ENHANCING STUDENT MATHEMATICS SUCCESS THROUGH SERVICE-LEARNING: AN EXAMINATION OF STUDENT MOTIVATION USING THE SELF-DETERMINATION THEORY

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ABSTRACT

The increase in collegiate enrollment, yet bleak graduation rates, poses a significant problem for students and educators alike. Contributing to the high attrition rates, a lack of academic motivation often leads to poor performance in gateway mathematics courses. Factors influencing academic motivation include self-efficacy, anxiety, perceptions about the importance and utility value of math, and soft skills. To heighten student motivation and improve academic success, educators have implemented active-learning strategies, such as service-learning, which have shown positive effects on academic performance. The self-determination theory guided this study as a theoretical framework for student motivation. During the spring 2019 semester, 615 undergraduates completed an online survey instrument. Of these respondents, 140 students were enrolled in a service-learning section of Elementary Statistical Analysis, and 475 were enrolled in non-service-learning sections. Results indicate that student's sociodemographic characteristics, academic backgrounds, participation in service-learning, and motivational factors have significant relationships with the probability of student success in their gateway math course. Implementing service-learning curricular components that attend to the basic psychological needs of competence, autonomy, and relatedness can facilitate student success in mathematics courses and the attainment of undergraduate degrees.

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CHAPTER 1: INTRODUCTION

Higher education is now a reality for more students than ever before in our nation's history. According to the National Center for Education Statistics (NCES), collegiate student enrollment at degree-granting institutions increased from approximately 4 million in 1960 to over 20 million students in 2015 (NCES, 2018). This influx of students is largely due to the broad recognition that earning a college degree is a critical accomplishment that leads to social mobility, career opportunities, and economic returns (Abel & Deitz, 2014; Hout, 2012). The surge in higher education is particularly noteworthy from 2005 to 2015, as enrollments increased 15 percent for students under age 25 and 13 percent for those aged 25 and over (NCES, 2018). Furthermore, the NCES projects these trends to continue, specifically for younger students, with another 17 percent increase by 2026 for students under 25 and an eight percent increase for students age 25 and over. For educational administrators and researchers, the increased enrollment has stimulated considerable interest in degree completion of college students in universities.

Despite decades of attention, the six-year graduation rates for first-time, full-time undergraduate students who began seeking a bachelor's degree at a four-year-degree-granting institution in fall 2011 range between 31% at the least selective institutions and 87% at the most selective institutions, with an overall rate of 60% (NCES, 2019). The increased enrollments yet bleak graduation rates have universities scrambling to improve the quality of education to preserve their reputation in society (Steiner, Sundström, & Sammalisto, 2013). Consequently, institutions of higher education are reinventing their academic strategies to focus less on student characteristics and more on what they can do to help students overcome obstacles (McNair, Bensimon, Cooper, McDonald, & Major, 2016). Given the prominence of collegiate graduation rates and university reputation, academic leaders are turning their attention to the identification of potential pitfalls and the importance of academic success for undergraduate students.

An emerging strategy for enhancing postsecondary degree attainment is to identify specific points in students' collegiate pathways when they are most likely to encounter roadblocks to graduation (Wright, McKay, Hershock, Miller, & Tritz, 2014). One of the primary issues contributing to attrition is poor performance in gateway courses (Koch & Pistilli, 2012). Gateway courses are defined as lower-division, foundational, credit-bearing courses that present a critical juncture in students' academic progression and, ultimately, the attainment of a four-year degree (Bloemer, Day, & Swan, 2017; Flanders, 2017). The Gardner Institute (2018) furthered this definition by identifying gateway courses as those in which large numbers of students are at risk of failure with the propensity to block student progress and degree completion.

While there are gateway courses in every discipline, Callahan and Belcheir (2017) specifically cited academic success in entry-level mathematics courses as an essential lynchpin to degree attainment. Mathematics courses have been historically recognized as "gatekeepers" for educational success in all majors (Stinson, 2004), and multiple scholars have researched student achievement in gateway math courses (e.g., Bloemer et al., 2017; Gupta, Harris, Carrier, & Caron, 2006). The Gardner Institute (2018) found the DFW rates, which included students who earned a D or F, or withdrew from their course, in entry-level mathematics courses to range from approximately 30.6% to 49.9%, with an average of 34.4% of all undergraduate students failing or withdrawing from freshman-level math courses.

Research has indicated that students' academic motivation greatly contributes to their mathematics performance (Murayama, Pekrun, Lichtenfeld, & Hofe, 2013; Singh, Granville, &

Dika, 2002). Academic motivation is influenced by factors such as students' perceptions of their self-efficacy and educational goals (Zimmerman, Bandura, Martinez-Pons, 1992). In fact, self-efficacy often predicts academic motivation, which is also influenced by student beliefs related to the value of mathematics (Pajares & Graham, 1999). When given a choice, students who feel some measure of competence, especially when others also value the activity, are more likely to pursue the endeavor (Deci & Ryan, 2008a, 2008b). Therefore, academic motivation has long been a significant predictor of student commitment, persistence, and accomplishment (Wong & Csikszentmihalyi, 1991) and is central to understanding scholastic success (Green et al., 2012).

Another essential factor that contributes to academic success in mathematics is a connection between the course content and the real world. Indeed, the absence of such a relationship is one of the most pervasive problems in a mathematics classroom today (Schulteis, 2013; Speck, 2001). This disconnect often compounds negative attitudes towards mathematics and produces low levels of student confidence and engagement in a math course (Hall & Ponton, 2005; Zimmerman et al., 1992). Academic experiences devoid of meaning or personal significance reduce students' motivation to complete tasks and diminish the likelihood of student success in math (DeWitz, Woolsey, & Walsh, 2009; Simzar, Martinez, Rutherford, Domina, & Conley, 2015).

Not only does the disconnect between mathematical concepts and their use in the real-world rob students of the opportunity to associate their learning to future applications, but it leaves them lacking crucial people skills required for scholastic and career success (Majid, Liming, Tong, & Raihana, 2012). Unfortunately, instruction and assessment are often solely focused on addressing technical skills, which neglects the soft skills that are vital to student success and motivation (Heckman & Kautz, 2012; Junita, Suarman, & Kartikowati, 2018; Stone, 2005). For example, skills such as problem-solving and critical-thinking are imperative for mathematical competency (Cragg & Gilmore, 2014). Furthermore, interaction with others and the building of interpersonal skills have been found to enhance students' learning of discipline-related skills (Laskey & Hetzel, 2010; Schulz, 2008). Soft skills such as communication, teamwork, and a willingness to learn, predict student achievement and are required for students to complete their college courses and earn their degrees (Chamorro-Premuzic, Arteche, Bremner, Greven, & Furnham, 2010; Harris & Rogers, 2008).

Given the factors that diminish student motivation and attribute to high attrition rates, educators have employed active-learning instructional methods, such as team projects, challenging discussions, and peer tutoring, to engage students and promote degree completion and student success (Lopez & Jones, 2017; Roberts, 2019; Wright, Bergom, & Bartholomew, 2019). One such strategy, service-learning, uses an experience-based approach to increase efficacy, personal values, soft skills, and engagement in the classroom (Astin, Vogelgesang, Ikeda, & Yee, 2000). Service-learning projects heighten student learning by cultivating personal development, motivation, and a sense of well-being (Conway, Amel, & Gerwien, 2009), increasing multicultural awareness and social responsibility in a real-world context (Warren, 2012), and fostering cognitive development of problem-solving and critical-thinking skills (Yorio & Ye, 2012).

Service-learning tasks have a positive effect on students' math attitudes (Henrich, Sloughter, Anderson, & Bahuaud, 2016), enhance their soft skills (Celio, Durlak, & Dymnicki, 2011), and provide an opportunity for students to learn the value and application of mathematics in a real and meaningful way (Hydorn, 2007). Despite the overwhelmingly positive effects of service-learning programs, they are quite rare in math classrooms (Schulteis, 2013). Abes, Jackson, and Jones (2002) cited anticipation of logistical problems with community organizations and extensive time requirements as top factors that deter faculty from using service-learning. Math faculty are unsure that students benefit from the experience and have difficulty in establishing community partnerships. This gap in practice has led to a dearth of research in mathematics, while a wealth of service-learning research exists in other disciplines (Yorio & Ye, 2012). Not surprisingly, to date, I have found a very limited number of studies that focus on mathematics achievement from a service-learning perspective. None of the studies that I have reviewed examines the extent to which students' motivations, perceptions, and soft skills impact their academic performance in gateway mathematics courses.

Therefore, the present study attempts to address the gap in service-learning research in the area of mathematics and leads to recommendations that could improve student academic success and, ultimately, degree completion. Adding to the literature concerning potential benefits of service-learning curriculum make this study an important component of the collective understanding of the impact of motivation for college students.

In the next sections, I present the statement of the problem and the purpose of the study to explain the rationale for the research questions. After the presentation of the research questions, I provide a brief overview of the methodology and the guiding theoretical framework. Finally, this chapter concludes with the significance of the study, a list of pertinent definitions, and a summary to knit the numerous sections together.

Statement of the Problem

Collegiate enrollment is continually increasing (NCES, 2018), yet only 60% of first-time, full-time undergraduate students who began seeking a bachelor's degree at a four-year-degree-granting institution graduate within six years (NCES, 2019). One of the most prominent issues contributing to attrition is poor performance in gateway mathematics courses (Callahan & Belcheir, 2017; Koch & Pistilli, 2012). Multiple factors contribute to unsuccessful university outcomes, including a lack of academic motivation that stems from poor student perceptions of math (Ganley & Lubienski, 2016; Turki, Jdaitawi, & Sheta, 2017). Many of the students struggling to obtain their degrees have little mathematical self-efficacy (Hall & Ponton, 2005), are fearful of engaging in collegiate math activities (Chang & Beilock, 2016), do not see value in mathematical knowledge or a connection between math content and its utility in the real-world (Hulleman, Godes, Hendricks, & Harackiewicz, 2010), and do not develop the soft skills necessary for scholastic success (Junita et al., 2018).

Active-learning strategies, such as service-learning, have shown positive effects on the math attitudes of students (Henrich et al., 2016). Service-learning heightens student learning by developing motivation, self-efficacy, soft skills, and engagement in the classroom (Astin et al., 2000; Conway et al., 2009). Furthermore, service-learning connects mathematics course content to the real-world in a meaningful way and fosters a sense of social responsibility (Hydorn, 2007; Warren, 2012). However, due to logistical hurdles, collegiate math faculty rarely implement such projects (Abes, Jackson, & Jones 2002; Schulteis, 2013). The dearth of implementation has led to a research gap on the impact of service-learning course components and student motivation factors that include self-efficacy, anxiety, perceptions about the importance and usefulness of math, and interpersonal skills on student performance in math.

Purpose of the Study

Given the impact of student self-efficacy, math anxiety, perceptions about math, and soft skills on student success in gateway mathematics courses, the purpose of this study is to analyze differences between service-learning and non-service-learning student groups and to determine the extent to which students' sociodemographic characteristics, academic background, motivation, and participation in service-learning affect their performance in college-level mathematics. Additionally, this present study attempts to address the gap in service-learning research in the area of mathematics and leads to potential recommendations that may improve student academic success and, ultimately, degree completion. Adding to the literature concerning potential benefits of service-learning curriculum makes this study an important component of the collective understanding of the impact of motivation for college students.

Research Questions

The research questions posited for this study concerned students' sociodemographic characteristics, academic background, and motivations for students in service-learning mathematics courses and comparing them to students in non-serving-learning sections. Four research questions guided the present study.

1. Is there a difference between students enrolled in mathematics courses with a service-learning component (thereafter service-learning students) and those enrolled in mathematics courses without a service-learning component (thereafter non-service-learning students) regarding their sociodemographic characteristics and academic background?
2. Is there a difference between service-learning and non-service-learning students regarding their mathematics performance?
3. Is there a difference between service-learning and non-service-learning students regarding their motivation during the semester?
4. To what extent do students' sociodemographic characteristics, academic background, motivation, and participation in service-learning relate to their mathematics

performance?

Methodology

This quantitative study, framed by the self-determination theory, used survey methods to explore the impact of students' sociodemographic characteristics, academic background, motivation, and participation in service-learning on mathematics achievement. To conduct this study, I chose to survey students enrolled in on-campus sections of a gateway mathematics course (i.e., Elementary Statistical Analysis) during the spring of 2019 to gauge the impact of service-learning and student motivation factors that include student perceptions of self-efficacy, math anxiety, the personal importance and usefulness of math, and interpersonal skills across a diverse population of undergraduates.

The survey was deployed to 743 students across five sections of Elementary Statistical Analysis, of which one section employed the service-learning curriculum. To increase the number of participants, the same survey was delivered twice to students during the first few weeks of the semester and again two months later using an online format. A total of 615 unique students completed the survey, and constitute the sample for this study.

Once the data were collected, I identified variables related to student demographics, academic background, socio-economic status, section type, and grades. I performed exploratory factor analysis to identify and categorize six motivational factors, which were grouped according to the motivational constructs in the self-determination theory. I also used a series of reliability tests to ensure the questionnaire was adequately measuring the identified constructs. Additional analysis methods included calculating descriptive statistics, tabulating frequency distributions, computing mean differences using chi-square analysis and independent *t*-tests, and equating a series of logistic regression models to address the study research questions.

Theoretical Framework

Since an important focus of the current study is students' motivation and perception, I chose to use self-determination theory (SDT) as the theoretical framework for the present study. In the following subsections, I discuss the three constructs of SDT that describe how motivation stems from basic psychological needs.

Motivation is broadly defined as the process by which goal-directed activity is instigated or sustained (Schunk, Meece, & Pintrich, 2012). The self-determination theory (SDT) of motivation considers the quality of motivation to be more significant than the quantity (Ryan & Deci, 2000b). Deci and Ryan (1985b) posited in SDT that the degrees to which students' basic psychological needs are supported or thwarted determined students' academic motivations and outcomes. Thus, motivation centers on the satisfaction of innate psychological needs. The three specific needs positioned within SDT were competence, autonomy, and relatedness (Deci & Ryan, 1985a). Deci and Ryan (2000) further indicated that these needs were essential to understanding the *what* and *why* of student motivation.

Competence

The need for competence, which is related to a person's perception of their own ability, is a critical component of SDT (Deci & Ryan, 1985a; Ryan & Deci, 2000a). Individuals are inclined to participate within domains in which they feel competent (Durmaz & Akkuş, 2016). Consequently, fostering the need for competence is critical to enhancing student engagement and performance, and becomes possible when students feel they are good or can become good at an activity (Sheldon & Krieger, 2007). Thus, the psychological need for competence is informed by one's interaction with one's learning environment.

Because academic motivation is positively associated with a variety of scholastic outcomes (Vecchione, Alessandri, & Marsicano, 2014), the lack of competence stemming from poor self-efficacy and mathematical anxiety often hamper students' willingness to engage and ultimately harnesses their success. In contrast, high self-efficacy and low or controlled anxiety would enhance students' academic motivation because their inherent need for competence would be supported. Competent students may also develop an interest in mathematical tasks, which could foster the second basic psychological need for autonomy.

Autonomy

Defined as a volitional act in the exercise of choice, autonomy represents a person's willingness to proceed with an activity because they perceive control over their actions without pressure (Deci et al., 2001; Deci & Ryan, 1985a). Autonomous motivation involves a true sense of choice, a sense that students feel free to do what they have chosen to do (Boggiano, Flink, Shields, Seelbach, & Barrett, 1993; Deci & Ryan, 1991). These self-initiated behaviors are motivated by both intrinsic and extrinsic factors (Deci & Ryan, 2008a). Intrinsic motivation is derived out of an individual's degree of genuine interest in an activity, which ideally, has been internalized within their sense of self; whereas, autonomous extrinsic motivation is guided by external factors that align with personal needs such as the expected value or gain. Together, the autonomous motivational factors provide students with a sense of agency and could explain why student's perceptions of the importance of math and its utility value are correlated to their academic achievement (Wigfield & Eccles, 2000). Deci and Ryan (1985a) characterized autonomous behavior as a student's inclination to view their actions as opportunities to learn, which may also lead students to choose certain tasks in order to relate to others.

Relatedness

Grounded in the role that extrinsic motivation plays in motivating behaviors, relatedness refers to the need to be connected to and loved by others (Deci & Ryan, 2000). Ryan and Deci (2000a) concluded that people are likely to engage in activities that are not inherently interesting to them because others value the behavior. Hence, the need for relatedness is a motivational force that can be separated from the desire to attain an academic outcome (Vansteenkiste, Lens, & Deci, 2006). The overarching need to belong becomes the guiding motivational factor. Even though the need for extrinsic connections can undermine intrinsically-motivated factors (Deci & Ryan, 1985b), the basic necessity to relate to others may illuminate why students in service-learning courses tend to engage in the curriculum at higher rates than their non-service-learning counterparts (Astin et al., 2000). This need for social interaction might also explain why soft skills, such as teamwork, contribute to academic performance in math.

In summary, when students feel supported in their power to choose activities in which they feel some measure of competence, especially when others also value the task or knowledge-base, they are more likely to pursue the endeavor (Deci & Ryan, 2008a, 2008b). Subsequently, educational environments that support students' basic physiological needs for competence, autonomy, and relatedness, enhance their academic motivation and performance (Boggiano et al., 1993). For these reasons, the SDT provides a reasonable framework within which to study the impact of students' motivational and academic factors on mathematics achievement.

Significance of the Study

Despite the overwhelmingly positive effects of service-learning programs and a wealth of service-learning research that exists in other disciplines (Warren, 2012; Yorio & Ye, 2012), there is a substantial lack of implementation in collegiate math classrooms (Schulteis, 2013). This void in practice has led to a research gap on the impact of service-learning course components on student motivation factors that include self-efficacy, anxiety, perceptions about the importance and usefulness of math, and interpersonal skills. The present study attempts to address this gap in mathematics research concerning the benefits of service-learning and the impact of motivation for college students.

The outcomes of this study have significant relevance to future course design and practical insight for public institutions of higher education. Knowing the impact of course activities on self-efficacy, math anxiety, student perceptions about math and soft skills, as well as their relationship with course grades, will help steer course redesign efforts for instructors and curriculum directors. While specific implications for practice remain to be seen, this study provided insight into the effect of mathematical perspectives of students. Such valuable information will help faculty and administrators deploy targeted solutions and provide the necessary resources to assist students with the ultimate goal of completing their college degrees.

Definition of Terms

Active-learning. "Any instructional method that engages students in the learning process" (Prince, 2004, p. 223). Consists of a wide array of techniques such as team assignments, challenging discussions, role-playing, peer tutoring, and service-learning projects, all of which help engage students with the faculty and their peers (Deeley, 2010; Prince, 2004).

Attainment value. The personal importance of doing well on a task (Eccles et al., 1983).

Autonomy. A volitional act in the exercise of choice that represents a person's willingness to proceed with an activity because they perceive control over their actions without pressure (Deci et al., 2001; Deci & Ryan, 1985a).

Competence. A person's perception of their own ability (Deci & Ryan, 1985a; Ryan & Deci, 2000a), enhanced when they feel they are good or can become good at an activity (Sheldon & Krieger, 2007).

External regulation. The least self-determined parameter, which is initiated and maintained by the expectation of rewards or the avoidance of punishment (Ryan & Deci, 2000a).

Extrinsic motivation. Actions are guided by external factors that align with personal needs, such as expected value or gain (Deci & Ryan, 2008a).

Gateway courses. Lower-division, credit-bearing courses that are foundational to students' academic progression and, ultimately, the attainment of a four-year degree (Bloemer et al., 2017; Flanders, 2017).

Identified regulation. Extrinsically motivated behavior in which a student begins to identify with the goal and align the personal importance and value of the activity with their own identity (Ryan & Deci, 2000a).

Integrated regulation. The most self-determined form of extrinsic motivation in which a student's behavior emanates from within their sense of self that stems less from an individual's interest in a task and more from the perception of its importance (Ryan & Deci, 2000a).

Intrinsic motivation. Activity derived out of an individual's genuine interest or inherent satisfaction in a task (Deci & Ryan, 2008a). Motives include the positive experience associated with exercising and extending one's abilities (Deci & Ryan, 1985a).

Introjected regulation. A type of extrinsic motivation whereby an individual engages in behavior to advance their ego, feel worthy, or avoid shame (Ryan & Deci, 2000a).

Math anxiety. The "feeling of tension, apprehension or even dread, that interferes with the ordinary manipulation of numbers and the solving of mathematical problems" (Ashcraft & Faust, 1994, p. 98).

Motivation. The process by which goal-directed activity is instigated or sustained (Schunk et al., 2012).

Relatedness. The need to be connected to and loved by others (Deci & Ryan, 2000) that drives people to engage in activities because others value the behavior (Ryan & Deci, 2000a).

Self-determination. The freedom to choose one's own actions without external pressure, which is necessary for the cultivation of intrinsic motivation (Deci & Ryan, 1985a).

Self-efficacy. A personal belief in one's ability to succeed in specific situations or accomplish a task (Artino, 2012; Bandura, 1993).

Service-learning. A credit-bearing, educational experience in which students meet the need of a community organization and reflect on the activity to further their understanding of course content, broaden their appreciation of the discipline, and enhance their sense of civic responsibility (Jones, 2003).

Soft skills. Generalizable interpersonal skills, such as communication, problem-solving, teamwork, presentation, self-management, and work ethic, that facilitate learning and academic and career success (Robles, 2012; Schulz, 2008).

Utility-value. The associated usefulness of the task or how the task fits into an individual's future plans (Eccles et al., 1983).

Chapter 1 Summary

The increase in collegiate enrollment (NCES, 2018), yet bleak graduation rates (NCES, 2019), poses a significant problem for students and educators alike. Contributing to the high attrition rates, a lack of academic motivation and poor student perceptions of math (Ganley & Lubienski, 2016; Turki et al., 2017) often lead to poor performance in gateway mathematics courses (Callahan & Belcheir, 2017; Koch & Pistilli, 2012). To heighten student motivation and improve academic success, educators have implemented active-learning strategies, such as service-learning, which have shown positive effects on the math attitudes of students (Henrich et al., 2016). While service-learning heightens student learning in a variety of ways (Astin et al., 2000; Conway et al., 2009), logistical hurdles frequently prevent collegiate math faculty from implementing such projects (Abes et al., 2002; Schulteis, 2013). The dearth of practice has led to a research gap on the impact of service-learning course components on student motivation factors that include self-efficacy, anxiety, perceptions about the importance and usefulness of math, and interpersonal skills. The present study attempts to address this gap in mathematics research concerning the benefits of service-learning and the impact of motivation for college students.

