematics.	SD	D	N	A	SA
42. If I got the highest grade in math I'd prefer no one knew.	SD	D	N	A	SA
43. It would be really great to win a prize in mathematics.	SD	D	N	A	SA
44. If I had good grades in math, I would try to hide it.	SD	D	N	A	SA
45. Being first in a mathematics competition would make me pleased.	SD	D	N	A	SA
46. Being regarded as smart in mathematics would be a great thing.	SD	D	N	A	SA
47. Winning a prize in mathematics would make me fell unpleasantly conspicuous.	SD	D	N	A	SA
48. People would think I was some kind of a grind if a got A's in math.	SD	D	N	A	SA

Appendix: H

Mathematics Self-Efficacy and Anxiety Questionnaire (MSEAQ)

To better understand what you think and feel about your college mathematics courses, please respond to each of the following statements. If there are questions you do not wish to answer, please select “No Response.”
NR – No response   1 – Never   2 – Seldom   3 – Sometimes   4 – Often   5 – Usually

1. I feel confident enough to ask questions in my mathematics class.	NR	1	2	3	4	5
2. I get tense when I prepare for a mathematics test.	NR	1	2	3	4	5
3. I get nervous when I have to use mathematics outside of school.	NR	1	2	3	4	5
4. I believe I can do well on a mathematics test	NR	1	2	3	4	5
5. I worry that I will not be able to use mathematics in my future career when needed.	NR	1	2	3	4	5
6. I worry that I will not be able to get a good grade in my mathematics course.	NR	1	2	3	4	5
7. I believe I can complete all of the assignments in a mathematics course.	NR	1	2	3	4	5
8. I worry that I will not be able to do well on mathematics tests	NR	1	2	3	4	5
9. I believe I am the kind of person who is good at mathematics.	NR	1	2	3	4	5
10. I believe I will be able to use mathematics in my future career when needed	NR	1	2	3	4	5
11. I feel stressed when listening to mathematics instructors in class.	NR	1	2	3	4	5
12. I believe I can understand the content in a mathematics course.	NR	1	2	3	4	5
13. I believe I can get an “A” when I am in a mathematics course.	NR	1	2	3	4	5

14. I get nervous when asking questions in class.	NR	1	2	3	4	5
15. Working on mathematics homework is stressful for me	NR	1	2	3	4	5
16. I believe I can learn well in a mathematics course.	NR	1	2	3	4	5
17. I worry that I do not know enough mathematics to do well in future mathematics courses.	NR	1	2	3	4	5
18. I worry that I will not be able to complete every assignment in a mathematics course.	NR	1	2	3	4	5
19. I feel confident when taking a mathematics test.	NR	1	2	3	4	5
20. I believe I am the type of person who can do mathematics.	NR	1	2	3	4	5
21. I feel that I will be able to do well in future mathematics courses.	NR	1	2	3	4	5
22. I worry I will not be able to understand the mathematics	NR	1	2	3	4	5
23. I believe I can do the mathematics in a mathematics course	NR	1	2	3	4	5
24. I worry that I will not be able to get an "A" in my mathematics course	NR	1	2	3	4	5
25. I worry that I will not be able to learn well in my mathematics course.	NR	1	2	3	4	5
26. I get nervous when taking a mathematics test	NR	1	2	3	4	5
27. I am afraid to give an incorrect answer during my mathematics class	NR	1	2	3	4	5
28. I believe I can think like a mathematician.	NR	1	2	3	4	5
29. I feel confident when using mathematics outside of school.	NR	1	2	3	4	5

VITA

Latoya Rochell Johnson

Candidate for the Degree of

Doctor of Philosophy

Dissertation: EXAMINING THE BELEIFS, ACADEMIC ACHEIVEMENTS, AND BACKGROUND CHARACTERSTICS OF STUDENT'S ENROLLED IN QUANTITATIVE REASONING AND PRE-CALCULUS I AT A COMMUNITY COLLEGE

Major Field: Mathematics Education

Biographical:

Education:

Completed the requirements for the Doctor of Philosophy in Mathematics Education at Oklahoma State University, Stillwater, Oklahoma in July, 2020.

Completed the requirements for the Master of Science in Mathematics Education at Northeastern State University, Tahlequah, OK in 2012.

Completed the requirements for the Bachelor of Science in Mathematics at Northeastern State University, Broken Arrow, OK in 2010.

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Adjunct Professor of Mathematics, Tulsa Community College, Tulsa, OK, Aug. 2012 - Present

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Research Council of Mathematics Learning
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