Chapter 1 included a presentation of motivational factors that impact student achievement in math and baccalaureate degree attainment. The discussion included the statement of the problem, the purpose of the study, the research questions, and a brief methodology section followed by the self-determination theory as the theoretical framework for this study. Finally, this chapter concluded with the significance of the study and a list of pertinent definitions. In the next chapter, I provide a review of the literature surrounding academic success in mathematics, sources of student motivation, and active-learning strategies. Additionally, the literature review contains a detailed appraisal of how researchers have used the self-determination theory to connect student motivation to academic achievement.

CHAPTER 2: LITERATURE REVIEW

This study pulls from the literature surrounding student motivation and the impact of student perceptions on academic success as well as how active-learning strategies, such as service-learning, can enhance student achievement. Before addressing the details surrounding math self-efficacy and anxiety, student perceptions of the importance of math and its utility value, and the necessity of soft skills, it is essential to provide some context as to why success in mathematics is crucial to baccalaureate degree attainment. Then, I address how active-learning instructional methods are used to engage students and heighten academic performance, and follow that section by a survey of the literature on the implications of using service-learning, a specific active-learning approach, in math classrooms. Lastly, this chapter concludes with a description of the research using the self-determination theory in the framework. The methods used in each study and the author's analysis were of particular interest as well, so the reader will notice the statistics that support the results throughout the literature review. Here, I start with a brief background of the importance of student success in mathematics and its connection to collegiate graduation.

Importance of Student Success in Mathematics

For educational administrators and researchers, high attrition rates have stimulated considerable interest in student success and postsecondary degree completion (Lee et al., 2011). Yet, only 60% of first-time, full-time undergraduate students who began seeking a bachelor's degree at a four-year, degree-granting institution in fall 2011 graduated within six years (NCES, 2019). To better understand student performance, many colleges have turned to learning analytics and predictive models that have uncovered a need to develop effective strategies aimed at fostering student success in gateway courses (Wright et al., 2014). Gateway courses are defined as lower-division, foundational, credit-bearing courses that present a critical juncture in students' academic progression and, ultimately, the attainment of a four-year degree (Bloemer et al., 2017; Flanders, 2017).

While there are gateway courses in every discipline, Callahan and Belcheir (2017) specifically cited academic success in entry-level mathematics courses as an essential lynchpin to degree completion. Mathematical literacy is a necessity in order to respond to the quantitative demands of life (Wilson, 2014), and therefore, math skills serve as a prerequisite to facilitating academic and societal success (Wismath & Worrall, 2015). In academia, a moderate proficiency in mathematics is required for achievement in any science, technology, engineering, or mathematics (STEM) field along with various other collegiate disciplines (Dika & D'Amico, 2016). Given the prominence and necessity of mathematics, multiple scholars have researched student success in gateway math courses (e.g., Bloemer et al., 2017; Gupta et al., 2006). In a case study of 1,326 total university students, 880 enrolled in traditional gateway math courses such as College Algebra, Trigonometry, PreCalculus, Business Math, and Calculus (Li, Uvah, & Li, 2017). The researchers found that 41% of these students either failed or withdrew from their course. The traditional gatekeeper math courses are typically taken by students pursuing a degree in science, technology, engineering, or mathematics, otherwise known as STEM majors. Not surprisingly, STEM students who complete college mathematics gatekeeper courses are more likely to graduate with STEM degrees (Redmond-Sanogo, Angle, & Davis, 2016). Therefore, the lack of academic success in traditional entry-level math courses presents a roadblock to graduation for many students.

In addition to STEM majors, early academic success is important for all degree fields (Dika & D'Amico, 2016). Understanding mathematics is considered vital to students' professional success and effective personal management for all majors, particularly those that require statistics (Azar & Mahmoudi, 2014). It is common for students in education, business, and liberal arts fields such as criminal justice and political science to have a statistics degree requirement (Griffith, Adams, Gu, Hart, & Nichols-Whitehead, 2012). In fact, Li, Uvah, and Li (2017) recorded statistics as a burgeoning popular gateway course for many degree plans with over one-third of the students in their study enrolling in a statistics course. However, the authors found that 33% of these students also failed to complete the gateway course successfully. Thus, the absence of achievement in entry-level mathematics courses hinders students in all majors.

Achieving academic success requires the cultivation of positive attitudes towards math and learning (Bregant, 2017). In a study of 5,200 students, Kitsantas, Cheema, and Ware (2011) concluded that steady completion of homework leads to a greater understanding of mathematical concepts and improves student confidence in their abilities. To examine these connections, students completed an assessment containing 85 math problems, self-reported time spent on homework, and answered questions related to self-efficacy on a five-point scale. The researchers' multiple regression model showed self-efficacy, race, gender, and homework-related predictors to account for 44% ($\Delta R^2 = 0.20$, $p < 0.001$) of the total variation in mathematics achievement. These findings complement other studies that have illustrated how sustained achievement in math can keep students progressing toward course and degree-completion (Buckley, Reid, Goos, Lipp, & Thomson, 2016), and that students' willingness to engage in academic material is critical to their educational success (Gaffney & Kercsmar, 2016). Motivating students to achieve success in initial entry-level mathematics courses has proven to be especially vital to degree attainment (Callahan & Belcheir, 2017).

Bloemer, Day, and Swan (2017) argued that while gateway courses with high failure rates contribute directly to student attrition, student success is largely dependent upon a student's individual characteristics. Factors such as race, age, and enrollment status can influence how students respond to curricular activities (Arnold, Kuh, Vesper, & Schuh, 1993; Shores, Kim, & Still, 2020). Unfortunately, a large portion of undergraduate students also dreads tackling their math coursework and fear that failure to do so successfully will inhibit their future options in academics and life (Hall & Ponton, 2005). Students frequently lack interest in the subject and do not value the social importance of mathematics (Mohr-Schroeder et al., 2017). Hall and Ponton (2005) suggest this deficiency in student motivation, along with a negative perception of mathematics, contributes to a decline in student performance and often catapults students into a cyclical pattern of failure. The lack of academic success in entry-level math courses presents a substantial roadblock to graduation for many students. Since mathematics is critical to the attainment of students' goals in college, it is imperative to understand how students' motivation is affected by their mathematical self-efficacy and anxiety.

Effects of Self-Efficacy and Anxiety on Student Motivation

Students' perceptions of mathematical self-efficacy and anxiety directly affect their performance in math (Justicia-Galiano, Martin-Puga, Linares, & Pelegrina, 2017). A poor perception of self-efficacy negatively impacts mathematical problem-solving (Pajares & Miller, 1994), and anxiety can affect students' emotional well-being, which shapes their engagement in learning and determines academic outcomes (Geertshuis, 2019). The feelings of ineptness in math directly contribute to math anxiety, both of which are predictive factors to academic underachievement (Azar & Mahmoudi, 2014). Furthermore, math anxiety, self-efficacy, and performance have a debilitating reciprocal relationship (Ahmed, Minnaert, Kuyper, & van der Werf, 2012; Foley et al., 2017). Anxiety and low perceptions of ability contribute to underperformance, which in turn heightens anxiety and reduces self-efficacy. Together, math anxiety and poor math self-efficacy decrease academic motivation (Geertshuis, 2019) and often prohibit students from finding success within their mathematics courses (Zimmerman et al., 1992). The relationship with student success outcomes makes it critical to examine further the components and effects of self-efficacy and anxiety on student motivation.

Self-Efficacy

Cognitive development is often stimulated by factual knowledge, environmental influences, and self-regulatory processes of agency (Bandura, 1989). "Among the mechanisms of agency, none is more central or pervasive than people's beliefs about their capabilities to exercise control over their own level of functioning and over events that affect their lives" (Bandura, 1993, p. 118). This referenced belief is the concept of self-efficacy, which is defined as a personal belief in one's ability to succeed in specific situations or accomplish a task (Artino, 2012). Since the publication of Bandura's seminal article entitled "Self-Efficacy: Toward a Unifying Theory of Behavioral Change" in 1977, countless researchers have used self-efficacy to help explain a variety of human functions and achievements. Due to the nature of the self-efficacy theory, there is a broad range of applicability within research and practice (Bandura, 1986). While the impact of self-efficacy is extensive, it is frequently used to assess student success in collegiate-level mathematics courses and is widely recognized as one of the most accurate predictors of student achievement (Hall & Ponton, 2005; Pajares, 1996; Robbins et al., 2004; Zientek, Schneider, & Onwuegbuzie, 2014).

Bandura (1977) posited there are four sources of personal efficacy beliefs developed through previous accomplishments, vicarious experience, verbal persuasion from others, and one's own physiological state. *Past performance* is especially influential because it is based on personal mastery experiences. After a strong sense of self-efficacy has been established through frequent and recurring successes, the occasional failure is less likely to have a negative impact. *Vicarious experience* occurs when individuals see others successfully perform what they perceive as intimidating activities. With *verbal persuasion*, people can be led through suggestions into believing they can cope successfully with what has overwhelmed them in the past. And finally, it is extensively documented that higher stress debilitates performance, so one's own emotions can influence one's *physiological state* and perceived self-efficacy. Thus, these four principal sources of self-efficacy impact students' motivations and perceptions, as well as their academic achievement.

Past performance is an especially influential source of self-efficacy because it is based on individual experiences. According to Bandura (1977), success raises mastery expectations and repeated failures lower them, particularly when the failure is early in the course of events. After a strong sense of self-efficacy has been established through frequent and recurring successes, the occasional failure is less likely to have a negative impact (Bandura, 1977). This means that early development of self-efficacy through recurrent accomplishment is critical for future success in any endeavor.

In addition to personal mastery experiences, students may strengthen their own self-efficacy by watching others. When individuals see others successfully perform what they would have perceived as intimidating activities, this experience "can generate expectations in observers that they too will improve if they intensify and persist in their efforts" (Bandura, 1977, p. 197). However, *vicarious experience* is a less dependable source of information about one's capabilities because it relies on social comparison. The direct evidence of personal accomplishments is a stronger source of self-efficacy.

The third source of self-efficacy is *verbal persuasion* from others. Again, this source is limited because simply informing people that they will or will not succeed in a task does not mean that they will necessarily believe what they are told. The efficacy expectations created from verbal coaxing are typically weaker than those built from one's past accomplishments because they lack the authentic experience as a foundation (Bandura, 1977). However, this is a widely used tenet of self-efficacy theory because of its ease and ready availability. Generally, people are led through suggestion into believing they can cope successfully with what has overwhelmed them in the past.

Finally, the last source of self-efficacy lies within one's own *physiological state*. One's own emotions can influence perceived self-efficacy during seemingly intimidating circumstances (Bandura, 1977). People judge their abilities to succeed based on their level of anxiety and their vulnerability to stress. It is widely recognized that higher stress debilitates performance. Thus, an individual's state of mind can heighten or diminish their own self-efficacy.

Essential to academic achievement, self-efficacy impacts student's feelings, thoughts, behaviors, and how they motivate themselves (Bandura, 1993; Zulkosky, 2009). Students' feelings can be driven by how they judge their ability to handle certain situations. Students who perceive their ability as deriving from personal inadequacies rather than situational influences are more likely to have lower self-efficacy expectations (Bandura, 1977). Feelings of a low sense of efficacy are commonly associated with stress, depression, anxiety, and helplessness (Johnson & Sarason, 1978). Furthermore, individuals with low self-efficacy often become pessimistic about their accomplishments and personal development. On the contrary, people with a high sense of self-efficacy feel as if they can conquer any presented challenge.

A strong sense of efficacy facilitates cognitive processes and performance in a variety of settings, including the quality of decision-making and the handling of information by the individual (Bandura, 1993). A reciprocal effect exists between the way students think and their perceived ability to perform tasks. Cognitive appraisals and subsequent achievement of difficult tasks will enhance perceived self-efficacy, and a heightened sense of self-efficacy will yield more optimistic thoughts about an individual's ability to accomplish a specific chore (Bandura, 1977).

In addition to thoughts and feelings, self-efficacy can influence a student's choice of activities. For example, individuals with lower self-efficacy and increased anxiety can experience apprehension toward tasks that require computation (Anis, Krause, & Blum, 2016). Because self-efficacy affects thought patterns that may create "self-aiding or self-hindering" behaviors (Bandura, 1989, p. 1175), students' self-efficacy beliefs may lead them to opt-in or out of participation in certain activities. In particular, a deficiency in self-efficacy can negatively influence a students' college experience, which can lead to drop-out (DeWitz et al., 2009).

Lastly, self-efficacy beliefs can increase or hamper motivation. Students with high self-efficacy approach difficult tasks as challenges, whereas students with low self-efficacy will avoid certain circumstances (Betz & Hackett, 1983). Overall, students' level of motivation, the amount of effort they will utilize during an activity, and how long they will persist when encountering obstacles is determined by their self-efficacy beliefs (Bandura, 1989). The strength of personal expectations of completion will not only affect the beginning and the duration of an action but also whether or not someone will attempt to participate in a given situation (Bandura, 1977). Simply stated, a lack of motivation due to low self-efficacy will prohibit students from engaging in or continuing particular academic activities.

Academic confidence is positively correlated with a myriad of educational outcomes, including reading comprehension, essay writing, mathematics problem-solving, science competence, and overall GPA (Robbins et al., 2004). Students who believe in their ability to do math and who stay motivated in their studies enhance their academic attainment (Zimmerman et al., 1992). In a study of 285 university students enrolled in an entry-level statistics course, Salazar (2018) found that math self-efficacy ($\beta = .34$, $t = 3.63$, $p < .001$) was a positive predictor of statistics motivation after accounting for variables such as gender, ethnicity, and college GPA. These findings aligned with earlier results from Kitsantas et al. (2011), who studied 5,200 students from 274 schools. Their multiple regression model indicated that self-efficacy in math accounted for more of the variance ($\Delta R^2 = 0.20$, $p < 0.001$) in math achievement than race, gender, or access to academic resources. Furthermore, math self-efficacy reduced achievement gaps between races and proved to be the most significant predictor of student success (Kitsantas et al., 2011).

Unfortunately, it is common for freshman students to struggle in math due to feelings of inadequacy (Hall & Ponton, 2005). A poor perception of self-efficacy negatively impacts mathematical problem-solving and performance (Pajares & Miller, 1994), and can limit students' ability to strategize (Hoffman & Spatariu, 2008). Even when controlling for mathematical background knowledge, math self-efficacy influences a student's ability to accurately and efficiently solve problems, which prohibits students from excelling in the discipline (Hoffman & Spatariu, 2008). This repetitive cycle of negative perceptions of mathematics, poor outcomes in math, and low self-efficacy has a crippling effect on students' motivation and often prohibits students from finding success within their mathematics courses, which stops them from obtaining a college degree (Zimmerman et al., 1992). The feelings of ineptness in math not only result in academic underachievement but directly contribute to other predictive factors such as math anxiety (Azar & Mahmoudi, 2014), which is a feeling of tension that interferes with the ability to manipulate numbers (Finlayson, 2014). Thus, we now shift our focus to the effects of mathematical anxiety on student motivation and success.

Math Anxiety

For decades researchers have been trying to ascertain why otherwise proficient students perform poorly in mathematics (Gough, 1954; Suárez-Pellicioni, Núñez-Peña, & Colomé, 2016; Tobias & Weissbrod, 1980). First dubbed *mathemaphobia* (Gough, 1954), and then *number anxiety* (Dreger & Aiken Jr., 1957), math anxiety refers to the "feeling of tension, apprehension or even dread, that interferes with the ordinary manipulation of numbers and the solving of mathematical problems" (Ashcraft & Faust, 1994, p. 98). Other definitions of math anxiety, include "an irrational and impeditive dread of mathematics" (Lazarus, 1974, p. 16), "the panic, helplessness, paralysis and mental disorganization that arises among some people when they are required to solve a mathematical problem" (Tobias, 1978, p. 65), and a "general fear of contact with mathematics" (Hembree, 1990, p. 45). Collectively, these definitions convey the idea that for some students dealing with numbers or math-related situations evokes a negative emotional response that disrupts students' cognitive processes and undermines their academic performance (Ashcraft, 2002; Suárez-Pellicioni et al., 2016).

Math anxiety is quite common among college students (Betz, 1978; Chang & Beilock, 2016; Perry, 2004) and directly affects outcomes in mathematics (Justicia-Galiano et al., 2017). Perry (2004) indicated that approximately 85% of students in entry-level mathematics courses experience at least mild math anxiety. Students reported understanding the mathematics quite well, but panicking during exams and ultimately failing. In fact, high anxiety students continually underperform on math tests when compared to students with no or low anxiety

(Hembree, 1990). Anis, Krause, and Blum (2016) studied 73 college students and discovered that math anxiety significantly impacted their scores on the mathematics section of the SAT. They found statistically significant differences in the SAT math scores between students with low math anxiety ($M = 546.98$, $SD = 55.88$) and those with high mathematics anxiety ($M = 495.67$, $SD = 61.95$), ($F(1, 69) = 7.27$ $p < .05$, $\eta_p^2 = 0.095$). Furthermore, there was a negative correlation between math anxiety and performance on the mathematics segment of the SAT, $r(71) = -0.40$, $p < .01$). Therefore, higher levels of mathematics anxiety correlated with lower math SAT scores.

While math anxiety directly affects math outcomes, Justicia-Galiano, Martín-Puga, Linares, and Pelegrina (2017) found that math anxiety also affected students' math self-efficacy, which further contributed to a decrease in students' academic achievement in math. In a study of 167 students, Justicia-Galiano et al. (2017) found that math anxiety directly affected students' performance in math ($p < .01$). The authors also found that math anxiety affected students' math self-concept, which further affected students' academic achievement in math ($p < .05$). Thus, the lack of self-confidence is one source of anxiety (Finlayson, 2014), but it is also a mediating factor between anxiety and achievement (Justicia-Galiano et al., 2017). Moreover, Foley et al. (2017) examined assessment data from 64 educational systems across the globe and concluded that math anxiety and math performance have a reciprocal relationship. As students develop anxiety and low perceptions of their math abilities, then they underperform. And when they fail to achieve success in mathematical endeavors, their anxiety continues to increase. Foley et al. (2017) found that, on average, a 1-unit difference in country-level math anxiety corresponded to a 73-point score difference on the math assessment (large effect size, Cohen's $d = 0.81$). This apprehension contributes to the repetitive cycle of negative perceptions of mathematics, poor outcomes in math, and low self-efficacy, which often prohibits students from finding success within their mathematics courses and stops them from obtaining a college degree (Zimmerman et al., 1992). Although this toxic pattern affects students of all kinds, Foley et al. (2017) suggested that math anxiety is associated with a larger decrease in performance for students in the 90^{th} percentile, which puts even high performing students at risk of not achieving their full potential in math.

Anxiety and avoidance behaviors can affect students' emotional well-being, which shapes their engagement in learning and determines academic outcomes (Geertshuis, 2019). However, not all math anxiety results in negative consequences for students (Wang et al., 2015). Wang et al. (2015) posited that moderate levels of anxiety might facilitate performance in students with high math motivation. In two studies, one of 262 pairs of school-age twins and one with 237 undergraduate students, the researchers found that overall math anxiety was increasingly associated with poor math performance for students with low levels of motivation, but that performance peaked for students with high levels of motivation. Specifically in their college-level study, math performance was represented using four categories of mathematical tasks: composing and decomposing numbers, problem verification, calculation, and applied problems. While mean levels of math anxiety negatively affected math performance in most cases, the predictive negative effects of math anxiety on each respective task were greater for students with low motivation ($\beta = -0.20$; $\beta = -0.18$; $\beta = -0.25$; $\beta = -0.25$) than for those with higher levels of motivation ($\beta = -0.07$; $\beta = 0.05$; $\beta = -0.10$; $\beta = -0.19$). Their findings suggest that anxiety presents in different forms and that students can overcome moderate levels of anxiety if they are highly motivated.

While it is evident that students with math anxiety struggle with mathematical tasks, their apprehension may not directly imply a weakness in their computational ability. Students who struggle with math anxiety are not necessarily less skilled at math with a lower math ability than students who do not experience apprehension (Maloney & Beilock, 2012). As early as first grade, students can begin to exhibit signs of math anxiety and encounter physical reactions to mathematical calculations (Ramirez, Gunderson, Levine, & Beilock, 2013). For math-anxious children, even the thought of a math-related task sends the right amygdala regions of the brain used for processing negative emotions into overdrive, which reduces activity in regions known to support working memory and numerical reasoning (Young, Wu, & Menon, 2012). This obstructed connectivity in students' brains reduces their capacity to reach the mathematical information necessary to solve problems regardless of their level of intelligence. Beilock and Maloney (2015) further suggest that anxiety manifests in worries about performing poorly, which preoccupy a student's mind and block thinking and reasoning resources needed for mathematical tasks.

In addition to impairments in math performance (Anis et al., 2016; Foley et al., 2017) and the ability to recall foundational math concepts (Beilock & Maloney, 2015; Young et al., 2012), math anxiety can present as physical symptoms such as pain and nausea (Lyons & Beilock, 2012; Perry, 2004). In an experimental study of 14 people with high mathematics anxiety (HMA) and 14 low math-anxious (LMA) individuals, Lyons and Beilock (2012) asked participants to rate their reaction to 25 math-related situations. As participants completed math-tasks and responded to math-cues, researchers simultaneously conducted MRIs to measure neural activity in four regions of the brain: bilateral dorso-posterior insula (INSp), mid-cingulate cortex (MCC), and a dorsal segment of the right central sulcus (CSd). HMA's showed significant interaction between the anxiety ratings and the brain activity in all four regions associated with pain perception (Left INSp: $F(1,24) = 10.91$, $p = .003$, $\eta^2 = .313$; Right INSp: $F = 6.00$, $p = .022$, $\eta^2 =$

.200; MCC: $F = 18.44$, $p < .001$, $\eta^2 = .434$; Right CSd: $F = 5.45$, $p = .028$, $\eta^2 = .185$), whereas LMA's did not exhibit significant correlations in any region (Left INSp: $r_p(11) = 2.384$, $p = .195$; Right INSp: $r_p = 2.119$, $p = .698$; MCC: $r_p = 2.507$, $p = .077$; Right CSd: $r_p = 2.379$, $p = .422$). It was further determined that high levels of math anxiety predicted increased physical pain during the anticipation of math-related tasks ($p < .01$), but not necessarily during the math task itself. Thus, math anxiety can induce physical pain with merely the thought of math.

Both Beilock and Maloney (2015) and Lyons and Beilock (2012) suggest the manifestations of anxiety in worries about performing poorly and physical pain, respectively, lead to avoidance behaviors. Thus, some students are likely to try and circumvent learning math as a means to escape their struggles with math and computational anxiety. Not only does anxiety and avoidance behaviors affect students' engagement in learning and academic outcomes (Geertshuis, 2019), but math anxiety may lead students to avoid careers that use math (Scarpello, 2007) and math-related tasks altogether (Ashcraft & Ridley, 2005). Therefore, math anxiety may reduce the importance of math for some students or cause them to ignore its utility value in life, additional factors that should be considered in examining the motivational and academic effects of student mathematical perceptions.

Student Expectancy-Value of Mathematics

Initially studied in the domain of math achievement, Eccles et al.'s (1983) expectancy-value model pertains to student performance, motivation, and choice. Specifically, student expectancies and values directly influence academic choices and motivation, which have been shown to impact achievement (Wigfield & Eccles, 2000). However, those beliefs are simultaneously influenced by ability beliefs and other student perceptions. Wigfield and Eccles (2000) defined expectancies for success as a person's belief about how well they will do on an upcoming or future task. Furthermore, the authors defined ability beliefs as an individual's perception of present competence. These definitions are similar to Bandura's (1977) discussion of self-efficacy, where efficacy expectations are defined as an individual's belief that they can accomplish a task, and outcome expectancies are beliefs that a given action will lead to a given outcome. Wigfield and Eccles (2000) delineated that their "measures of ability beliefs and expectancies have tended to be domain rather than activity specific, and so [their] approach has been somewhat more general than much of Bandura's research" (p. 72). Thus, Wigfield and Eccles's (2000) definitions of ability beliefs characterize a student's idea of math and it is their achievement values that are of particular interest in the present study.

Eccles et al.'s (1983) model defined four different components of achievement value. First, attainment value is defined as the personal importance of doing well on a task. Second, intrinsic value is the enjoyment one gains from doing a task. Next, utility value is the associated usefulness of the task or how the task fits into an individual's future plans. And finally, cost refers to the decisions about how engaging in the task may limit access to other activities, the amount of effort that will be necessary to complete the task, and any emotional drain for engaging in the activity. To determine how student perceptions affect their academic motivation, we will concentrate on the constructs concerning the attainment and utility value of mathematical tasks.

While researchers often analyze these task values as a single factor, attainment and utility task values are conceptually distinct and have been associated with measures of student motivation when examined separately (Hulleman et al., 2010). Hulleman, Godes, Hendricks, and Harackiewicz (2010) described the attainment value of a mathematical task as the personal importance that a computational activity may hold for a student determined by the personal significance of the task. The importance of math is personal to a student, whereas the utility value of mathematics is associated with students' external feelings toward the usefulness of an object or activity. While student perceptions of the importance of math and its usefulness are often interrelated (Chouinard & Roy, 2008), one construct is personal, and the other is rather impassive, so the individual interest in mathematics does not necessarily correlate to its utility value (Eccles & Wigfield, 2002). It is plausible for a student to see a global value in the usefulness of mathematics without it having any personal relevance to their lives. Therefore, it is vital to understand how each construct can affect students' academic motivation. We first investigate the literature surrounding the importance of math and then move to student perceptions about the utility value of mathematics.

Attainment Value and the Personal Importance of Math

The attainment value of a mathematical task is the personal importance that a computational activity may hold for a student, which is determined by the personal significance of the task (Hulleman et al., 2010). Thus, the enthusiasm to complete an academic chore is impacted by whether or not a student finds meaning or personal worth in the educational experience (DeWitz et al., 2009). When students lack academic motivation and see little value in their experiences, they may fail to achieve collegiate success (Turki et al., 2017).

Given the importance of motivation in math classrooms, several researchers have studied interventions aimed at enhancing student perceptions of the importance of math (Gaspard et al., 2015; Harackiewicz, Smith, & Priniski, 2016). Pantziara and Philippou (2015) found that interest in mathematics was highly correlated with self-efficacy beliefs ($n = 312$, $r = 0.698$). Students who do not perform well in math are less likely to view the subject as personally relevant and have fewer motives to learn mathematics (Pantziara & Philippou, 2015). To increase student motivation in math classrooms, practitioners and researchers have used interventions designed to enhance student perceptions of the importance of math (Gaspard et al., 2015; Harackiewicz et al., 2016). In a study of 1,978 students, Gaspard et al. (2015) found that interventions conveying the usefulness of mathematics through quotations from other people increased the personal relevance of mathematics among students ($\beta = 0.76$, $p < .001$). The premise in their findings combines both vicarious experience and verbal persuasion, which are two tenets of self-efficacy theory (Bandura, 1977) and confirm correlations between math interest and self-efficacy, as seen in Pantziara and Philippou's (2015) results. Moreover, Harackiewicz, Smith, and Priniski (2016) speculated that practical interventions that highlight the importance of math could enhance motivation, increase individual interest in the discipline, and promote student learning outcomes and higher grades.

Interventions that amplify a student's interest in math are especially essential because the decline in mathematical importance, motivation, and utility value is on-going as students age (Chouinard & Roy, 2008). In a study with 1,130 participants from 18 secondary schools, Chouinard and Roy (2008) used attitudinal scales administered at the beginning and end of three academic years to analyze perceptions of students who initially enrolled in regular math courses in grades 7 and 9. The researchers found that the perceptions of the importance of math declined over time for both boys and girls, particularly at the ends of 7^{th} ($t = -5.12$, $p < .001$), 8^{th} ($t = -3.80$, $p < .001$), and 10^{th} ($t = -3.82$, $p < .001$) grades. With boys and girls finding no personal relevance to mathematical activities, their mathematical motivation also decreased. Furthermore, the results showed boys' competence to be higher than girls initially, with girls' competence beliefs remaining fairly stable over time. However, a pronounced reduction in boys' aptitude beliefs resulted in the genders having similar beliefs about ability in high school. The authors' findings also confirmed a steady decrease in perceptions of the utility value of mathematics that was more pronounced for boys than girls. Thus, the decline in mathematical importance, motivation, and subsequently utility value for school-age children may explain some of the perceptions of collegiate students, specifically surrounding the usefulness of math. For this reason, we now turn our attention to the literature concerning university student perceptions of the utility of mathematics.

Utility Value and Usefulness of Math

Classroom activities rarely connect students to real-world mathematics (Schulteis, 2013; Speck, 2001). Students are consistently asked to solve artificial problems devoid of realistic settings (Duke, 1999). This widespread disconnect between class assignments and real-life furthers the perception that math is not useful. Subsequently, poor student perceptions of the utility value of mathematics contribute to a lack of motivation and academic achievement (Guo, Marsh, Parker, Morin, & Yeung, 2015). Fabricated educational activities remove opportunities for students to appreciate the usefulness of math, which can compound negative attitudes towards mathematics and produce low levels of student confidence and engagement in a math course (Hall & Ponton, 2005; Zimmerman et al., 1992).

To improve student perceptions of the usefulness of math, several researchers have studied utility value interventions (e.g., Canning & Harackiewicz, 2015; Shechter, Durik, Miyamoto, & Harackiewicz, 2011). Canning and Harackiewicz (2015) performed a series of utility value interventions to see how students with varying levels of confidence responded to different communication strategies. The interventions required groups of students to work through basic arithmetic problems using a newly learned technique. Students were randomly assigned to a self-generated utility value intervention groups where they were asked to think of ways a technique would be useful in life. The directly communicated group watched a presentation emphasizing how the technique was used in everyday tasks, and the control group did not receive any instructional program. In their first study of 88 undergraduate participants, the authors found that individuals who lacked confidence seemed to react negatively to directly communicated utility value interventions ($\beta = -0.20$, $p = .07$). They discovered that activities which allow students to self-generate utility value perceptions were more effective than directly communicating utility value. While self-generated utility value tasks stimulated performance for all participants, they were particularly beneficial for low self-efficacy individuals ($\beta = 0.34$, $p < .05$). In the second study of 113 collegiate students, they revealed that directly communicated utility value and self-generated utility value have a synergistic effect and can help low-confidence participants when combined ($\beta = 0.17$, $p < .05$). Their findings also seemed to suggest that students with low-confidence relate more to everyday-leisure examples of utility value rather than future career examples. Overall the results from studies 1 and 2 showed that students with lower exam scores reported more interest in the course after the intervention than those in the control group. This may mean that higher-performing students already have more interest than low-performing students who may benefit more from the utility value intervention.

In another similar set of studies involving a series of utility value interventions with 458 students, Shechter, Durik, Miyamoto, and Harackiewicz (2011) found that men solved more problems than women, and that initial interest in mathematical tasks positively predicted performance for both genders in the first ($\beta = 0.39$, $p < .01$) and the second study ($\beta = 0.23$, $p < .01$). These authors also explored how students of varying cultures responded to the utility value interventions and discovered that European Americans born in the U.S., referred to as Westerners, responded more to short-term utility value interventions. In contrast, those born in

China, Taiwan, Japan, or Korea, whom the researchers called Asian students, responded more to interventions with long-term value. Their study illustrated how cultural background might act as a mitigating factor in how students react to utility value interventions.

It is evident from both studies that student perceptions of utility value and self-efficacy in mathematics are interrelated and directly influence student achievement (Canning & Harackiewicz, 2015; Shechter et al., 2011). Furthermore, while utility value interventions lead to the transference of technical math skills, they also commonly include the development of students' soft skills, which are critical to their collegiate success (Nealy, 2005). Therefore, we now review the literature surrounding the importance of soft skills in academic achievement.

Impact of Students' Soft Skills on Academic Achievement

While most university curriculum focuses solely on the conveyance of hard or technical skills within a discipline (Matteson, Anderson, & Boyden, 2016), it is speculated that soft or people skills, such as communication, conflict-resolution, and teamwork, contribute to almost 85% of one's success in college and career (Wats & Wats, 2009). Certainly, technical knowledge is absolutely essential to student achievement, but aptitude alone is not sufficient (Conard, 2006). The development of soft skills can complement and enhance the learning of hard skills (Schulz, 2008). For students to process technical knowledge, they must deploy reasoning and critical thinking skills that help them generalize and transfer hard skills to new contexts (Pereira & Costa, 2017). Therefore, the lack of soft skills impedes students' academic performance and can negatively influence their motivation to achieve (Junita et al., 2018; Majid et al., 2012).

Soft skills include a wide variety of interpersonal skills, such as communication, problem-solving, teamwork, presentation, self-management, and work ethic (Robles, 2012; Schulz, 2008). These skills predict student achievement and are required for students to complete their college courses and earn their degrees (Chamorro-Premuzic et al., 2010; Harris & Rogers, 2008). In fact, Chamorro-Premuzic and Furnham (2003) found that personal skills, such as self-discipline, significantly correlated with academic performance ($r = .22$, $p < .01$). Moreover, the three factors of dutifulness, achievement striving, and activity, which the authors categorized within the traits of extraversion and conscientiousness, significantly predicted students' exam grades ($F(3, 243) = 33.45$, $p < .01$) and explained 28% of the variance in scores. These skills are particularly necessary for the field of mathematics, where critical thinking abilities are imperative for math competency (Cragg & Gilmore, 2014).

While the literature connecting soft skills to math achievement is scarce, Cragg and Gilmore (2014) assert that the abilities to problem-solve, be flexible in thought, and control one's actions, are necessary for math achievement and predictive of student performance in mathematics. In a study of 185 undergraduate students in Economics, soft skills (i.e., team-building, conflict resolution, leadership, communication, and innovativeness), predicted learning achievement ($\beta = 0.584$, $p < .001$) and mediated the effect of achievement motivation (i.e., success-orientated, responsibility, attentiveness, likes challenges, and works independently) on learning (Sobel $t = 4{,}370$, $p < .001$) (Junita et al., 2018). The authors concluded that student achievement is largely dependent upon the mastery of soft skills. These generalizable soft skills that include the ability to communicate and maintain working relationships with others are just as academically challenging as the traditional technical skills and are critically important components for scholarship in courses requiring computation (Johnston & McGregor, 2005).

The ability to communicate and work on a team is especially essential for first-year college students in entry-level classes where university students are first being introduced to institutional demands (Harris & Rogers, 2008; Powell, 2013). While it is known that SAT and

ACT scores to contribute to student performance (Camara & Echternacht, 2000; Zwick & Sklar, 2005), Powell (2013) expanded this research and studied the impact of soft skills for 334 first-time, full-time undergraduate students at a university. She discovered that general soft skills significantly correlated with the first-semester college GPA ($r = .26$, $p < .01$). Specifically, responsibility ($r = .25$, $p < .01$), motivation ($r = .24$, $p < .01$), and study habits/skills ($r = .20$, $p < .01$) were correlated with student's first term GPA. In addition to the significant relationship between and impact of soft skills on first-semester college GPA, soft skills significantly predicted first term GPA after accounting for ACT score and high school GPA (F-change (1, 246) = 3.976, $p < .05$). Thus, soft skills are a contributing factor to student success in college.

Given the influence of soft skills on student outcomes, curriculum that integrates generalizable math skills with student interests is more likely to facilitate learning and heighten the appreciation of mathematics (Wu & Greenan, 2003). In a quasi-experimental study of 84 students, Wu and Greenan (2003) found instructional strategies that included student discussions about problem-solving skills contributed to higher math achievement ($F(1, 82) = 6.19$, $p < .05$). Their findings indicated that generalizable soft skill inventions significantly increased the learning of mathematics skills. Kraebber and Greenan (2012) also reported mild correlations that increase with age between generalizable communication skills and math self-concept for postsecondary students ($n = 175$, $r = .23$, $p < .05$). Thus, relationships between self-efficacy, the usefulness of mathematics, and soft skills may help explain student achievement in math.

In addition to the importance of soft skills on student achievement (Chamorro-Premuzic et al., 2010), research previously discussed showed a direct relationship between self-efficacy and math anxiety (Azar & Mahmoudi, 2014), and a connection between students' perceptions of the importance of math and the utility value of mathematics (Chouinard & Roy, 2008).

Furthermore, low self-efficacy (Hall & Ponton, 2005), math anxiety (Foley et al., 2017), poor perceptions regarding the importance of math (Pantziara & Philippou, 2015) and the utility value of math (Guo et al., 2015), and a lack of soft skills (Junita et al., 2018) negatively affect student motivation (Pajares & Graham, 1999; Zimmerman et al., 1992) and academic performance (Murayama et al., 2013; Wong & Csikszentmihalyi, 1991). Hall and Ponton (2005) suggest this deficiency in academic motivation and decline in student performance reinforce negative perceptions of mathematics and often catapult students into a cyclical pattern of failure (Hall & Ponton, 2005). This toxic cycle of continual poor outcomes in mathematics is illustrated in Figure 1.

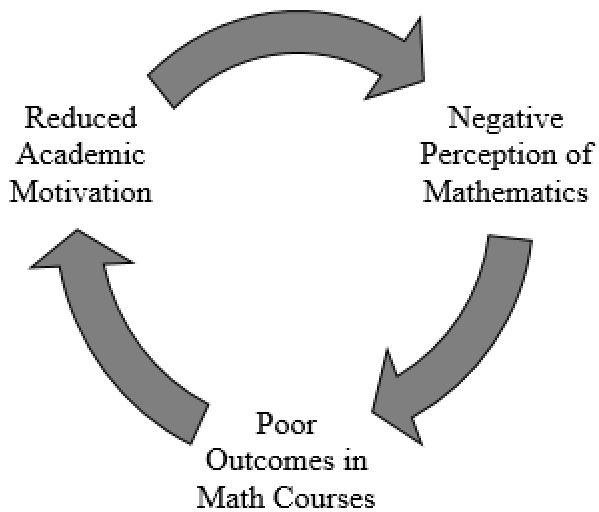

Figure 1. Toxic academic cycle for students with reduced motivation, negative math perceptions, and continual poor outcomes in mathematics coursework.

Breaking this negative cycle to increase success in higher education is a priority for postsecondary educators (Wood & Breyer, 2017). To heighten student motivation and improve academic success, educators have implemented active-learning strategies, such as service-learning, which have shown multiple positive effects for students, including the improvement of math attitudes (Henrich et al., 2016). Hence, we now shift our focus to academic initiatives aimed at enhancing student perceptions and collegiate success.

Active-Learning Strategies

Activities and programs designed to sustain achievement in mathematics can keep students progressing toward course and degree-completion (Buckley et al., 2016). Therefore, instructors and curriculum directors have implemented a variety of instructional approaches and modified course designs to heighten self-efficacy, resolve anxiety, help shape positive perceptions of math, and build interpersonal skills (Barr & Wessel, 2017; Nealy, 2005; Peters, 2013). Academic integration, which connects students to the classroom through active-learning and interaction with faculty, is one educational strategy that promotes degree completion and student success (Lopez & Jones, 2017; Roberts, 2019). “Active-learning is generally defined as any instructional method that engages students in the learning process” (Prince, 2004, p. 223). Students’ willingness to engage in academic material is critical to their educational success, so the core element in active-learning is student activity rather than a passive, traditional lecture (Gaffney & Kercsmar, 2016).

Benefits of Active-Learning

To heighten academic success and increase the probability that students will persevere in long-term learning, educators have implemented methods specifically aimed at improving student self-efficacy (Artino, 2012). Since some students struggle with insecurity, anxiety, and negative self-perception (Concannon & Barrow, 2009), pedagogical strategies that enhance their self-assurance have significant value (Usher & Pajares, 2008; Zimmerman et al., 1992). These scholastic approaches include the development of real-world curriculum and the implementation of group work (Finlayson, 2014). Interventions that demonstrate the utility value of mathematics have also increased student motivation and performance for some learners (Hulleman et al., 2010). These educational strategies create learner-centered classrooms, which are characterized by teamwork and thought-provoking discussions, and are more likely to engage students and contribute to deeper, richer learning (Fisher, Perényi, & Birdthistle, 2018; Wright et al., 2019).

Active-learning instructional methods consist of a wide array of techniques such as team assignments, challenging discussions, role-playing, peer tutoring, and service-learning projects, all of which help engage students with the faculty and their peers (Deeley, 2010; Prince, 2004). Peer interaction has proven a crucial means of support for students, particularly those battling feelings of tension and anxiety in the university environment (Finlayson, 2014). Students are eager to help each other and value collaborative activities in class (Ellis, 2013). The instructional use of small groups of students who work together to accomplish common goals and maximize their own and other's learning is known as cooperative learning (Smith, 1996). The benefits of team assignments include higher achievement, greater productivity, social competence, and self-esteem (Johnson, Johnson, & Smith, 1991; Smith, 1996). Due to the broad nature of group work, the active-learning strategy can be implemented in a variety of ways. For example, professors in an engineering class had 105 students work together to develop a board game (Azizan, Mellon, Ramli, & Yusup, 2018). Students embedded technical questions related to kinetic design and other facets of engineering content into the game. Through reflections and a self-report survey, students reported enjoying the challenging task, and 60.6% claimed an enhanced understanding of the subject matter, and 86.9% acquired higher-order thinking skills and conveyed an improvement in confidence and creativity, as well as an increase in their teamwork skills.

Other dynamic learning strategies can run a gamut of student engagement, particularly in large classrooms. For instance, using multimedia images that require students to think critically about the meaning of the images and engage with one another during a lecture can stimulate key characteristics of active-learning strategies (Roberts, 2019). In a study of 315 university students, faculty used compelling images to spark challenging discussions among their students. Roberts (2019) discovered that the illustrations guided students towards understanding, thereby making them active co-producers of knowledge in the class. The researcher found a 50-80% increase in engagement for students in the images group when compared to students with text alone. This active-learning technique proved especially useful in large, lecture-style classrooms where student interaction may be traditionally challenging.

While engaging students in the classroom can be difficult, Tews, Jackson, Ramsay, and Michel (2015) suggested that students value fun delivery of course content and peer socializing. Activities such as role-playing where students adopt the persona of a character can immerse students in the social aspects of learning while broadening and deepening student awareness (Kilgour, Reynaud, Northcote, & Shields, 2015). Stevens (2015) proposed that role-playing provides a safe environment where students can interact without the fear of being embarrassed and that the technique is particularly useful at prompting students to ask questions and help them to develop critical thinking skills. In her qualitative study of 144 undergraduate history students, 89% of them said the role-playing activity heightened their learning of the course content. In a mathematics classroom, these activities also reduced fear and anxiety for students and heightened excitement in learning the topics (Kilgour et al., 2015). Using coding and theme-analysis of 59 student reflections, Kilgour, Reynaud, Northcote, and Shields (2015) found that in addition to decreasing nervousness, role-playing made the mathematics more fun, changed student's attitudes about math, and enhanced their perceptions about the importance of mathematics.

Studying the effects of active-learning techniques on math anxiety is an important endeavor for several other researchers as well (Malik, 2015; Metje, Frank, & Croft, 2007). Metje, Frank, and Croft (2007) found that students in service-level mathematics courses often do not have the foundational math skills to be successful in the course, which heightens their anxiety. However, the implementation of group problem-solving sessions and student discussions created a secure learning environment that allowed students to feel more at ease with the subject-matter and engage more freely with their instructors and peers. In a phenomenological study with six participants, Malik (2015) explored student anxiety in an introductory statistics course. Students reported that working on real-world problems, having visuals to process information, and the use of different and engaging teaching techniques reduced their anxiety.

Additional strategies that reduce student apprehension include peer tutoring, even when such an intervention is required (Lunsford, Poplin, & Pederson, 2018). In student-directed activities, students value learning from others and obtaining others' perspectives (Hammond, Bithell, Jones, & Bidgood, 2010). Other benefits of peer tutoring include an increase of time on task, mastery of a topic, and accuracy in computations (Arreaga-Mayer, 1998). Students who participate in peer tutoring develop both academic and social skills and are more successful than non-participants (n = 1508, $p < .001$) (Lunsford et al., 2018). Specifically, peer tutoring has a positive impact on math final exam scores, particularly for students with below-average SAT scores (n = 1224, β = 45.868, $p < .05$) (Xu, Hartman, Uribe, & Mencke, 2001). Therefore, these techniques constitute effective ways to heighten student success.

Embedded within each of the active-learning strategies is an aspect of a community of learners. Service-learning is one specific active-learning approach that combines teamwork and peer interaction with a civic-based project to connect learners to the community at large. Since service-learning provides students with the opportunities to interact with others, gain career and academically necessary skills, and serve our community (Astin et al., 2000; Yorio & Ye, 2012), it is imperative to examine the multitude of student benefits within the approach.

Service-Learning: Benefits and Student Skills

Service-learning is defined as a credit-bearing, educational experience in which students meet the need of a community organization and reflect on the activity to further their understanding of course content, broaden their appreciation of the discipline, and enrich their sense of civic responsibility (Jones, 2003). The technique uses an experience-based approach to increase efficacy, personal values, interpersonal skills, and engagement in the classroom (Astin et al., 2000). Interpersonal skills and attributes, otherwise known as soft skills, typically include career-necessary abilities such as teamwork, conflict resolution, professionalism, communication, and presentation skills (Robles, 2012). According to Robles (2012), university curriculum should place a heavy emphasis on student soft skills, and service-learning seems to fulfill that mission.

While service-learning is a unique pedagogical approach, it has a broad range of applicability, so projects often span a variety of disciplines and take on various forms of implementation (Yorio & Ye, 2012). Examples of service-learning projects include courses about health psychology, where students provided direct assistance to individuals in homeless shelters by educating them about health care options and access, developed educational materials for a homeless shelter, and assisted with research examining the efficacy of programs that connected clients of a homeless shelter to health care access (Bringle, Ruiz, Brown, & Reeb, 2016). Additionally, students in an honors course aimed at enhancing citizenship and civil society helped community agencies to provide education for children with special needs, after-school recreation for children, or social daycare for the elderly (Deeley, 2010). While service-learning projects are rare in math, most of the tasks fall into three categories: mathematical modeling, statistics, and education-related activities such as tutoring (Hadlock, 2005). The most common application is to have math majors tutor students in lower-level mathematics courses (Butler, 2013).

Service-learning projects in any discipline have shown to heighten student learning by cultivating personal development, motivation, and a sense of well-being (Conway et al., 2009), increasing multicultural awareness and social responsibility in a real-world context (Warren, 2012), and fostering cognitive development of problem-solving and critical-thinking skills (Yorio & Ye, 2012). In a study involving 96 undergraduate students, half of which participated in service-learning versions of liberal arts courses, Batchelder and Root (1994) coded student journals to create decision-making scores and administered course evaluations. When comparing service-learning students to non-service-learning students, the individuals in the service-learning sections showed significant increases in their decision-making ($t = 4.406$, $p < .05$), social reasoning ($t = 6.949$, $p < .05$), and empathy ($t = 2.061$, $p < .05$). In a more recent study of university students in 2012 ($n = 961$), Dienhart et al. (2016) used chi-square analysis to conclude that service-learning students were more likely to plan to participate in future community work ($\chi^2 = 9.2$, $p < .05$) than non-service-learning students.

For math, service-learning tasks provide an opportunity for students to learn the value and application of mathematics in a real and meaningful way (Hydorn, 2007), and have a positive effect on the math attitudes of students (Henrich et al., 2016). Henrich, Sloughter, Anderson, and Bahuaud (2016) administered a survey and collected qualitative data from 85 students, 87% of whom were female, in a service-learning qualitative reasoning mathematics course. Their findings indicated that 60.3% of students improved their attitudes toward success in math ($p < .05$), 66.7% enhanced their beliefs about math ($p < .01$), 82.1% heightened their math ability confidence ($p < .001$), 71.8% showed an increase in motivation ($p < .001$), and 60.3% found math to be more useful ($p < .01$). Furthermore, out of 80 students in a business statistics course, 87.04% of service-learning students felt the experience contributed to their development as a student ($p < .01$) and would help them in their future studies (Phelps & Dostilio, 2008).

Despite the overwhelmingly positive effects of service-learning programs and a wealth of service-learning research that exists in other disciplines (Warren, 2012; Yorio & Ye, 2012), collegiate math faculty do not commonly implement such projects (Schulteis, 2013), and the literature regarding service-learning effects in math is quite scarce. Abes et al. (2002) cited anticipation of logistical problems with community organizations and extensive time requirements as top factors that deter faculty from using service-learning. Specifically for math, faculty are unsure that students benefit from the experience and have difficulty in establishing community partnerships (Abes et al., 2002; Schulteis, 2013).

In addition to the apprehension expressed by math instructors, there is some opposition research that points to a few negative effects of service-learning (Blouin & Perry, 2009; Sax, Astin, & Avalos, 1999). Blouin and Perry (2009) reported that service-learning focuses on students and professors without high regard of the community. They presented problems such as disrespectful student conduct, poor fits between projects and course objectives, and a lack of communication between the faculty and the organizations. A journalist in a fairly recent news article furthered those observations by saying that service-learning emphasizes student work rather than the outcomes for the communities (Wexler, 2016). Along those same lines, Sax, Astin, and Avalos (1999) cited a feeling of disempowerment in some cases when students realize that an individual person can do little to change society. These negative viewpoints speak to a need to ensure service-learning projects are implemented with great care and sufficient prior planning (Jones, 2003). When executed appropriately, service-learning projects have the potential to impact students, universities, and the community in mutually beneficial ways.

Theoretical Framework

The theory of self-determination (SDT) serves as the theoretical framework for the present study. According to SDT (Deci & Ryan, 1985a), math student outcomes may be impacted by academic factors that support or hinder their scholastic motivation and math perceptions. Since the purpose of this study is to analyze factors contributing to students' motivation and to determine the extent to which they affect students' academic performance in college-level mathematics, SDT provides a reasonable framework. This section examines the self-determination theory and illuminates how researchers have used SDT to help explain student motivation and achievement.

The three specific needs positioned within SDT were competence, autonomy, and relatedness (Deci & Ryan, 1985a). As the basic needs are supported, students' motivation is reinforced through a continuum of intrinsic and extrinsic sources (Deci & Ryan, 2000). SDT specifically suggests that intrinsic motivation is sustained by the satisfaction of competence and autonomy and that extrinsic motivation is facilitated by the gratification of students' needs for autonomy and relatedness (Deci, Koestner, & Ryan, 1999; Niemiec & Ryan, 2009). Intrinsic motivation is propelled by students' interest or competence in the activity itself, whereas extrinsic motivation is contingent on the behavior yielding some type of external reward (Deci & Ryan, 1991).

According to SDT and as illustrated in Figure 2, extrinsic motivation contains four types of motivational factors that exist on a continuum from less self-determined to more self-determined behaviors (Ryan & Deci, 2000a). As the least self-determined parameter, *external regulation* is initiated and maintained by the expectation of rewards or the avoidance of punishment. Such actions are rarely continued once the controlling contingencies, such as grades, have been removed. Next, *introjected regulation* refers to behaviors in which an individual engages to advance their ego or avoid shame. This source of extrinsic motivation is particularly interesting because the pressure to perform in order to feel worthy stems from a somewhat controlled form of internalized extrinsic motivation (Gagné & Deci, 2005). Next on the continuum is *identified regulation* in which students begin to identify with the goal and accept the behavior as part of their own identity (Ryan & Deci, 2000a). The personal importance and value of the activity move an individual toward a greater degree of self-determination.

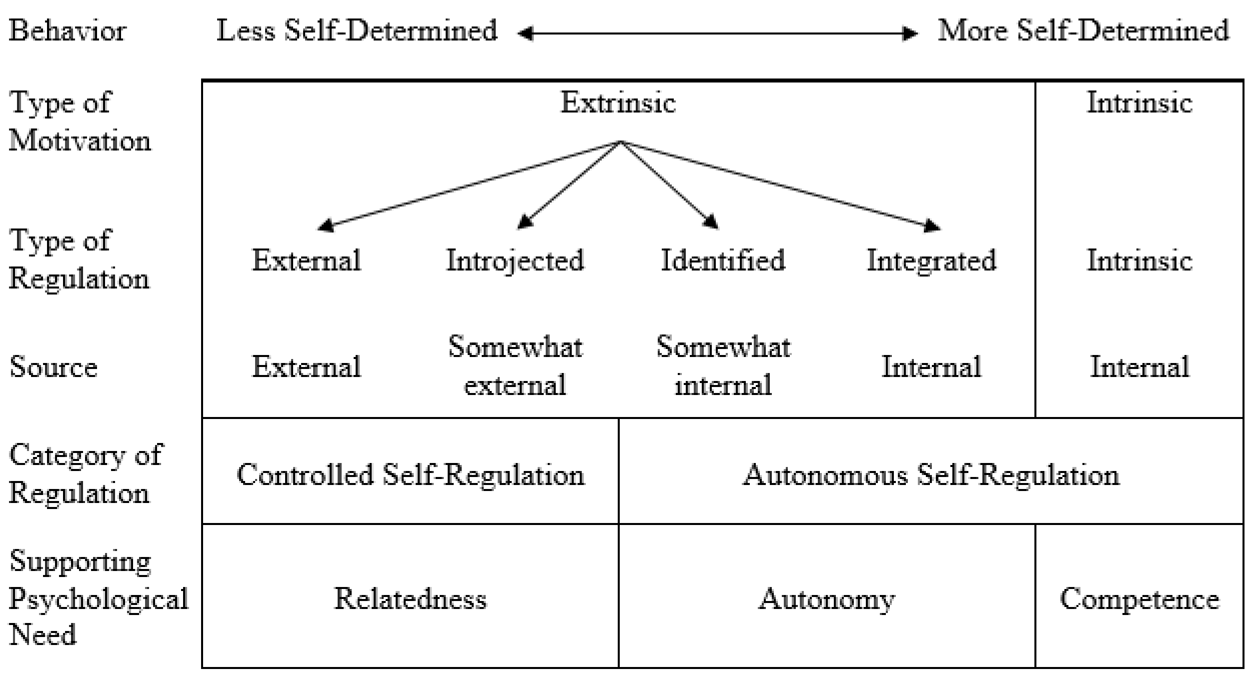

Figure 2. The continuum of motivation regulation, according to SDT. Adapted from “Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being,” by R. M. Ryan and E. L. Deci, 2000, *Journal of American Psychologist*, *55*, p. 72.

The most self-determined form of extrinsic motivation is *integrated regulation*, in which a student's behavior emanates from within their sense of self. Even though integrated regulation derives from an internal source, it is still considered extrinsic motivation because the behavior stems less from an individual's interest in a task and more from the perception of an activity as important to their personal goals (Cate, Kusurkar, & Williams, 2011). In summary, the SDT continuum moves from external regulation as the most controlled or least self-determined type of motivation through the progressively more self-determined types of extrinsic motivations (i.e., introjected, identified, and integrated regulations) to ultimately culminate in intrinsic motivation, which is the most self-determined source of behavior (Ryan & Deci, 2000a). Thus, students become increasingly self-determined as their basic psychological needs of competence, autonomy, and relatedness are supported (Deci & Ryan, 2000).

Understanding motivation is vital for addressing issues of student success and collegiate degree completion. Broadly defined as the process by which goal-directed activity is instigated or sustained (Schunk et al., 2012), motivation often explains why students engage in their mathematics coursework or why they may avoid the subject area. Because the self-determination theory considers the quality of motivation to be more significant than the quantity (Ryan & Deci, 2000b), investigators have applied the SDT to a variety of educational research studies focused on what motivates students in law (Sheldon & Krieger, 2007), mathematics (León, Núñez, & Liewet, 2015), medicine (Kusurkar, Ten Cate, Vos, Westers, & Croiset, 2013), music (Evans, 2015), psychology (Reis, Sheldon, Gable, Roscoe, & Ryan, 2000), sports (Standage, Gillison, Ntoumanis, & Treasure, 2012), and many other academic areas (e.g., Boggiano et al., 1993; Cate et al., 2011; Guiffrida, Lynch, Wall, & Abel, 2013; Niemiec & Ryan, 2009; Reeve, 2002; Vallerand, Fortier, & Guay, 1997).

According to SDT, student behavior and their levels of motivation are greatly influenced by their perceptions and environment (Ryan & Deci, 2000a). Because intrinsic and extrinsic motivations stem from the satisfaction of three basic psychological needs (Deci & Ryan, 1985a), it is imperative to examine the impact of curriculum and student motivation on academic achievement. In a study of survey results and grades for 383 university medical students, internal motivation significantly correlated with GPA ($r = .147$, $p < .01$), and motivation determined by external factors was negatively correlated but not significant ($r = -.009$) (Kusurkar et al., 2013). This is not surprising since research showed the continuum of internal forces of motivation to be stronger than external stimulants (Ryan & Deci, 2000a). However, when the intrinsic and extrinsic motivation were combined to create an overall motivation factor, Kusurkar, Ten Cate, Vos, Westers, and Croiset (2013) found correlation with GPA was significant ($r = .121$, $p < .05$). The authors' structural equation model showed overall motivation to positively predict good study habits ($\beta = 0.351$, $p < .001$), which then predicted academic performance measured by GPA ($\beta = 0.199$, $p < .001$). Thus, learning is enhanced when students' motivation is cultivated.

SDT stresses the importance of fostering feelings of competence, autonomy, and relatedness in math students in order to facilitate growth in all levels of motivation (Cate et al., 2011). However, traditional mathematics curriculum is composed of pre-arranged content presented lecture-style, which can reduce academic motivation and achievement by infringing on students' perceptions of proficiency, choice, and engagement (Niemiec & Ryan, 2009; Valås & Søvik, 1994). Student-centered curriculum, such as service-learning, which includes problem-based learning and group work, can stimulate motivation (Cate et al., 2011). Problem-based activities that involve student choice and develop their interests may create feelings of autonomy, stimulate relatedness through group interaction, and create satisfactory feelings of competence when mastered content is explained to their peers.

The fostering of student's competence, autonomy, and relatedness is especially productive when it leads to higher levels of intrinsic motivation (Deci & Vansteenkiste, 2004; Ryan & Deci, 2000b, 2000b). In fact, students' feelings of competence, autonomy, and relatedness can predict their levels of motivation (Durmaz & Akkuş, 2016). Regression analysis involving survey results from 230 mathematics students showed that autonomy, competence, and relatedness significantly predicted ($p < .01$) and explained 28% of the variance in intrinsic motivation, 24% of the variance in identified regulation, 12% of the variance in introjected regulation, and 4% of the variance in extrinsic regulation. Durmaz and Akkuş's (2016) findings are consistent with SDT assertions that claim the level of self-determination in motivational behaviors increases, and the internalization of external forces becomes easier when the three basic psychological needs are satisfied (Deci & Vansteenkiste, 2004; Ryan & Deci, 2000b, 2000b).

To determine whether the three basic psychological needs were relatively independent of each other, Reis, Sheldon, Gable, Roscoe, and Ryan (2000) computed averaged within-person correlations among daily ratings of autonomy, competence, and relatedness ($n = 67$). Their meta-analytic correlations were significant, although the effect sizes are modest (autonomy-competence, $r = .23$, $p < .001$; autonomy-relatedness, $r = .14$, $p < .001$; and competence-relatedness, $r = .10$, $p < .005$). Their findings support the assumption that the three basic needs represent distinct motivational systems and indicate reasonable levels of discriminant validity. Therefore, the next three sub-sections are devoted to research within the context of each respective need.

Competence

This section highlights research with results specifically related to competence, which is a person's perception of their own ability, and a critical intrinsically motivating component of SDT (Deci & Ryan, 1985a; Ryan & Deci, 2000a). Guiffrida, Lynch, Wall, and Abel (2013) conducted a study of 2,520 undergraduate students and asked them to complete a questionnaire with demographic, academic background, and motivational questions. They discovered a positive association between competence and persistence in college ($\beta = 0.287$, $p < .01$) as well as grade point average ($\beta = 0.176$, $p < .01$). The standardized coefficients aligned with SDT to show that feelings of competence motivate college students to continue seeking their degrees.

In another study of 198 participants from two law schools, Sheldon and Krieger (2007) examined the impact of students' self-reported levels of the three basic psychological needs on student grade point average (GPA). While autonomy ($r = .13$), competence ($r = .25$), and relatedness ($r = .05$) were all positively correlated with GPA, autonomy and relatedness declined over the three-year period ($p < .01$) so that the change in competence was the only remaining SDT variable that positively predicted GPA ($\beta = 0.241$, $p < .01$). The other two constructs were not insignificant to student perceptions because relatedness did predict well-being ($\beta = 0.13$, $p < .05$) and autonomy predicted career motivation ($\beta = 0.33$, $p < .05$). These relationships confirmed earlier research by Reis et al. (2000) who found averaged daily variables of autonomy ($r = .25$), competence ($r = .30$), and relatedness ($r = .16$) were positively correlated with overall well-being ($p < .0001$). Furthermore, competence scores measured by daily activities and questionnaires positively predicted well-being ($\beta = 6.92$, $p < .001$). Consequently, fostering the need for competence is critical to enhancing student engagement and performance (Sheldon & Krieger, 2007). Since individuals are inclined to participate within domains in which they feel competent (Durmaz & Akkuş, 2016), environments that develop competence and interest in mathematical tasks could also foster the second basic psychological need for autonomy.

Autonomy

This section highlights research with results specifically related to autonomy, which is defined as a volitional act in the exercise of choice and represents a person's willingness to proceed with an activity because they perceive control over their actions without pressure (Deci et al., 2001; Deci & Ryan, 1985a). Self-initiated autonomous behaviors are motivated by both intrinsic and extrinsic factors (Deci & Ryan, 2008a) derived out of an individual's degree of genuine interest in an activity, and guided by external factors that align with personal needs, respectively. In alignment with these SDT notions, Guiffrida et al. (2013) found autonomy to be positively associated with persistence in college ($\beta = 0.134$, $p < .01$) and grade point average ($\beta = 0.117$, $p < .01$). The standardized coefficients revealed that students who are motivated by autonomy, facilitated by intrinsic and extrinsic factors, are more likely to continue seeking their degrees and achieve higher grades.

Autonomous motivation involves a true sense of choice, a sense that students feel free to do what they have chosen to do (Boggiano et al., 1993; Deci & Ryan, 1991). Boggiano, Flink, Shields, Seelbach, and Barrett, (1993) proposed that directives which reduce students' sense of self-determination through the removal of choice, would have detrimental effects on problem-solving skills and controlling statements such as 'You should do X' would have a negative impact on student achievement. To test this premise, they conducted an experiment with 34 students in an introductory psychology course by randomly assigning students to groups with controlling-directives or non-controlling-directives. Students in the controlling-directives group reported significantly lower feelings of autonomy ($F(1,30) = 12.64$, $p < .001$). In a follow-up study with 83 similar students, those with reduced perceptions of autonomy performed significantly worse on analytic reasoning problems ($F(1,79) = 5.90$, $p < .02$). Thus, the absence of choice negatively affected student achievement.

Since fostering feelings of autonomy is crucial for success in math (Cate et al., 2011). León, Núñez, and Liew (2015) collected survey data for a sample of 1,412 students. They found autonomy, cultivated by classroom environment, was positively correlated to motivation (r = .39), effort regulation (r = .25), deep-processing (r = .57), and math grades (r = .14). Through structural equation modelling, León et al. (2015) also discovered that autonomy significantly predicted motivation (β = 0.65, p < .001), which then predicted effort regulation (β = 0.58, p < .001) and deep-processing (β = 0.77, p < .001). Effort regulation further predicted math grades (β = 0.47, p < .001), and the model overall explained 20% of the math achievement variance. Their findings reaffirm the need to cultivate autonomy through a sense of meaningful choice and purpose. León et al. (2015) furthered the case presented by Cate et al. (2011) that teachers can help students' develop a sense of autonomy by acknowledging interests and building choice into the school curricula.

Results from the correlation and regression analysis in Reis' et al. (2000) study illustrated a positive correlation between averaged daily variables of autonomy ($r(67)$ = .25) and overall student well-being (p < .0001). Measured by daily activities and questionnaires, daily scores of autonomy (β = 4.98, p < .001) also positively predicted the well-being of participants. Additionally, Vallerand, Fortier, and Guay (1997) investigated autonomous motivation toward persistence in school. Their model posited that student perceptions of autonomy could influence behaviors toward drop-out, and they found a main effect for types of students ($F(1, 4521)$ = 27.89, p < .0001). Students who dropped out of school (μ = 3.53, SD = 1.28) reported themselves to have significantly lower perceptions of autonomy in school activities than students who persisted in their studies (μ = 3.95, SD = 1.25). Taken together, these studies of autonomous motivational factors illustrate the necessity to provide students with a sense of agency, and when possible, to incorporate their interests in the curriculum. Activities that also include problem-based learning and group work may cultivate autonomy as well as relatedness.

Relatedness

This section highlights research with results specifically related to relatedness, which is grounded in the role that extrinsic motivation plays in motivating behaviors, and refers to the need to be connected to and loved by others (Deci & Ryan, 2000). The concept of relatedness often considers students' well-being and their desire to engage socially. Reis et al. (2000) determined a positive correlation between averaged daily scores of relatedness ($n = 67$, $r = .16$) and overall well-being ($p < .0001$). Relatedness was positively associated with communicating about personal matters ($t = 4.23$, $p < .001$), participating in shared activities ($t = 3.29$, $p < .001$), feeling understood and appreciated ($t = 10.07$, $p < .001$) and participating in pleasant or otherwise enjoyable activities, ($t = 2.59$, $p < .01$) (Reis et al., 2000). Additionally, relatedness scores positively predicted a well-being composite score ($\beta = 2.46$, $p < .01$). Sheldon and Krieger (2007) also found student perceptions of relatedness to predict well-being ($\beta = 0.13$, $p < .05$). They further examined the impact of students' self-reported levels of relatedness and discovered a positive correlation with GPA ($n = 198$, $r = .05$).

Guiffrida et al. (2013) found associations among relatedness, persistence, and GPA to be more complex and identified four types of relatedness: school/faculty, school peers, home/altruistic, and home/keep up. They illuminated only a marginal association between relatedness to school/faculty and persistence ($n = 2{,}520$, $\beta = 0.082$, $p < .08$). However, a significant association among two of the four types of relatedness and college GPA did exist. A negative association between relatedness to peers and college GPA ($\beta = -0.350$, $p < .01$) was the strongest statistical relationship, while relatedness to faculty displayed a weaker yet positive association with college GPA ($\beta = 0.130$, $p < .01$). The connection to instructors may help explain why student-centered curriculum also fostered feelings of competence and autonomy (Cate et al., 2011). When students feel supported in their power to choose activities in which they feel some measure of competence, especially when others also value the task or knowledge-base, they are more likely to pursue the endeavor (Deci & Ryan, 2008a, 2008b). Subsequently, educational environments that support students' basic physiological needs for competence, autonomy, and relatedness, enhance their academic motivation and performance (Boggiano et al., 1993).

Chapter 2 Summary

Based on the literature, the lack of academic success in gateway mathematics courses prohibits students from attaining a four-year degree (Callahan & Belcheir, 2017). These students commonly have low self-efficacy (Hall & Ponton, 2005), math anxiety (Foley et al., 2017), poor perceptions regarding the importance of math (Pantziara & Philippou, 2015) and the utility value of math (Guo et al., 2015), and an underdevelopment of soft skills (Junita et al., 2018), all of which decrease academic motivation and negatively affect student performance (DeWitz et al., 2009; Robbins et al., 2004; Turki et al., 2017). Service-learning is a specific active-learning approach that aims to engage students with the community to heighten success in mathematics and promote degree completion (Lopez & Jones, 2017; Roberts, 2019; Wright et al., 2019).

Service-learning projects expose students to math in a real and meaningful way (Hydorn, 2007), have a positive effect on the math attitudes of students (Henrich et al., 2016), and increase both content-related and soft skills, which prove crucial to academic and career success (Astin et al., 2000; Robles, 2012; Wismath & Worrall, 2015). However, there is a research gap on the impact of service-learning course components and student motivation factors that include self-efficacy, anxiety, perceptions about the importance and usefulness of math, and interpersonal skills. Thus, this study, framed by the self-determination theory, attempts to address this gap in mathematics education research on service-learning and the motivational effects on collegiate student success in mathematics.

Chapter 2 surveyed the literature supporting the idea that student motivation impacts student success in gateway mathematics courses. The research confirmed an existing interrelationship between students' basic psychological needs, and motivational factors such as self-efficacy, anxiety, perception of the importance and utility value of math, and soft skills. In the next chapter, I outline the research methods necessary to complete this study.

CHAPTER 3: RESEARCH METHOD

This chapter consists of the research methods used in this study. I address the overall research design and provide a description of the research site and study participants. Then, I outline the creation of the instrument used in this study and discuss how the research methodology appropriately aligns with the research questions. The data collection and analysis procedures are explained in detail. I begin with a brief synopsis of the purpose of this study, which leads to a review of the research questions.

The purpose of this study was to analyze factors contributing to students' motivation and to determine the extent to which students' sociodemographic characteristics, academic background, motivation, and participation in service-learning affect their performance in college-level mathematics. Poor performance in gateway math courses is one of the most prominent issues contributing to collegiate attrition (Callahan & Belcheir, 2017; Koch & Pistilli, 2012). Though rarely implemented in math (Abes et al., 2002; Schulteis, 2013), active-learning strategies, such as service-learning, have been shown to enhance student motivation and engagement in the classroom (Astin et al., 2000; Conway et al., 2009). Therefore, this present study attempts to address the gap in service-learning research in the area of mathematics and lead to potential recommendations that may improve student academic success and, ultimately, degree completion.

Research Questions

The research questions posited for the present study concerned potential differences in students' sociodemographic characteristics, academic background, and motivation for students in service-learning and non-serving-learning sections of a gateway mathematics course, as well as the impact of students' sociodemographic characteristics, academic background, motivation, and participation in service-learning on math performance. Specific sociodemographic and academic variables included gender, race/ethnicity, age, student classification, financial aid, transfer credit, full-time student status, SAT/ACT math scores, semester credit hours (SCH) completed prior to course enrollment, and course grades. Motivational variables that aligned with the three constructs of the self-determination theory included self-efficacy of math, self-efficacy of public speaking, anxiety of asking math questions, importance of math, utility value of math, and community and teamwork. Four research questions guided this study.

1. Is there a difference between students enrolled in mathematics courses with a service-learning component (thereafter service-learning students) and those enrolled in mathematics courses without a service-learning component (thereafter non-service-learning students) regarding their sociodemographic characteristics and academic background?
2. Is there a difference between service-learning and non-service-learning students regarding their mathematics performance?
3. Is there a difference between service-learning and non-service-learning students regarding their motivation during the semester?
4. To what extent do students' sociodemographic characteristics, academic background, motivation, and participation in service-learning relate to their mathematics performance?

Research Design

The scientific nature of the research questions required a quantitative rather than a qualitative research approach (Davies & Hughes, 2014). Quantitative methods are more appropriate to study characteristics of groups in order to determine causal relationships and provide predictions within populations. Specifically, this study used a causal-comparative research design to explain the effect of independent variables on the dependent variable within the context of the educational phenomenon of service-learning (Gall, Gall, & Borg, 2007).

I used survey methods to collect data for quantitative analyses to explore the impact of students' sociodemographic characteristics, academic background, motivation, and participation in service-learning on mathematics achievement. The design of this study is *ex post facto* because it relied on the observation of naturally occurring variations in the independent and dependent variables, and because the students were retroactively responding to survey items (Gall et al., 2007).

Research Site Selection

The selected location is an urban, public, Carnegie R-1 institution in North Texas, which I refer to as Central University. Central University offers over 180 degree programs and has an overall enrollment encroaching 60,000 students (*Fast facts*, n.d.). The mission of the university is the advancement of knowledge and the pursuit of excellence with a commitment to both access and rigor. The school is further committed to the promotion of lifelong learning and the formation of good citizenship through its community service-learning programs (*Mission, vision, and values*, 2020). While these characteristics make this institution an ideal location for a service-learning study, the site was also one of convenience. Through my employment, accessibility to this campus eased access to the participants and their data.

Participant Selection & Data Collection

To conduct this study, I chose a freshman-level mathematics course (i.e., Elementary Statistical Analysis) to gauge the impact of service-learning on student motivation factors that include student perceptions of self-efficacy, math anxiety, the personal importance and usefulness of math, and interpersonal skills across a diverse population of undergraduates. The chosen course serves varying majors, is rigorous in terms of the mathematical difficulty level, and both service-learning and non-service-learning sections have comparable instructional structures that utilize similar course components and assessments.

I invited all students ($N = 743$) who enrolled in the spring semester of 2019 in an on-campus section of Elementary Statistical Analysis, a freshman-level mathematics course at Central University. The course was taught in a 16-week semester and was structured with one lecture and two lab days per week. Commonly selected by students in non-STEM majors (e.g., liberal arts, nursing, kinesiology, and social work), this course is frequently the second out of two math classes required for a degree in those fields. That said, the only prerequisite for the course is being classified as college-ready by the state.

To inform and recruit the students, I attended one lab meeting of each section during the first week of classes to make an in-class presentation about the research study. I introduced myself, invited students to participate in the study, and asked them to complete a survey. I returned to a lab meeting a few months later to recruit additional participants using another wave of the same survey. The survey was also posted as an announcement in the course learning management system so that students not present in the lab still had the opportunity to participate. The selected mathematics course used an incentive called Stats Coins for extra credit. Thus, to encourage participation, students were given three stats coins for completing the first wave of the survey and ten stats coins for completing the second wave of the survey. This incentive was equivalent to a 100 on a homework assignment and a 100 on a quiz assessment, respectively.

The survey was deployed to 743 students across five sections of Elementary Statistical Analysis, of which one section employed the service-learning curriculum. Within the target population, there were 148 students in the focal group of the service-learning section of the math course. These students were given the opportunity to opt-in or out of the research study. There were 595 students in other non-service-learning sections of the same course, and those students also had the opportunity to opt-in or out of the research study as the control group. A total of 536 students completed the survey in the first wave during the first few weeks of the semester, of which 129 were in the service-learning section. Additionally, a total of 464 students completed the survey during the second wave, of which 114 were in the service-learning section.

Data was collected from students who completed the survey at either time, and listwise deletion was used so that only students who completed all survey questions in the questionnaire were included in the sample. The responses for students who completed the survey twice were averaged together to obtain single answers to each question. A total of 615 unique students completed the survey at least once, and constitute the sample for this study.

Survey Instrument

The questionnaire was developed with items addressing students' perceptions of their self-efficacy in mathematics, their feelings of anxiety toward math activities, and other various aspects of learning collegiate mathematics. These items were adapted from the Mathematics Self-Efficacy and Anxiety Questionnaire (MSEAQ) (May, 2009), which was a derivative of the Mathematics Self-Efficacy Scale (MSES) (Betz & Hackett, 1983) and the Fennema-Sherman Mathematics Attitudes Scales (FSMAS) (Fennema & Sherman, 1976). According to Gall, Gall, and Borg (2007), self-report measures allow the researcher to make inferences from numerical scores about how students differ on various aspects of self, such as academic perceptions.

A combination of several additional self-report scales was used to determine and explore relationships between students' perceptions of their self-efficacy in mathematics, their utility value of mathematics, their interpersonal skills, and their abilities surrounding specific course objectives. Specifically, the survey instrument was created using questions from two primary scales, along with self-authored questions founded in research and the course content. The questions related to self-efficacy (e.g., ‘I believe I am the type of person who can do mathematics’) and anxiety (e.g., ‘I get nervous when asking questions in my math class’) were adapted from the MSEAQ (May, 2009). Survey items assessing the importance of math (e.g., ‘Understanding the course content in a math or statistics course is important to me’) and the utility value of mathematics (e.g., ‘I believe statistical skills are useful in the real-world’) were inspired by a shortened form of the FSMAS (Mulhern & Rae, 1998). And finally, the questions measuring student perceptions of their soft skills (e.g., ‘I believe I work effectively with others’) were created from the course learning objectives. The items used a five-point Likert scale, ranging from *completely disagree* to *completely agree*.

In addition to scales measuring student perceptions, the survey contained questions related to personal background information, including demographics, academic history, and student major. Overall, the survey instrument contained eight demographic background questions and 27 perception questions, and is included in Appendix A. The same questionnaire was distributed twice to increase participation and gauge overall student perceptions of self-efficacy, anxiety, the importance of math, the utility value of mathematics, and soft skill abilities. The survey underwent peer review by a mathematics instructor for the course before being delivered to students enrolled in the spring 2019 semester of the Elementary Statistical Analysis course. The survey was electronic, delivered through an online system called Qualtrics, and required each student to authenticate into the system through the university's single-sign-on system. Unique student identification numbers were collected in the survey and used to match student responses to their respective course grade data later.

Variables and Measurement

Once the data were collected, I identified variables related to student demographics, academic background, socio-economic status, section type, and grades. To obtain a binary outcome variable, I coded course letter grades of A, B, and C as passing grades, and coded letter grades of D, F, and W (withdrawals) as fails or non-successful attempts. Using conversion tables (College Board, 2018), I derived one of the academic variables, to combine new SAT, old SAT, and ACT scores into one variable called SAT/ACT math score. The original data set contained 481 new SAT scores, so I converted 88 ACT scores and 69 old SAT scores to the new SAT score equivalents. Therefore, a total of 538 students had an SAT/ACT math score, and the remaining 105 had no placement exam score. The names, measurements, and coding for all variables are shown in Table 1.

Table 1

Study Variables, Measurement, and Coding

Variables	Measurement and Coding
Outcome variable	
Pass/Fail course	Derived dichotomous variable (Fail(DFW)=0, Pass(ABC)=1)
Demographic variables	
Age	Continuous variable (Range 18 to 66)
Gender	Dichotomous variable (Female=0, Male=1)
Race/Ethnicity	5-category variable (Asian=1, Black=2, Hispanic=3, Multiracial/Foreign=4, White=5)
Academic variables	
Transfer	Dichotomous variable (No=0, Yes=1)
SAT/ACT math score	Derived continuous variable (Range 340 to 800)
Full-time status	Dichotomous variable (No=0, Yes=1)
Classification	4-category variable (Freshman=0, Sophomore=1, Junior=2, Senior=3)
SCH completed	Continuous variable (Range 0 to 270)

Major	11-category variable (Undecided=0, Art=1, Business=2, Criminal Justice=3, Education=4, English=5, Kinesiology=6, Nursing=7, Political Science=8, Social Work=9, STEM=10)
Financial aid variables	
Scholarship	Dichotomous variable (No=0, Yes=1)
Loan	Dichotomous variable (No=0, Yes=1)
Grant	Dichotomous variable (No=0, Yes=1)
Grouping variable	
Service-learning	Dichotomous variable (No=0, Yes=1)

I also performed exploratory factor analysis to categorize six motivational factors. To examine the factors, I applied principal axis factor analysis using Promax rotation with Kaiser normalization (Yong & Pearce, 2013). Questions that did not load at $|.40|$ or higher or that loaded on multiple constructs were removed from the final set of factors. It is imperative that the correlation coefficient *r* is at least $|.30|$ or higher, or else the relationship between the variables would be too weak (Yong & Pearce, 2013). Thus, through factor analysis, I identified six factors within the survey using 20 out of 27 original perception items, and I grouped them according to the motivational constructs in the self-determination theory.

To validate the items and the six motivational factors, I used a series of reliability tests to ensure the questionnaire was adequately measuring the identified constructs. To certify the reliability of a questionnaire, with correlated and inter-related items without redundancy, Tavakol and Dennick (2011) recommend a range between 0.70 and 0.90 for the Cronbach's alpha index. The Cronbach's alpha on the original set of 27 questions was 0.893. Only one question showed that the Cronbach's Alpha would increase if the item was deleted, 'I believe working with the local community is important,' and the factor analysis process also indicated the removal of that question. I reran the reliability test on the remaining 20 items, and the Cronbach's alpha index score stayed within the acceptable range at 0.863. Table 2 displays the questions that contributed to each final factor, along with the factor loadings.

Table 2

Factor Loadings for Exploratory Factor Analysis

Motivation Construct	Factor	Survey Question	Factor Loading
Competence			
	Self-Efficacy of Math		
		I worry that I will not be able to get a good grade in my mathematics course.	0.970
		I worry that I will not be able to get an "A" in my statistics course.	0.955
		I believe I can get an "A" when I am in a mathematics course.	0.828
		I feel confident when taking a mathematics test.	0.733
		I believe I am the type of person who can do mathematics.	0.629
		I believe I can understand the content in a math or statistics course.	0.505
		I get tense when I prepare for a math or statistics test.	0.492
	Self-Efficacy of Public Speaking		
		I feel confident when speaking in public.	0.966
		I am comfortable giving presentations in front of the class.	0.826
	Anxiety of Asking Math Questions		
		I get nervous when asking questions in my math class.	0.793
		I am afraid to give an incorrect answer during my statistics class.	0.752
		I feel confident enough to ask questions in my math class.	0.423
Autonomy			
	Importance of Math		
		It is important to me to do well in a math or statistics course.	0.706
		Understanding the course content in a math or statistics course is important to me.	0.639
	Utility Value of Math		
		I believe statistical skills are useful in the real-world.	0.775
		I believe I will be able to use math or statistics in my future career when needed.	0.682
		I do not see the value of mathematics in real-life.	0.481
Relatedness			
	Community and Teamwork		
		Working on a team makes me nervous.	0.608
		Participating in community activities is stressful.	0.593

In accordance with the self-determination theory, factors related to competence included self-efficacy of math, self-efficacy of public speaking, and anxiety of asking math questions. The second construct of autonomy included the importance of math and the utility value of math. And finally, the third SDT construct of relatedness contained the community and teamwork factor. Taken together, these factors measure student motivation. To ensure that each scale contained a reliable set of questions, I calculated the Cronbach's alpha index on each construct. The reliability indexes for each factor are displayed in Table 3.

Table 3

Reliability of the Six Motivational Factors Using Cronbach's Alpha Index Scores

Factor	Cronbach's Alpha (α)	*N*
Self-Efficacy of Math	0.883	7
Self-Efficacy of Public Speaking	0.889	2
Anxiety of Asking Math Questions	0.752	3
Importance of Math	0.700	2
Utility Value of Math	0.700	3
Community and Teamwork	0.612	2

All but one of the reliability tests confirmed the factor analysis results. However, the Cronbach's alpha indicated the removal of one question from the math anxiety scale, 'I get nervous when I have to use math or statistics outside of school.' The original Cronbach's alpha with four items was 0.735, but the reliability index increased to 0.752 when the one question was deleted. Of the six motivational scales, all but one fell within Tavakol and Dennick's (2011) recommended range of 0.70 to 0.90. While the last construct scored slightly below the suggested minimum score of 0.7, there was a moderate correlation (α = 0.612) within the relatedness items. Since the questionnaire was kept as short as possible to avoid survey fatigue, several of the scales ended up with only two or three questions. Therefore, I deemed the index score as acceptable because Cronbach's alpha is highly influenced by the number of items in a scale

(Tavakol & Dennick, 2011). Furthermore and according to *Kaiser's criterion* (Kaiser, 1960), any factor with an eigenvalue of 1 or more should be retained (Yong & Pearce, 2013). Since the factor analysis generated an eigenvalue higher than 1 for the community and teamwork factor, the questions within the relatedness construct were preserved.

The overarching goal of the present study was to analyze the extent to which sociodemographic, academic, and motivational variables, along with participation in service-learning, affect students' academic performance in college-level mathematics. Because the self-determination theory guided this study, the motivational variables were grouped according to the three basic psychological needs of competence, autonomy, and relatedness. Thus, the students' sociodemographic characteristics, academic background, motivation, and participation in service-learning were considered within the achievement model, as illustrated in Figure 3.

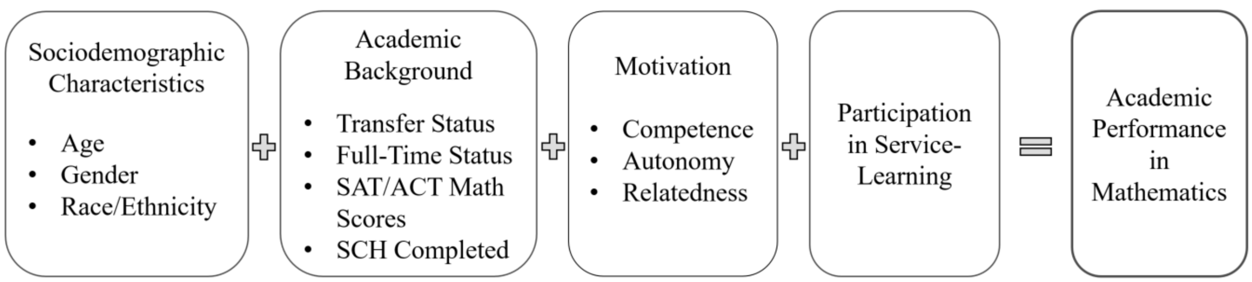

Figure 3. Achievement model for academic performance in mathematics using students' sociodemographic characteristics, academic background, self-determination theory for motivation, and participation in serving-learning.

Data Analysis

As summarized in Table 4, I used a variety of methods to address the research questions. To address research question 1 (RQ1), I used independent sample *t*-tests for scale or numerical variables and chi-square analysis for nominal or categorical variables to determine any differences in sociodemographic characteristics and academic background between service-learning students and non-service-learning students. An independent-measures or between-subjects research design is appropriate to use when two separate samples are representing two different populations; in this case, service-learning and non-service-learning students (Gravetter & Wallnau, 2013). Furthermore, the evaluation of numerical or scale variables requires a parametric *t*-test to examine the mean differences between those two populations. To evaluate group differences between the proportions of categorical or nominal variables, a non-parametric test using the chi-square statistic is necessary.

Table 4

Research Questions and Corresponding Analysis Methods

	Research Question	Variable	Research Method
RQ1	Is there a difference between students enrolled in mathematics courses with a service-learning component (thereafter service-learning students) and those enrolled in mathematics courses without a service-learning component (thereafter non-service-learning students) regarding their sociodemographic characteristics and academic background?	Nominal variables included gender, race/ethnicity, student classification, financial aid variables, academic variables, and student major. Scale variables included age, SAT/ACT math scores, and SCH completed.	Chi-square analysis for nominal variables and independent sample *t*-tests for scale variables.
RQ2	Is there a difference between service-learning and non-service-learning students regarding their mathematics performance?	Binary pass/fail course.	Chi-square analysis.
RQ3	Is there a difference between service-learning and non-service-learning students regarding their motivation during the semester?	Survey items and six motivational factors: Self-efficacy of math, self-efficacy of public speaking, anxiety of asking math questions, importance of math, utility value of math, and community and teamwork.	Independent sample *t*-tests on the individual survey items and the six respective factors.

RQ4	To what extent do students' sociodemographic characteristics, academic background, motivation, and participation in service-learning relate to their mathematics performance?	Gender, race/ethnicity, age, transfer credit, full-time status, SAT/ACT math score, number of SCH completed prior to enrollment, participation in service-learning, self-efficacy of math, self-efficacy of public speaking, anxiety of asking math questions, importance of math, utility value of math, and community and teamwork.	Logistic regression analysis with a binary pass/fail outcome variable.

To investigate RQ2, and to determine if there were differences in the mathematics performance of service-learning and non-service-learning students, I used chi-square analysis on the derived pass/fail course outcome variable. Next, for RQ3, motivation was measured using the mean scores from the survey of the six factors (i.e., self-efficacy of math, self-efficacy of public speaking, anxiety of asking math questions, importance of math, utility value of math, and the interpersonal skills related to working with a team and the community). To ascertain any differences between service-learning and non-service-learning students regarding their motivation during the semester, I used independent sample *t*-tests on the mean results of the six respective factors.

Finally, to answer RQ4, I used the binary pass/fail outcome variable created by defining pass to include letter grades A, B, and C, and fail to include D, F, and W. In alignment with other student success research (e.g., Bloemer, 2017; Callahan & Belcheir, 2017), a letter grade of D was considered an unsuccessful attempt because it rarely satisfies student degree requirements or prerequisites for future courses. As previously discussed, research points to students' need to successfully complete their gateway mathematics courses in order to continue pursuing their post-secondary degree (Callahan & Belcheir, 2017). Therefore, in justification of the pass/fail outcome variable, a passing letter grade would allow students to move forward in their academic journey, while an unsuccessful letter grade contributes to student attrition. Thus, I performed a series of binary logistic regression analyses with the pass/fail outcome variable to measure the extent to which students' sociodemographic characteristics, academic background, motivation, and participation in service-learning affected their mathematics performance.

Logistic regression is a technique that uses several independent variables to obtain an accurate probability of whether a participant will have a particular categorical outcome noted as the dependent variable for all members of the population (Gravetter & Wallnau, 2013). Results are commonly presented in terms of odds ratios, which are ratios of the probability of one outcome to the probability of the other outcome. In this case, the binary logistic regression used the student's sociodemographic characteristics, academic background, motivation scores, and participation in service-learning to compute the probability that a student would pass or fail the gateway mathematics course. Overall, regression analysis is a means of explaining relationships among variables to produce an equation that models the effect of each independent variable on the dependent variable (Mertler & Reinhart, 2017). Logistic regression is more flexible than multiple regression or discriminant analysis because the independent variables do not have to be normally distributed, linearly correlated, or have equal variances within each group. Another advantage is that logistic regression has the capacity to analyze continuous, discrete, and dichotomous variables.

While logistic regression is a flexible method, researchers should carefully consider four assumptions (Mertler & Reinhart, 2017; Tabachnick & Fidell, 2007). First, logistic regression may produce extremely large parameter estimates if there is not a reasonable ratio between the sample size and the number of independent variables. Using all 615 participants in the logistic regression, rather than separating the analysis by section group, satisfied this issue. Next, logistic regression relies on a goodness-of-fit test, which requires moderate frequencies for each discrete variable. Logistic regression is also sensitive to outliers and high correlations between independent variables, so special attention was given to these limitations.

Chapter 3 Summary

In this quantitative *ex post facto* survey study, framed by the self-determination theory, I explored the impact of students' sociodemographic characteristics, academic background, motivation, and participation in service-learning on mathematics achievement. The survey instrument containing self-authored questions, items adapted from the MSEAQ (May, 2009), and a shortened form of the FSMAS (Mulhern & Rae, 1998), along with demographic and academic questions (Appendix A) was presented to 743 students via online survey software. The study sample included a total of 615 unique participants who completed at least one survey, in either wave, in its entirety. Analysis methods included calculating descriptive statistics, tabulating frequency distributions, performing factor analysis, identifying Cronbach alphas, computing mean differences using chi-square analysis and independent *t*-tests, and equating a series of logistic regression models to address the study research questions.

CHAPTER 4: RESULTS

Overview

In this chapter, I present the results of the data analysis conducted, as outlined in the previous chapter. The first section of this chapter contains descriptive statistics and frequency distributions related to the sociodemographic characteristics and academic background of students enrolled in Elementary Statistical Analysis during the spring of 2019, as well as the listing of motivational items from the survey. The descriptive analyses provide an overview of the sample. The chapter concludes with the inferential statistics containing the results from the chi-square tests for independence and independent samples *t*-tests that address research questions 1, 2, and 3, as well as the logistic regression analysis with probability models and odds ratios that address research question 4.

1. Is there a difference between students enrolled in mathematics courses with a service-learning component (thereafter service-learning students) and those enrolled in mathematics courses without a service-learning component (thereafter non-service-learning students) regarding their sociodemographic characteristics and academic background?
2. Is there a difference between service-learning and non-service-learning students regarding their mathematics performance?
3. Is there a difference between service-learning and non-service-learning students regarding their motivation during the semester?
4. To what extent do students' sociodemographic characteristics, academic background, motivation, and participation in service-learning relate to their mathematics performance?

Descriptive Statistics of the Sample

During the spring semester of 2019, there were five on-campus sections of Elementary Statistical Analysis, containing a total of 743 students. There were 148 students in the focal service-learning section, and 595 students in the other four non-service-learning sections. A total of 536 students completed the survey during the first wave, of which 129 were in the service-learning section. Additionally, a total of 464 students completed the survey during the second wave, of which 114 were in the service-learning section. Student responses to the survey were used to obtain variables measuring student motivation during the semester. Responses include the results from students who completed the survey at either time as well as the averaged responses for each perception item from students who completed the survey twice. Then, the mean scores within each of the six respective factors were used as the measurements of student motivation. A total of 615 unique students, 140 in service-learning and 475 in non-service-learning, completed the survey at least once, and constitute the study sample.

Descriptive statistics for the service-learning and non-serving-learning students are presented categorically, starting with their sociodemographic characteristics and academic background, and then motivational variables. Table 5 outlines the descriptive statistics for the sociodemographic and academic categorical variables of gender, race/ethnicity, student classification, financial aid, transfer credit, full-time status, student major, and the pass/fail outcome variable. Then, Table 6 includes the descriptives for the continuous variables of age, SAT/ACT math score, and semester credit hours (SCH) completed prior to course enrollment. Finally, Table 7 displays the descriptives for the survey items and motivational factors. Each table presents the statistics for the entire sample as well as the corresponding distributions within each of the two section groups: service-learning and non-service-learning students.

Sociodemographic Characteristics

Overall, twice as many females (*n* = 410, 66.7%) enrolled in any section of Elementary Statistical Analysis at Central University as males (*n* = 205, 33.3%) (see Table 5). The breakdown by gender also shows that a higher percentage of females (*n* = 100, 24.4%) chose to take the service-learning version of the course than males (*n* = 40, 19.5%). In both section groups, the majority of participants identified as Latino (*n* = 237, 38.5%). The next most represented race/ethnicity in the sample was White (*n* = 137, 22.3%) students followed by Asian (*n* = 96, 15.6%), Black (*n* = 92, 15.0%), and students with foreign or multiple ethnicities (*n* = 53, 8.7%). Interestingly, Asian (*n* = 30, 31.3%) and students with foreign or multiple ethnicities (*n* = 16, 30.2%) were more likely to choose the service-learning section than students within the remaining race/ethnicity categories: White (*n* = 24, 17.5%), Black (*n* = 13, 14.1%), and Latino (*n* = 57, 24.1%).

Table 5

Descriptive Statistics for Categorical Variables

Variable	Service-learning		Non-service-learning		Total	
	n	%	*n*	%	*n*	%
Sociodemographic characteristics						
Gender						
Male	40	19.5	165	80.5	205	33.3
Female	100	24.4	310	75.6	410	66.7
Race/Ethnicity						
White	24	17.5	113	82.5	137	22.3
Asian	30	31.3	66	68.8	96	15.6
Black/African American	13	14.1	79	85.9	92	15.0
Hispanic/Latino	57	24.1	180	75.9	237	38.5
Foreign	11	33.3	22	66.7	33	5.4
Multiple Ethnicities	5	25.0	15	75.0	20	3.3
Classification						
Freshman	127	24.1	400	75.9	527	85.7
Sophomore	11	16.9	54	83.1	65	10.6

Junior	1	6.3	15	93.8	16	2.6
Senior	1	14.3	6	85.7	7	1.1
Financial variables						
Scholarship						
Received scholarship	59	25.1	176	74.9	235	38.2
Did not receive scholarship	81	21.3	299	78.7	380	61.8
Loan						
Received loan	58	21.6	210	78.4	268	43.6
Did not receive loan	82	23.6	265	76.4	347	56.4
Grant						
Received grant	88	24.8	267	75.2	355	57.7
Did not receive grant	52	20.0	208	80.0	260	42.3
Academic background						
Transfer						
Transfer credit on file	70	22.3	244	77.7	314	51.1
No transfer credit	70	23.3	231	76.7	301	48.9
Full-time status						
Enrolled full-time	130	25.0	390	75.0	520	84.6
Enrolled part-time	10	10.5	85	89.5	95	15.4
Major						
STEM	12	22.2	42	77.8	54	8.8
Art/Theater/Music	5	13.5	32	86.5	37	6.0
Business/Communications	12	23.5	39	76.5	51	8.3
Criminal Justice	4	13.3	26	86.7	30	4.9
Education	3	37.5	5	62.5	8	1.3
English/Linguistics/History	7	21.9	25	78.1	32	5.2
Kinesiology/Exercise Science	22	34.4	42	65.6	64	10.4
Nursing	52	23.4	170	76.6	222	36.1
Political Science	4	16.0	21	84.0	25	4.1
Social Work	4	21.1	15	78.9	19	3.1
Undecided	15	20.5	58	79.5	73	11.9
Mathematics performance						
Passed (A,B,C) course	125	26.3	351	73.7	476	77.4
Failed (D,F,W) course	15	10.8	124	89.2	139	22.6
Total	140	22.8	475	77.2	615	100.0

Students who participated in the service-learning section of the statistics course were younger on average (M = 18.98, SD = 1.90) than students who did not participate in service-learning (M = 19.73, SD = 3.76) (see Table 6). Also, the vast majority of all participants were freshmen (n = 527, 85.7%), meaning these students had less than 30 total credit-hours at the start of the spring 2019 semester. The next largest classification group was sophomore (n = 65, 10.6%), trailed by junior (*n* = 16, 2.6%) and then senior (*n* = 7, 1.1%). Likewise, more freshman (*n* = 127, 24.1%) chose to take the service-learning section of statistics when compared to the other classifications: sophomore (*n* = 11, 16.9%), junior (*n* = 1, 6.3%), and senior (*n* = 1, 14.3%).

Within the financial aid variables, 38.2% of participants had scholarships, 43.6% had student loans, and 57.7% received a grant for part of their tuition. The distributions were quite similar for all three socio-economic variables for service-learning students: scholarship (*n* =59, 25.1%), loan (*n* =58, 21.6%), and grant (*n* =88, 24.8%).

Academic Background

A majority of students (*n* = 314, 51.1%) had at least one course transferred from another institution, and 22.3% of the transfer students chose to take the service-learning course. Furthermore, 84.6% of the 615 participants enrolled as full-time students with at least 12 credit-hours in the spring 2019 semester. Of those full-time students, 25.0% enrolled in the service-learning section.

Participants enrolled in Elementary Statistical Analysis were at least three times more likely to be a nursing (*n* = 222, 36.1%) major than any other major. The next closest group within the major variable was undecided (*n* = 73, 11.9%) students followed by kinesiology and exercise science (*n* = 64, 10.4%), science, technology, engineering, and math (STEM) (*n* = 54, 8.8%), business and communications (*n* = 51, 8.3%), art, theater, and music (*n* = 37, 6.0%), English, linguistics, and history (*n* = 32, 5.2%), criminal justice (*n* = 30, 4.9%), political science (*n* = 25, 4.1%), social work (*n* = 19, 3.1%), and finally, education (*n* = 8, 1.3%) majors. While education majors make-up the smallest group of majors overall, education majors (*n* = 3, 37.5%) were more likely to choose the service-learning section than any other major. The remaining breakdown by percentage within the major for students enrolled in the service-learning section included: kinesiology and exercise science (*n* = 22, 34.4%), business and communications (*n* = 12, 23.5%), nursing (*n* = 52, 23.4%), STEM (*n* = 12, 22.2%), English, linguistics, and history (*n* = 7, 21.9%), social work (*n* = 4, 21.1%), undecided (*n* = 15, 20.5%), political science (*n* = 4, 16.0%), art, theater, and music (*n* = 5, 13.5%), and criminal justice (*n* = 4, 13.3%).

Surprisingly, the means of SAT/ACT math scores for both service-learning students (*M* = 544.17, *SD* = 73.68) and non-service-learning students (*M* = 544.17, *SD* = 75.42) in the sample were identical (see Table 6). Service-learning students had, on average, completed fewer courses or semester credit hours (*M* = 17.45, *SD* = 11.57) prior to enrolling in the spring 2019 mathematics course when compared to non-service-learning students (*M* = 19.40, *SD* = 20.20). And finally, a total of 476 participants (77.4%) passed the course with an A, B, or C, including 125 (26.3%) service-learning students and 351 (75.7%) non-service-learning students.

Table 6

Descriptive Statistics for Continuous Variables

	Service-Learning			Non-Service-Learning			Total		
Variable	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Age	140	18.98	1.90	475	19.73	3.76	615	19.56	3.44
SAT/ACT math score	127	544.17	73.68	410	544.17	75.42	537	544.17	74.95
SCH completed prior	140	17.45	11.52	475	19.40	20.20	615	18.95	18.59

Motivational Variables

Participants were asked to rate themselves on a Likert scale from one to five on statements related to their competency, autonomy, and relatedness. Within those three constructs, six motivational factors were created using the means of the survey items within each respective set. Specifically, scores for the self-efficacy of math are the means of the seven items within that factor. The factors for self-efficacy of public speaking, the importance of math, and community and teamwork were all made using the means of two items, while the anxiety of asking math questions and the utility value of math were constructed from the means of three items. Notably, statements written in a negative context, such as 'I worry that I will not be able to get a good grade in my mathematics course,' were reverse coded so that scores closest to five represent the positive version of the item or construct, and scores closer to one represent a lack of motivation within that respective area.

As seen in Table 7, non-service-learning students self-reported higher motivation on the majority of the six motivational factors, although scores were quite similar for both groups. Specifically, the means were lower for service-learning students than those of non-service-learning students for the self-efficacy of math ($M = 2.90$, $SD = 0.74$) vs. ($M = 2.94$, $SD = 0.81$), the self-efficacy of public speaking ($M = 2.79$, $SD = 1.15$) vs. ($M = 2.90$, $SD = 1.17$), the anxiety of asking math questions ($M = 2.78$, $SD = 0.85$) vs. ($M = 2.81$, $SD = 0.87$), the importance of math ($M = 4.11$, $SD = 0.69$) vs. ($M = 4.12$, $SD = 0.71$), and community and teamwork ($M = 3.22$, $SD = 0.76$) vs. ($M = 3.31$, $SD = 0.88$). Since questions related to math anxiety and community and teamwork were reverse coded, the lower means on each of these factors indicates that the service-learning students had higher anxiety and were more stressed by community activities than the non-service-learning students. Service-learning students also reported higher average scores for the utility value of math ($M = 3.58$, $SD = 0.74$) when compared to non-service-learning students ($M = 3.54$, $SD = 0.76$).

Table 7

Descriptive Statistics for Motivational Factors

Survey Item	Service-Learning			Non-Service-Learning			Total		
	n	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*
Competence									
Self-Efficacy of Math	140	2.90	0.74	475	2.94	0.81	615	2.93	0.79
I worry that I will not be able to get a good grade in my mathematics course.[a]	139	2.71	1.05	475	2.75	1.15	614	2.74	1.13
I worry that I will not be able to get an "A" in my statistics course.[a]	140	2.49	0.97	475	2.47	1.08	615	2.47	1.06
I believe I can get an "A" when I am in a mathematics course.	140	3.44	1.07	474	3.36	1.12	614	3.38	1.11
I feel confident when taking a mathematics test.	139	2.68	0.83	475	2.80	0.98	614	2.77	0.94
I believe I am the type of person who can do mathematics.	140	3.30	0.96	473	3.38	1.08	613	3.36	1.05
I believe I can understand the content in a math or statistics course.	140	3.47	0.78	473	3.57	0.85	613	3.5	0.84
I get tense when I prepare for a math or statistics test.[a]	139	2.22	1.04	466	2.27	1.12	605	2.26	1.10
Self-Efficacy of Public Speaking	140	2.79	1.15	473	2.90	1.17	613	2.88	1.16
I feel confident when speaking in public.	140	2.85	1.18	471	2.94	1.23	611	2.92	1.22
I am comfortable giving presentations in front of the class.	140	2.73	1.22	473	2.87	1.23	613	2.84	1.23
Anxiety of Asking Math Questions	140	2.78	0.85	475	2.81	0.87	615	2.80	0.87
I get nervous when asking questions in my math class.[a]	140	2.61	1.06	474	2.65	1.13	614	2.64	1.11
I am afraid to give an incorrect answer during my statistics class.[a]	140	2.24	1.00	471	2.35	1.09	611	2.33	1.07
I feel confident enough to ask questions in my math class.	140	3.49	0.94	475	3.43	1.01	615	3.44	0.99

Autonomy									
Importance of Math	140	4.11	0.69	473	4.12	0.71	613	4.12	0.71
It is important to me to do well in a math or statistics course.	139	4.33	0.67	468	4.36	0.73	607	4.35	0.72
Understanding the course content in a math or statistics course is important to me.	140	3.88	0.86	473	3.88	0.89	613	3.88	0.88
Utility Value of Math	140	3.58	0.74	475	3.54	0.76	615	3.55	0.75
I believe statistical skills are useful in the real-world.	140	3.64	0.84	474	3.57	0.96	614	3.58	0.93
I believe I will be able to use math or statistics in my future career when needed.	139	3.45	0.85	475	3.32	0.98	614	3.35	0.95
I do not see the value of mathematics in real-life.[a]	140	3.63	0.96	474	3.74	0.96	614	3.71	0.96
Relatedness									
Community and Teamwork	140	3.22	0.76	475	3.31	0.88	615	3.29	0.85
Working on a team makes me nervous.[a]	140	3.42	0.88	473	3.40	1.05	613	3.40	1.01
Participating in community activities is stressful.[a]	139	3.04	0.91	474	3.23	1.01	613	3.18	0.99
Items not included in final factors[b]									
I feel stressed when listening to math or statistics instructors in class.[a]	139	3.12	1.10	473	3.05	1.19	612	3.07	1.17
I feel confident when using statistics outside of school.	138	2.90	0.89	469	2.91	0.96	607	2.90	0.94
I worry I will not be able to understand statistics.[a]	140	2.96	0.92	473	2.85	1.08	613	2.88	1.05
I get nervous when I speak to people I do not know.[a]	140	2.82	1.00	474	2.82	1.13	614	2.82	1.10
I worry that I will not be able to use math or statistics in my future career when needed.[a]	139	3.27	1.05	469	3.33	1.00	608	3.32	1.01
I get nervous when I have to use math or statistics outside of school.[a]	138	3.19	1.03	473	3.34	1.03	611	3.31	1.03
I believe working with the local community is important.	140	4.02	0.75	474	4.04	0.79	614	4.04	0.78
I believe I work effectively with others.	140	3.92	0.74	474	3.87	0.86	614	3.88	0.83

Note. [a] Reverse Coded; [b] Items excluded based on factor analysis and reliability test results.

Research Question 1

Categorical Variables

Chi-square tests for independence were conducted to find if there were statistically significant differences between service-learning and non-service-learning students regarding gender, race/ethnicity, student classification, financial aid variables, transfer credit, and full-time status, respectively. Chi-square results are displayed in Table 8. The variables where differences between section groups proved to be statistically significant included race/ethnicity, χ^2 (4, n = 615) = 11.861, $p < .05$ and full-time status, χ^2 (1, n = 615) = 9.571, $p < .01$.

Table 8

Chi-Square Tests for Categorical Variables

Variables	n	χ^2	df	p
Gender	615	1.850	1	.174
Race/Ethnicity	615	11.861	4	.018*
Classification	615	4.563	3	.207
Scholarship	615	1.187	1	.276
Loan	615	0.340	1	.560
Grant	615	1.957	1	.162
Transfer credit	615	0.081	1	.776
Full-time status	615	9.571	1	.002**

Note. * $p < .05$; ** $p < .01$

Continuous Variables

To further investigate RQ1, I conducted independent samples t-tests to determine whether there was a statistically significant difference in continuous variables, including age, SAT/ACT math scores, and semester credit hours (SCH) completed, between service-learning and non-service-learning students. As shown in Table 9, the mean difference in age was statistically significant, t (464.8) = 3.214, $p < .01$, signifying that service-learning students were younger (M = 18.98, SD = 1.90) than the non-service-learning students (M = 19.73, SD = 3.76). Levene's test indicated unequal variances assumed ($F = 11.623$, $p < .01$).

Table 9

Means, Standard Deviations, and t-Test Results for Continuous Variables

	Service-Learning		Non-Service-Learning		*t*	*df*	*p*	Confidence Interval	
Variables	*M*	*SD*	*M*	*SD*				Lower	Upper
Age	18.98	1.90	19.73	3.76	3.214	464.8	.001**	0.29	1.22
SAT/ACT math score	544.17	73.68	544.17	75.42	0.000	535.0	1.00	-14.97	14.96
SCH completed	17.45	11.52	19.40	20.20	1.448	407.2	.148	-0.70	4.59

Note. ** $p < .01$

Research Question 2

The results of the chi-square analysis were also used to find any difference between service-learning and non-service-learning students regarding their mathematics performance. Cross-tabulations for the pass/fail variable and the percentages of students within each group are provided in Table 10. Differences between section groups proved to be statistically significant in terms of passing the course with an A, B, or C, χ^2 (1, $n = 615$) = 14.642, $p < .001$. This result confirmed that students who participated in the service-learning section of the statistics course were more likely to pass the course than students who did not participate in service-learning.

Table 10

Cross-Tabulations for Pass/Fail Course Variable

Variable	Service-Learning (SL)			Non-Service-Learning (NSL)			Total	
	n	*% within SL*	*% within P/F*	*n*	*% within NSL*	*% within P/F*	*n*	*%*
Pass (A,B,C)	125	89.3	26.3	351	73.9	73.7	476	77.4
Fail (D,F,W)	15	10.7	10.8	124	26.1	89.2	139	22.6
Total	140	100.0	22.8	475	100.0	77.2	615	100.0

Research Question 3

To determine any significant differences between service-learning and non-service-learning students in regards to their motivation during the semester, I conducted independent samples *t*-tests on the averaged student responses to the survey items and the six motivational factors. Only one survey item, ‘participating in community activities is stressful,’ showed a statistically significant difference between service-learning and non-service-learning students, $t(246.7) = -2.127$, $p < .05$ with unequal variances assumed based on Levene’s test results ($F = 6.179$, $p < .05$). Because this question was reversed coded, this finding indicated that service-learning students ($M = 3.04$, $SD = 0.91$) were more stressed by the participation in community activities than their non-service-learning counterparts ($M = 3.23$, $SD = 1.01$).

Although the differences were not statistically significant, the means were lower for service-learning students than those of non-service-learning students for the self-efficacy of math, the self-efficacy of public speaking, the anxiety of asking math questions, the importance of math, and community and teamwork. Since questions related to math anxiety were also reverse coded, the lower means on this factor indicate that the service-learning students had higher anxiety than the non-service-learning students. Service-learning students reported higher average scores for the utility value of math when compared to non-service-learning students. Full results, including each survey item, are presented in Table 11 for service-learning and non-service-learning students.

Table 11

Means, Standard Deviations, and t-Test Results for Motivational Factors

Survey Item	Service-Learning		Non-Service-Learning		*t*	*df*	*p*	Confidence Interval	
	M	*SD*	*M*	*SD*				Lower	Upper
Competence									
Self-Efficacy of Math	2.90	0.74	2.94	0.81	0.510	613	.610	-0.11	0.19
I worry that I will not be able to get a good grade in my mathematics course.[a]	2.71	1.05	2.75	1.15	0.369	612	.712	-0.17	0.25
I worry that I will not be able to get an "A" in my statistics course.[a]	2.49	0.97	2.47	1.08	-0.202	249.2	.840	-0.21	0.17
I believe I can get an "A" when I am in a mathematics course.	3.44	1.07	3.36	1.12	-0.737	612	.462	-0.29	0.13
I feel confident when taking a mathematics test.	2.68	0.83	2.80	0.98	1.234	612	.218	-0.07	0.29
I believe I am the type of person who can do mathematics.	3.30	0.96	3.38	1.08	0.826	252.9	.409	-0.11	0.27
I believe I can understand the content in a math or statistics course.	3.47	0.78	3.57	0.85	1.238	611	.216	-0.06	0.26
I get tense when I prepare for a math or statistics test.[a]	2.22	1.04	2.27	1.12	0.509	603	.611	-0.15	0.26
Self-Efficacy of Public Speaking	2.79	1.15	2.90	1.17	0.990	611	.322	-0.11	0.33
I feel confident when speaking in public.	2.85	1.18	2.94	1.23	0.727	609	.468	-0.15	0.32
I am comfortable giving presentations in front of the class.	2.73	1.22	2.87	1.23	1.167	611	.244	-0.09	0.37
Anxiety of Asking Math Questions	2.78	0.85	2.81	0.87	0.325	613	.745	-0.14	0.19
I get nervous when asking questions in my math class.[a]	2.61	1.06	2.65	1.13	0.429	612	.668	-0.16	0.26

I am afraid to give an incorrect answer during my statistics class.[a]	2.24	1.00	2.35	1.09	1.076	609	.282	-0.09	0.31
I feel confident enough to ask questions in my math class.	3.49	0.94	3.43	1.01	-0.675	613	.500	-0.25	0.12
Autonomy									
Importance of Math	4.11	0.69	4.12	0.71	0.204	611	.839	-0.12	0.15
It is important to me to do well in a math or statistics course.	4.33	0.67	4.36	0.73	0.470	605	.639	-0.10	0.17
Understanding the course content in a math or statistics course is important to me.	3.88	0.86	3.88	0.89	0.019	611	.985	-0.17	0.17
Utility Value of Math	3.58	0.74	3.54	0.76	-0.551	613	.582	-0.18	0.10
I believe statistical skills are useful in the real-world.	3.64	0.84	3.57	0.96	-0.901	255.6	.368	-0.24	0.09
I believe I will be able to use math or statistics in my future career when needed.	3.45	0.85	3.32	0.98	-1.610	255.8	.109	-0.30	0.03
I do not see the value of mathematics in real-life.[a]	3.63	0.96	3.74	0.96	1.129	612	.259	-0.08	0.29
Relatedness									
Community and Teamwork	3.22	0.76	3.31	0.88	1.164	256.6	.246	-0.06	0.24
Working on a team makes me nervous.[a]	3.42	0.88	3.40	1.05	-0.194	265.8	.846	-0.19	0.16
Participating in community activities is stressful.[a]	3.04	0.91	3.23	1.01	2.127	246.7	.034*	0.01	0.37

Note. [a] Reverse Coded; * $p < .05$

Research Question 4

Stepwise binary logistic regression analysis was conducted to determine if a linear combination of independent sociodemographic, academic, and motivational variables, as well as participation in service-learning had a significant relationship with the likelihood of successfully completing the gateway mathematics course. Because of the large number of independent variables, the stepwise procedure was used to determine which specific variables made a meaningful contribution to the overall probability of passing the course. As this process progressed, each model was an improvement over the one before it because variables were reassessed to determine whether they continued to serve as substantial contributors in conjunction with each new set of variables. A total of three binary logistic models were created with only demographic variables in Model 1, sociodemographic, academic, and service-learning variables in Model 2, and then sociodemographic, academic, service-learning, and motivational variables in the third and final model.

Model 1

As shown in Table 12, the three demographic variables included gender, race/ethnicity, and age. The binary pass/fail variable was the outcome variable representing mathematics performance for all students.

Regression results indicated that the overall fit of the model with gender, race/ethnicity, and age was questionable (-2 Log likelihood = 519.33). However, the Hosmer and Lemeshow test showed the model to be reliable in distinguishing between successful or unsuccessful course outcomes, χ^2 (8) = 7.485, p = .485. Model 1 produced several significant findings, had a Nagelkerke R square value of 0.078, and accurately classified 80.2% of the participants. The findings are interpreted in terms of the odds ratios that indicate the likelihood of a student passing the course. For instance, the likelihood of success for Black students decreased by a factor of 0.345 when compared to White students. Similarly, the model produced a significant result for Latino students as their probability of success declined by a factor of 0.589 when compared to White students. Age also yielded statistically significant results, indicating that the probability for academic success reduces as students get older (β = -0.189, p < .01).

Table 12

Binary Logistic Regression Model 1 for Student Success Outcome

	Model 1					
Independent Variables	*B*	SE	*Wald*	*df*	*p*	Odds Ratio[a]
Gender (Female=ref)	0.134	0.245	0.300	1	.584	
Race/Ethnicity (White=ref)						
Asian	0.500	0.443	1.274	1	.259	
Black/African American	-1.065	0.362	8.655	1	.003**	0.345
Hispanic/Latino	-0.528	0.315	2.806	1	.094^{+}	0.589
Other[b]	-0.646	0.432	2.239	1	.135	
Age	-0.189	0.066	8.131	1	.004**	0.828
Constant	5.271	1.288	16.749	1	.000***	194.660

Note. [a] Odds ratios only reported for statistically significant coefficients.
[b] Foreign and Multiracial students; ^{+}p < .10; ** p < .01; *** p < .001

Model 2

In the second logistic regression model, the four independent academic variables of transfer credit, full-time status, SAT/ACT math score, and number of semester credit hours (SCH) completed prior to spring 2019, along with participation in service-learning were added to the original demographic variables of gender, race/ethnicity, and age. The results are provided in Table 13.

The regression results indicated that the overall fit for the second model was better, but still questionable (-2 Log likelihood = 466.340). Nevertheless, the Hosmer and Lemeshow test again showed the model to be reliable in distinguishing between successful or unsuccessful course outcomes, χ^2 (8) = 8.661, p = .372. The introduction of academic and service-learning variables in Model 2 shifted the significant findings and erased any probabilistic differences within race/ethnicity. Model 2 accurately classified 80.0% of the participants, and the Nagelkerke R square value increased to 0.218.

Table 13

Binary Logistic Regression Model 2 for Student Success Outcome

	Model 2					
Independent Variables	*B*	SE	*Wald*	*df*	*p*	Odds Ratio[a]
Block 1: Sociodemographic						
Gender (Female=ref)	0.009	0.261	0.001	1	.972	
Race/Ethnicity (White=ref)						
Asian	0.596	0.474	1.584	1	.208	
Black/African American	-0.650	0.397	2.685	1	.101	
Hispanic/Latino	-0.194	0.339	0.326	1	.568	
Other[b]	-0.568	0.465	1.492	1	.222	
Age	-0.247	0.091	7.414	1	.006**	0.781
Block 2: Academic/Service-learning						
Transfer credit on file	0.456	0.249	3.351	1	.067$^+$	1.578
Registered for > 12 hours	1.012	0.323	9.799	1	.002**	2.752
SAT/ACT math score	0.008	0.002	17.708	1	.000***	1.008
Number of SCH completed prior to spring 2019	0.023	0.009	6.152	1	.013*	1.023
Participated in service-learning	1.056	0.342	9.532	1	.002**	2.875
Constant	0.387	2.055	0.035	1	.851	

Note. [a] Odds ratios only reported for statistically significant coefficients.
[b] Foreign and Multiracial students; $^+p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$

While the differences between various races/ethnicities disappeared, a statistically significant relationship remained between age and the probability of passing the course ($p < .01$). Most notably, all four of the academic variables and participation in service-learning were statistically significant in Model 2. Students who transferred at least one course to Central University were one and a half times more likely to pass the course than students without any transfer credit on file. Additionally, full-time students who registered for at least 12 credit-hours during the spring 2019 semester were 2.752 times more likely to be successful. The most significant, positive indicator of student success in Model 2 was SAT/ACT math scores ($p < .001$), although the Odds Ratio was relatively small due to the vast range of placement scores. The regression model also showed that students with a greater number of SCH complete before enrolling in the course had a higher probability of a successful course outcome ($p < .05$). Lastly, and as the focus of this study, students who participated in the service-learning section of Elementary Statistical Analysis were almost three times more likely to achieve a passing letter grade and thus a successful outcome in the course.

Model 3

In order to determine the extent to which motivational variables affect mathematics performance, I completed one last logistic regression model. As shown in Table 14, the third and final model included the three demographic variables of gender, race/ethnicity, and age, the four academic variables of transfer credit, full-time status, SAT/ACT math score, and number of SCH completed prior to enrollment, and participation in service-learning, as well as the six independent motivational variables of self-efficacy of math, self-efficacy of public speaking, anxiety of asking math questions, importance of math, utility value of math, and community and teamwork. Again, the binary pass/fail outcome variable represented mathematics performance for all students.

Logistic regression results indicated that the overall fit improved in the final model, but was still slightly questionable (-2 Log likelihood = 437.997). Nonetheless, according to the Hosmer and Lemeshow test results, the model was reliable in distinguishing between successful or unsuccessful course outcomes, χ^2 (8) = 6.197, p = .625. The final model had a Nagelkerke R square value of 0.287 and accurately classified 82.1% of the participants.

Table 14

Binary Logistic Regression Final Model for Student Success Outcome

	Model 3 (Final model)					
Independent variables	*B*	SE	*Wald*	*df*	*p*	Odds Ratio[a]
Block 1: Sociodemographic						
Gender (Female=ref)	-0.162	0.284	0.327	1	.568	
Race/Ethnicity (White=ref)						
Asian	0.630	0.487	1.671	1	.196	
Black/African American	-0.927	0.417	4.937	1	.026*	0.396
Hispanic/Latino	-0.230	0.354	0.424	1	.515	
Other[b]	-0.576	0.497	1.343	1	.246	
Age	-0.254	0.098	6.766	1	.009**	0.776
Block 2: Academic/Service-learning						
Transfer credit on file	0.414	0.258	2.583	1	.108	
Registered for > 12 hours	1.217	0.342	12.695	1	.000***	3.378
SAT/ACT math score	0.006	0.002	8.035	1	.005**	1.006
Number of SCH completed prior to spring 2019	0.025	0.009	7.060	1	.008**	1.025
Participated in service-learning	1.076	0.353	9.279	1	.002**	2.934
Block 3: Motivation						
Self-efficacy_math	0.653	0.206	10.001	1	.002**	1.921
Self-efficacy_pubspeak	-0.113	0.114	0.986	1	.321	
Anxiety_math questions	0.331	0.180	3.393	1	.065^{+}	1.393
Importance of math	-0.245	0.185	1.754	1	.185	
Utility value of math	-0.081	0.195	0.172	1	.678	
Community/teamwork	0.181	0.155	1.363	1	.243	
Constant	-0.215	2.412	0.008	1	.929	

Note. [a] Odds ratios only reported for statistically significant coefficients.
[b] Foreign and Multiracial students; $^{+}p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$

The statistically significant results within the race/ethnicity category returned in the final model. The odds ratio of 0.396 indicates that Black students are less likely than White students to achieve a successful course outcome after controlling for all other factors in the model. Other findings suggest that older students are also less likely to pass the course when compared to younger students ($p < .01$). In the final model, full-time status proved to have the most significant relationship with student performance, as students who registered for at least 12 credit-hours in the spring term of 2019 were 3.378 times more likely to be successful than students who registered for less than 12 credit-hours of classes.

Higher scores on the math portion of the SAT/ACT placement test, as well as successful completion of a greater number of SCH prior to course enrollment, also proved to have a significant positive relationship with the likelihood of passing the course ($p < .01$). Furthermore, the active-learning course intervention increased the likelihood of student success because students who participated in the service-learning section of Elementary Statistical Analysis were almost three times more likely to achieve a passing letter grade in the course than students in the non-service-learning sections. In terms of student motivation, only factors within the competence construct produced statistically significant results. For each unit increase in the score of math self-efficacy, students were twice as likely to achieve a passing letter grade ($p < .01$). Additionally, the odds ratio of 1.393 indicates that students with higher scores on the anxiety of asking math questions scale were more likely to be successful in the course ($p < .10$). Because negative versions of the anxiety questions were reverse coded, a higher anxiety score means the more successful students were calmer and had less anxiety in their mathematical environment.

Chapter 4 Summary

The sample for this study included 615 participants who completed the online survey instrument. Of these respondents, 140 students were enrolled in a service-learning section of Elementary Statistical Analysis at Central University, and 475 were enrolled in a non-service-learning section. Statistically significant differences between section groups were observed within race/ethnicity, age, full-time status, and math performance variables. There were minimal differences between populations in student motivational factors, with only one survey item 'participating in community activities is stressful' showing a statistically significant difference between service-learning and non-service-learning students. Logistic regression analysis showed race/ethnicity, age, full-time status, SCH completed, SAT/ACT math scores, participation in service-learning, and competence measured by math self-efficacy and anxiety to have significant relationships with the probability of student success in their gateway math course. The results provided a reliable model in distinguishing between successful or unsuccessful course outcomes and illuminated factors that increase students' probability of success in mathematics.

CHAPTER 5: CONCLUSION

In this chapter, I begin with a brief summary of the present study and then discuss the results as related to sociodemographic, academic, service-learning, and motivational factors that influence mathematics achievement. The results of the statistical analysis support all conclusions. The chapter concludes with the limitations of the study, recommendations for policy, practice, and future research, and a final summary.

Summary of the Study

The purpose of this study was to determine the extent to which students' sociodemographic characteristics, academic background, motivation, and participation in service-learning affect their academic performance in college-level mathematics. An examination of differences in sociodemographic characteristics, academic background, motivation, and mathematics achievement between service-learning and non-service-learning students was also a central focus of the present study. Self-reported data from students enrolled in a gateway Elementary Statistical Analysis mathematics course at Central University gave insight into pertinent factors related to students' math perceptions, sociodemographic characteristics, academic background, and motivation.

The exploration of the literature supported the notion that student motivation impacts student success in gateway mathematics courses. The research confirmed an existing interrelationship between students' basic psychological needs, and motivational factors such as self-efficacy, anxiety, perception of the importance and utility value of math, and soft skills. These connections led to the use of the self-determination theory as a guiding theoretical framework for the study.

Based on the literature and the theoretical framework, research questions were developed to investigate two primary areas of inquiry: (1) to determine any differences between students enrolled in mathematics courses with a service-learning component and those enrolled in mathematics courses without a service-learning component regarding their sociodemographic characteristics, academic background, motivation during the semester, and their mathematics performance; and (2) to determine the extent to which students' sociodemographic characteristics, academic background, motivation, and participation in service-learning relate to their mathematics performance. To examine the research questions, this study used an *ex post facto* research design with survey methods to collect data for quantitative analyses to investigate factors related to student success in math. Students enrolled in an on-campus section of Elementary Statistical Analysis ($N = 743$) were invited to participate in the study and complete an online questionnaire containing math perception, demographic, and academic background questions. All participants who completed the survey in its entirety were included in the sample ($n = 615$).

The study results are expected to help administrators and educators to understand factors that affect academic success in gateway mathematics courses, and subsequently, the attainment of a baccalaureate degree (Callahan & Belcheir, 2017). As discussed in the next section, the data corroborated the literature reviewed for this study and revealed how service-learning, a specific active-learning approach, can help educators break the destructive student cycle of reduced motivation, negative math perceptions, and poor outcomes in math, by engaging students with the community to heighten success in mathematics and promote degree completion (Lopez & Jones, 2017; Roberts, 2019; Wright et al., 2019).

Discussion of Results

Chi-square and independent samples t-test analysis procedures were used to determine if there were any differences between service-learning students and non-service-learning students regarding their sociodemographic characteristics, academic background, mathematics performance, and motivation. The results indicated statistically significant differences in race/ethnicity, age, full-time status, course grades, and stress from working with the community. Quantifying the extent to which students' sociodemographic characteristics, academic background, participation in service-learning, and motivation related to their mathematics performance was the predominant focus of this study. The final logistic regression model showed race/ethnicity, age, full-time student status, semester credit hours (SCH) completed, SAT/ACT math scores, participation in service-learning, and competence measured by math self-efficacy and math anxiety had a statistically significant effect on the likelihood of students passing their gateway math course with an A, B, or C.

Sociodemographic Characteristics

Race/ethnicity. Student success is largely dependent upon a student's individual characteristics (Bloemer et al., 2017). The present study showed racial differences in the section groups and Black students to be less likely than White students to achieve a successful course outcome after controlling for all other factors in the model. Kitsantas et al. (2011) also concluded that race and ethnicity predict mathematics achievement. Similarly, Shechter et al. (2011) found cultural background to be a mitigating factor in how students respond to course curriculum, and Shores et al. (2020) pointed directly to academic opportunity and racial socioeconomic inequalities as reasons why White students commonly outperform their Black counterparts.

Age. Variations in student backgrounds may explain why some students were drawn to enroll in a service-learning course while others were not. On average, the service-learning students in this study were slightly younger than the non-service-learning students, and the findings suggested older students were less likely to pass the course when compared to younger students. Older students tend to have more off-campus responsibilities than younger students, which may occupy their time (Arnold et al., 1993). Previous research also illustrated that students' interest in math declines as students age (Chouinard & Roy, 2008). The steady decrease in perceptions of the utility value of mathematics and the waning of the personal relevance of math concepts contribute to lower performance. Since NCES (2018) projects an increase in the percentage of younger students who will attend college, it is imperative for students to complete their math requirements as early as possible.

Academic Background

Full-time status and number of SCH completed. Almost 93% of the service-learning students were enrolled in college as full-time students, whereas only 82% of the non-service-learning students were full-time. The additional demands of the service-learning curriculum to volunteer and work with the community may have deterred part-time students from participating. Therefore, section group differences may be a result of part-time students needing to work or fulfill other obligations, rather than joining the service-learning section. Whether or not a student can attend college full-time and the number of semester credit hours (SCH) into which they can enroll are factors that influence student success. Students who registered for at least 12 credit-hours were more likely to be successful than students who registered for less than 12 credit-hours of classes. Relatedly, students who had completed a greater number of SCH prior to course enrollment outperformed those with fewer finished courses. These findings directly align with the literature that speaks to academic opportunities, socioeconomic inequalities, and non-academic obligations (Arnold et al., 1993; Shores et al., 2020). Students who are unable to focus on school full-time take fewer classes and have non-collegiate commitments that divert scholastic efforts and reduce success rates.

SAT/ACT math scores. The next student characteristic that proved to be highly indicative of success in mathematics was students' SAT/ACT math scores. In the literature reviewed for this study, scores on the SAT/ACT and student GPA were prevalent predictors of student success (Camara & Echternacht, 2000; Kusurkar et al., 2013; Robbins et al., 2004; Zwick & Sklar, 2005). Thus, it is no surprise that higher scores on the math portion of the SAT/ACT placement exam would increase students' likelihood of passing their gateway mathematics course.

Mathematics performance. Next, it was imperative to determine if there was a difference between service-learning and non-service-learning students regarding their mathematics performance. Over 89% of service-learning students in the sample passed the course with an A, B, or C, compared to nearly 74% of non-service-learning students. Chi-square tests for independence confirmed this difference between the section groups of service-learning and non-service-learning students in terms of their pass rates and math achievement as statistically significant. This finding indicates that students in a gateway mathematics course with a service-learning component may be more likely to pass than those in traditional math courses without service-learning curriculum.

Motivational Factors

Considering Deci and Ryan's (1985a) theory of self-determination, a principal focus of this study aimed to investigate any differences between service-learning and non-service-learning students regarding their motivation during the semester. The independent samples *t*-tests of the six motivational factors (i.e., self-efficacy of math, self-efficacy of public speaking, anxiety of asking math questions, importance of math, utility value of math, and community and teamwork), did not yield any statistically significant differences between service-learning and non-service-learning students. However, one survey item within the relatedness construct, 'participating in community activities is stressful,' showed a statistically significant difference between service-learning and non-service-learning students. While the findings of the present study showed minimal motivational differences in section groups, items within the motivational construct of competence produced statistically significant results.

Competence. In alignment with the self-determination theory (Deci & Ryan, 1985a), educational environments that support students' basic physiological needs for competence, autonomy, and relatedness, enhance their academic motivation and performance (Boggiano et al., 1993). Since intrinsic motivation is propelled by students' competence (Deci & Ryan, 1991) and is the most self-determined source of behavior (Ryan & Deci, 2000a), it is not startling that competence proved to be the only motivational construct that increased students' probability of math success in this study. This finding is in agreement with other research that indicated a positive association between competence and students' collegiate grade point average (Guiffrida et al., 2013). Furthermore, the literature reviewed for this study highlighted that students' academic motivation is influenced by students' perceptions of their competence (Zimmerman et al., 1992) and greatly contributes to their mathematics performance (Murayama et al., 2013; Singh et al., 2002).

The findings of this study also align with Ryan and Deci's (2000a) notion that internal forces of motivation tend to be stronger than external stimulants on the SDT continuum. Fostering the need for competence leads to higher levels of intrinsic motivation (Deci & Vansteenkiste, 2004; Ryan & Deci, 2000b, 2000b) and is positively associated with scholastic outcomes (Vecchione et al., 2014). Moreover, competence stems from students' self-efficacy and mathematical anxiety. The literature showed a direct relationship between self-efficacy and math anxiety (Azar & Mahmoudi, 2014), and how students' perceptions of mathematical self-efficacy and anxiety affected their math performance (Justicia-Galiano et al., 2017). Therefore, the present study confirms that high self-efficacy and low or controlled anxiety enhances students' academic motivation and achievement because their inherent need for competence is being supported.

Math self-efficacy. Students in this study with higher rates of math self-efficacy were more likely to achieve a passing letter grade in their gateway mathematics course, than those with lower self-efficacy scores. As Bandura (1993) stated, "among the mechanisms of agency, none is more central or pervasive" (p. 118) than student's self-efficacy beliefs. The literature showcased self-efficacy, which is widely recognized as one of the most accurate predictors of student achievement, as a frequent assessment of student success in collegiate-level mathematics courses (Hall & Ponton, 2005; Pajares, 1996; Robbins et al., 2004; Zientek et al., 2014). The present findings concur with previous research that has shown math self-efficacy to be a positive predictor of motivation (Salazar, 2018) and a highly significant predictor of student success (Kitsantas et al., 2011). Therefore, educators should continue to develop curriculum that fosters students' sense of math self-efficacy, especially if the activities also reduce anxiety.

Math anxiety. The results indicated that students with higher scores, meaning less anxiety, on the anxiety of asking math questions scale were more likely to be successful in the course. While some research has indicated that students with moderate levels of anxiety have enhanced performance (Wang et al., 2015), the majority of the literature reviewed for this study indicate that math anxiety reduces students' likelihood for success (Anis et al., 2016; Ashcraft, 2002; Foley et al., 2017; Justicia-Galiano et al., 2017; Perry, 2004; Suárez-Pellicioni et al., 2016). The findings in the present study agree with the majority and show that math anxiety directly affects outcomes in math. Since math anxiety is quite common among college students (Betz, 1978; Chang & Beilock, 2016; Perry, 2004), it is important that educators implement service-learning and other course components that reduce student apprehension.

Autonomy. Service-learning and non-service-learning students showed no significant differences in their autonomous motivation measured by student perceptions of the importance of math and the utility value of math. This construct also did not yield significant results in the logistic models. However, course curriculum that enhances the application of mathematics in the real world is of great value to math students and contributes to their academic motivation (Harackiewicz et al., 2016; Henrich et al., 2016; Hydorn, 2007).

Deci and Ryan (2000) suggested that all types of motivation are reinforced as students' basic needs are supported throughout the continuum of intrinsic and extrinsic sources. Therefore, identified and integrated forms of autonomous self-regulation bolster more self-determined behaviors. Furthermore, previous research indicated that interest in mathematics is highly correlated with self-efficacy beliefs (Pantziara & Philippou, 2015) and that student perceptions of utility value and self-efficacy in mathematics are interrelated (Canning & Harackiewicz, 2015; Shechter et al., 2011). Thus, students' autonomous motivations may be contributing to their competence and indirectly influencing their mathematics achievement. Further research is needed to understand these connections and their relation to service-learning projects and student success in math courses.

Relatedness. The statistically significant difference between populations on one survey item within the relatedness construct indicates that service-learning students found working with the community to be slightly more stressful than non-service-learning students. By definition, service-learning is an educational experience in which students meet the need of a community organization and reflect on the activity to further their understanding of course content, broaden their appreciation of the discipline, and enrich their sense of civic responsibility (Jones, 2003). Since service-learning students were immersed in community activities that directly related to their course grades and learning, they may have encountered more stress in this area when compared to non-service-learning students.

Service-learning experiences are designed to stretch students' use and development of soft skills (Astin et al., 2000), which include career-necessary abilities such as teamwork, conflict resolution, professionalism, communication, and presentation skills (Robles, 2012). As an extrinsic form of motivation, the relatedness found in community activities draws heavily on students' need to be connected to others (Deci & Ryan, 2000). However, external regulation and introjected regulation are the least self-determined parameters, initiated by the expectation of rewards, such as grades. Therefore, service-learning students may have felt more pressure to perform in order to feel worthy in front of their peers (Gagné & Deci, 2005). Similar to Ryan and Deci's (2000a) conclusion, students are more likely to engage in activities in which others find value. Thus, the benefits of working on a team to help the community (Johnson et al., 1991; Smith, 1996) outweighed any personal costs.

Service-Learning

As a focal finding of this study, the active-learning course intervention increased the probability of student success in mathematics. Students enrolled in the service-learning section of Elementary Statistical Analysis were more likely to achieve a passing letter grade in the gateway math course than students in non-service-learning sections. This finding is monumental because the lack of service-learning research in mathematics was one of the investigative reasons for the present study. Numerous findings in other disciplines have shown service-learning to have positive effects on student achievement (e.g., Azizan et al., 2018; Batchelder & Root, 1994; Dienhart et al., 2016; Stevens, 2015; Warren, 2012; Yorio & Ye, 2012). Previous research has also publicized how service-learning heightens student learning by developing motivation, self-efficacy, soft skills, and engagement in the classroom (Astin et al., 2000; Conway et al., 2009), increases students decision-making, social reasoning, and empathy (Batchelder & Root, 1994), and contributes to student development (Phelps & Dostilio, 2008).

For math, previous service-learning research indicated that community projects provided opportunities for students to learn the value and application of mathematics in a real and meaningful way (Hydorn, 2007), and had positive effects on the math attitudes of students (Henrich et al., 2016). The literature concluded that service-learning increases self-efficacy, resolves anxiety, helps shape positive perceptions of math, and builds interpersonal skills (Barr & Wessel, 2017; Nealy, 2005; Peters, 2013), but the question remains as to how these concepts interact with one other to increase students' likelihood of success. The present study showed that service-learning is an essential component to success for math students. However, future research is needed to explain sociodemographic differences among service-learning and non-service-learning students and to parse out reasons why service-learning positively impacts student achievement in math and how it helps to facilitate degree completion.

These findings address the gap in service-learning mathematics research and align with other results in the literature that have shown service-learning interventions to increase student achievement (e.g., Azizan et al., 2018; Henrich et al., 2016; Hydorn, 2007). This is especially important because activities and programs designed to sustain achievement in mathematics can keep students progressing toward course and degree-completion (Buckley et al., 2016).

Therefore, service-learning students are more likely to complete their gateway math courses and advance in their pursuit of a baccalaureate degree.

In conclusion, the present study showed race/ethnicity, age, full-time student status, semester credit hours (SCH) completed, SAT/ACT math scores, competence measured by math self-efficacy and anxiety, and participation in service-learning to have significant relationships with the probability of student success in their gateway math course. The results of this study provide implications for administrators and educators to understand the factors that affect academic success in gateway mathematics courses and degree attainment. Therefore, these factors should be considered when developing curriculum and programs to combat student attrition. Specific recommendations include using service-learning curriculum in mathematics to break the student cycle of reduced motivation, negative math perceptions, and poor outcomes in math by engaging students with the community to heighten success in mathematics. Before discussing additional recommendations for policy, practice, and future research, I present the limitations of the study and then conclude the chapter with a final summary.

Limitations of the Study

It is important to note that several limitations constrained the present study. One of the cornerstones to creating a reliable survey instrument is the need to reduce measurement error whenever possible (Dillman, Smith, & Christian, 2014). However, the content and timing of this study did not allow for a pilot study to improve the set of questions. Since it is essential that survey questions adequately measure the concepts of interest, factor analysis ensured minimal overlap between measurements in the different groups of variables (Mertler & Reinhart, 2017).

Some limitations are inherent to survey research, including the use of self-report questionnaires (Pajares, 1996). Unlike demographic questions, items related to student perceptions increase response time because students have to think through their answers (Dillman et al., 2014). Students may have been influenced by the order and the context of the questions, may not have understood the questions, or may have struggled to recall information.

This study focused on specific course and instructional aspects, but I could not control for varying instructors' abilities, backgrounds, personalities, and interactions with the students. Since the theory of self-determination guided this study, all findings were viewed through the lens of student motivations derived from their perceptions of their mathematical abilities. Therefore, the character of the students who responded to the survey must be considered a limitation as well. Students who are more motivated to participate in academic tasks may have been more inclined to take the time to complete a survey than those who chose not to participate. Thus, both individual instructors and the students themselves brought some variance into the results.

Lastly, the data were collected at a single institution and from one mathematics course, so readers should be cautious of overgeneralizing the findings for implications at other schools and courses. Despite these limitations, this study provided valuable insight as to how curriculum design and community outreach can help students to overcome challenges and struggles, particularly in gateway mathematics courses at a four-year institution.

Recommendations for Policy, Practice, and Future Research

Policy and Practice

Based on the findings in this study, educators and administrators should develop policies and curricula that consider students' sociodemographic characteristics and academic background. This study indicated that Black students underperform when compared to their White counterparts. Therefore, it is particularly important to support the academic efforts of Black students in mathematics. To address racial inequalities, culturally relevant curriculum and service-learning projects could be considered. Since cultural background affects student's interests and how they respond to math curriculum, faculty could strive to partner with diverse community organizations to heighten student motivation. To overcome logistical hurdles and implement such projects successfully, faculty might require administrative support from the institution. Thus, four-year universities could consider providing clerical support, funding, training, load-reductions, and other resources to encourage culturally relevant active-learning initiatives.

This study also indicated that younger students have a greater likelihood of success in their math courses when compared to older students. To assist and help guide older students, higher education institutions could implement a policy that encourages students to take their math courses early in their academic journey. A policy of this nature would be especially helpful and logistically possible for students in majors that only require one or two math courses for their degree. Research also indicated that older students and those who attend school part-time often have non-academic obligations that prohibit them from focusing solely on their academic work. Since this study discovered that part-time students are less likely to achieve success in their gateway math courses, administrative considerations could include providing scholarships for struggling students so that they do not have to choose between meeting their non-academic obligations and participating in beneficial classroom and community activities. Relatedly, completion of more semester credit hours (SCH) was also associated with an increase in the probability of success for the students in this study, so institutions could ensure that older and part-time students have access to ample tutoring, on-campus day-cares, or other resources that might facilitate enrolling in additional courses and help them be successful in all courses in which they are registered.

As shown in the present study, motivational factors also contribute to student success in gateway mathematics courses. In particular, the findings of this study indicated that activities that foster student competence heighten student achievement and increase students' likelihood of passing their math courses. Educators could create activities that heighten and reinforce self-efficacy as well as reduce student anxiety. Additionally, curricular interventions that demonstrate the utility value of mathematics, increase peer interaction, and partner with the community are of great benefit to math students. For instance, the ability to communicate and work on a team is especially essential for first-year college students in entry-level classes. Instructors could strive to embed soft skills in their curricular initiatives so that students can build interpersonal skills while learning the course content.

Service-learning and other active-learning strategies have shown to heighten student motivation, improve academic success, and have overall positive effects for students. This study has shown that embedding service-learning activities into a math course enhances student achievement. Therefore, service-learning components could be added to mathematics courses when feasible to increase probabilities of student success and student motivation. Doing so will help to break the repetitive cycle of negative perceptions of mathematics, poor outcomes in math, and low self-efficacy, and facilitate student success in mathematics courses and the attainment of undergraduate degrees.

Future Research

Providing students with the opportunity to learn the value and application of mathematics in a real and meaningful way through service-learning projects has proven to heighten success in math. However, future research is needed to parse out reasons why service-learning positively impacts the math achievement of students with various sociodemographic characteristics and academic backgrounds and how it helps to facilitate degree completion. It is important to understand what factors draw some students to service-learning projects while other students choose not to participate in such activities.

Additional research is also necessary to determine how the integration of service-learning components in mathematical curriculum may impact students' perceptions of self-efficacy in mathematics, math anxiety, the importance and the utility value of math, and soft skills. Survey questions could be added to the ones used in the present study to further the research on student motivation factors. While motivational factors within the competence construct directly attributed to student success in this study, other autonomous and relatedness motivations may have indirectly influenced students' mathematics achievement. Further research is needed to understand these possible connections and their relation to service-learning projects and student success in math courses. This study also illuminated ways community teamwork heightens performance in mathematics classrooms, so additional research should focus on how various soft skills affect the motivation of math students and their performance.

Finally, qualitative research should be used to investigate how students respond to math service-learning projects. The nature of service-learning curriculum incorporates a significant amount of reflective essays and discussions, so researchers could glean information from these sources to inform the direction for more quantitative studies of service-learning in mathematics. Service-learning research efforts or all types should be expanded to other gateway and advanced math courses as well as focused on examining different locations. Since service-learning helps to increase student success, it would be a worthwhile endeavor to investigate how such projects impact students at other institutions and in other mathematics courses.

Final Summary

In conclusion, perceived motivation factors such as self-efficacy, anxiety, subject importance and value, and the development of soft skills both directly and indirectly influence personal decision-making and achievement. The impact of self-determination theory on how one is motivated to conquer certain tasks has a significant bearing on student academic success. Furthermore, active-learning instructional strategies, such as service-learning, enhance motivation and scholastic success to keep students progressing toward course and degree-completion. However, substantial variance in student achievement remains to be explained, and future research efforts need to focus on factors that influence student motivation and performance, particularly in the field of mathematics.

References

Abel, J. R., & Deitz, R. (2014). Do the benefits of college still outweigh the costs? *Current Issues in Economics and Finance*, *20*(3), 1–11.

Abes, E. S., Jackson, G., & Jones, S. R. (2002). Factors that motivate and deter faculty use of service-learning. *Michigan Journal of Community Service Learning*, *9*(1), 5–17.

Ahmed, W., Minnaert, A., Kuyper, H., & van der Werf, G. (2012). Reciprocal relationships between math self-concept and math anxiety. *Learning and Individual Differences*, *22*(3), 385–389. https://doi.org/10.1016/j.lindif.2011.12.004

Anis, Y., Krause, J. A., & Blum, E. N. (2016). The relations among mathematics anxiety, gender, and standardized test performance. *Research in the Schools*, *23*(2), 28–37.

Arnold, J. C., Kuh, G. D., Vesper, N., & Schuh, J. H. (1993). Student age and enrollment status as determinants of learning and personal development at metropolitan institutions. *Journal of College Student Development*, *34*(1), 11–16.

Arreaga-Mayer, C. (1998). Increasing active student responding and improving academic performance through classwide peer tutoring. *Intervention in School and Clinic*, *34*(2), 89–94. https://doi.org/10.1177/105345129803400204

Artino, A. R. (2012). Academic self-efficacy: From educational theory to instructional practice. *Perspectives on Medical Education*, *1*(2), 76–85. https://doi.org/10.1007/s40037-012-0012-5

Ashcraft, M. H. (2002). Math anxiety: Personal, educational, and cognitive consequences. *Current Directions in Psychological Science*, *11*(5), 181–185. https://doi.org/10.1111/1467-8721.00196

Ashcraft, M. H., & Faust, M. W. (1994). Mathematics anxiety and mental arithmetic performance: An exploratory investigation. *Cognition and Emotion*, *8*(2), 97–125. https://doi.org/10.1080/02699939408408931

Ashcraft, M. H., & Ridley, K. S. (2005). Math anxiety and its cognitive consequences. In J. I. D. Campbell (Ed.), *Handbook of mathematical cognition* (pp. 315–327). New York, NY: Psychology Press.

Astin, A., Vogelgesang, L., Ikeda, E., & Yee, J. (2000). How service learning affects students. *Higher Education*. Retrieved from https://digitalcommons.unomaha.edu/slcehighered/144

Azar, F. S., & Mahmoudi, L. (2014). Relationship between mathematics, self-efficacy and students' performance in statistics: The meditational role of attitude toward mathematics and mathematics anxiety. *Journal of Educational Sciences and Psychology*, *4*(1), 32–42.

Azizan, M. T., Mellon, N., Ramli, R. M., & Yusup, S. (2018). Improving teamwork skills and enhancing deep learning via development of board game using cooperative learning method in Reaction Engineering course. *Education for Chemical Engineers*, *22*, 1–13. https://doi.org/10.1016/j.ece.2017.10.002

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191–215. https://doi.org/10.1037/0033-295X.84.2.191

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall, Inc.

Bandura, A. (1989). Human agency in social cognitive theory. *American Psychologist*, *44*(9), 1175–1184. https://doi.org/10.1037/0003-066X.44.9.1175

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist*, *28*(2), 117–148.

Barr, D., & Wessel, L. (2017). Rethinking course structure: Increased participation and persistence in introductory post-secondary mathematics courses. *Fields Mathematics Education Journal*, *3*(1), 1–13. https://doi.org/10.1186/s40928-017-0004-8

Batchelder, T. H., & Root, S. (1994). Effects of an undergraduate program to integrate academic learning and service: Cognitive, prosocial cognitive, and identity outcomes. *Journal of Adolescence*, *17*(4), 341–355. https://doi.org/10.1006/jado.1994.1031

Beilock, S. L., & Maloney, E. A. (2015). Math anxiety: A factor in math achievement not to be ignored. *Policy Insights from the Behavioral and Brain Sciences*, *2*(1), 4–12. https://doi.org/10.1177/2372732215601438

Betz, N. E. (1978). Prevalence, distribution, and correlates of math anxiety in college students. *Journal of Counseling Psychology*, *25*(5), 441–448. https://doi.org/10.1037/0022-0167.25.5.441

Betz, N. E., & Hackett, G. (1983). The relationship of mathematics self-efficacy expectations to the selection of science-based college majors. *Journal of Vocational Behavior*, *23*(3), 329–345. https://doi.org/10.1016/0001-8791(83)90046-5

Bloemer, W., Day, S., & Swan, K. (2017). Gap analysis: An innovative look at gateway courses and student retention. *Online Learning*, *21*(3), 5–14.

Blouin, D. D., & Perry, E. M. (2009). Whom does service learning really serve? Community-based organizations' perspectives on service learning. *Teaching Sociology*, *37*(2), 120–135. https://doi.org/10.1177/0092055X0903700201

Boggiano, A. K., Flink, C., Shields, A., Seelbach, A., & Barrett, M. (1993). Use of techniques promoting students' self-determination: Effects on students' analytic problem-solving skills. *Motivation and Emotion*, *17*(4), 319–336. https://doi.org/10.1007/BF00992323

Bregant, T. (2017). Mathematical competence of a child—Life success of an adult. *Interdisciplinary Description of Complex Systems*, *14*(4), 353–359.

Bringle, R. G., Ruiz, A. I., Brown, M. A., & Reeb, R. N. (2016). Enhancing the psychology curriculum through service learning. *Psychology Learning & Teaching*, *15*(3), 294–309. https://doi.org/10.1177/1475725716659966

Buckley, S., Reid, K., Goos, M., Lipp, O. V., & Thomson, S. (2016). Understanding and addressing mathematics anxiety using perspectives from education, psychology and neuroscience. *Australian Journal of Education*, *60*(2), 157–170. https://doi.org/10.1177/0004944116653000

Butler, M. (2013). Learning from service-learning. *PRIMUS: Problems, Resources, and Issues in Mathematics Undergraduate Studies*, *23*(10), 881–892. https://doi.org/10.1080/10511970.2013.775978

Callahan, J., & Belcheir, M. (2017). Testing our assumptions: The role of first course grade and course level in mathematics and English. *Journal of College Student Retention: Research, Theory & Practice*, *19*(2), 161–175. https://doi.org/10.1177/1521025115611620

Camara, W. J., & Echternacht, G. (2000). *The SAT[R] I and high school grades: Utility in predicting success in college.* (Information Analyses Report No. CB-RN-10). Retrieved from https://eric.ed.gov/?id=ED446592

Canning, E. A., & Harackiewicz, J. M. (2015). Teach it, don't preach it: The differential effects of directly-communicated and self-generated utility–value information. *Motivation Science*, *1*(1), 47–71. https://doi.org/10.1037/mot0000015

Cate, O. T. J. Ten, Kusurkar, R. A., & Williams, G. C. (2011). How self-determination theory can assist our understanding of the teaching and learning processes in medical education. *Medical Teacher*, *33*(12), 961–973. https://doi.org/10.3109/0142159X.2011.595435

Celio, C. I., Durlak, J., & Dymnicki, A. (2011). A meta-analysis of the impact of service-learning on students. *Journal of Experiential Education*, *34*(2), 164–181. https://doi.org/10.1177/105382591103400205

Chamorro-Premuzic, T., Arteche, A., Bremner, A. J., Greven, C., & Furnham, A. (2010). Soft skills in higher education: Importance and improvement ratings as a function of individual differences and academic performance. *Educational Psychology*, *30*(2), 221–241. https://doi.org/10.1080/01443410903560278

Chamorro-Premuzic, T., & Furnham, A. (2003). Personality predicts academic performance: Evidence from two longitudinal university samples. *Journal of Research in Personality*, *37*(4), 319–338. https://doi.org/10.1016/S0092-6566(02)00578-0

Chang, H., & Beilock, S. L. (2016). The math anxiety-math performance link and its relation to individual and environmental factors: A review of current behavioral and psychophysiological research. *Current Opinion in Behavioral Sciences*, *10*, 33–38. https://doi.org/10.1016/j.cobeha.2016.04.011

Chouinard, R., & Roy, N. (2008). Changes in high-school students' competence beliefs, utility value and achievement goals in mathematics. *British Journal of Educational Psychology*, *78*(1), 31–50. https://doi.org/10.1348/000709907X197993

College Board (2018). *Guide to the 2018 ACT®/SAT® Concordance*. Retrieved from https://collegereadiness.collegeboard.org/pdf/guide-2018-act-sat-concordance.pdf

Conard, M. A. (2006). Aptitude is not enough: How personality and behavior predict academic performance. *Journal of Research in Personality*, *40*(3), 339–346. https://doi.org/10.1016/j.jrp.2004.10.003

Concannon, J. P., & Barrow, L. H. (2009). A cross-sectional study of engineering students' self-efficacy by gender, ethnicity, year, and transfer status. *Journal of Science Education and Technology*, *18*(2), 163–172. https://doi.org/10.1007/s10956-008-9141-3

Conway, J. M., Amel, E. L., & Gerwien, D. P. (2009). Teaching and learning in the social context: A meta-analysis of service learning's effects on academic, personal, social, and citizenship outcomes. *Teaching of Psychology*, *36*(4), 233–245. https://doi.org/10.1080/00986280903172969

Cragg, L., & Gilmore, C. (2014). Skills underlying mathematics: The role of executive function in the development of mathematics proficiency. *Trends in Neuroscience and Education*, *3*(2), 63–68. https://doi.org/10.1016/j.tine.2013.12.001

Davies, M. B., & Hughes, N. (2014). *Doing a successful research project: Using qualitative or quantitative methods* (2nd ed.). London, UK: Macmillan International Higher Education.

Deci, E. L., Koestner, R., & Ryan, R. M. (1999). A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. *Psychological Bulletin*, *125*(6), 627–688.

Deci, E. L., & Ryan, R. M. (1985a). *Intrinsic motivation and self-determination in human behavior*. New York, NY: Plenum.

Deci, E. L., & Ryan, R. M. (1985b). The general causality orientations scale: Self-determination in personality. *Journal of Research in Personality*, *19*(2), 109–134.

Deci, E. L., & Ryan, R. M. (1991). A motivational approach to self: Integration in personality. In *Nebraska symposium on motivation: Perspectives on motivation* (Vol. 38, pp. 237–288). Lincoln, NE: University of Nebraska Press.

Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry*, *11*(4), 227–268. https://doi.org/10.1207/S15327965PLI1104_01

Deci, E. L., & Ryan, R. M. (2008a). Facilitating optimal motivation and psychological well-being across life's domains. *Canadian Psychology*, *49*(1), 14–34.

Deci, E. L., & Ryan, R. M. (2008b). Self-determination theory: A macrotheory of human motivation, development, and health. *Canadian Psychology*, *49*(3), 182–185.

Deci, E. L., Ryan, R. M., Gagné, M., Leone, D. R., Usunov, J., & Kornazheva, B. P. (2001). Need satisfaction, motivation, and well-being in the work organizations of a former Eastern Bloc country: A cross-cultural study of self-determination. *Personality and Social Psychology Bulletin*, *27*(8), 930–942.

Deci, E. L., & Vansteenkiste, M. (2004). Self-determination theory and basic need satisfaction: Understanding human development in positive psychology. *Ricerche Di Psicologia*, *27*(1), 23–40.

Deeley, S. J. (2010). Service-learning: Thinking outside the box. *Active Learning in Higher Education*, *11*(1), 43–53. https://doi.org/10.1177/1469787409355870

DeWitz, S. J., Woolsey, M. L., & Walsh, W. B. (2009). College student retention: An exploration of the relationship between self-efficacy beliefs and purpose in life among college students. *Journal of College Student Development*, *50*(1), 19–34. https://doi.org/10.1353/csd.0.0049

Dienhart, C., Maruyama, G., Snyder, M., Furco, A., McKay, M. S., Hirt, L., & Huesman, R. (2016). The impacts of mandatory service on students in service-learning classes. *The Journal of Social Psychology*, *156*(3), 305–309. https://doi.org/10.1080/00224545.2015.1111856

Dika, S. L., & D'Amico, M. M. (2016). Early experiences and integration in the persistence of first-generation college students in STEM and non-STEM majors. *Journal of Research in Science Teaching*, *53*(3), 368–383. https://doi.org/10.1002/tea.21301

Dillman, D. A., Smyth, J. D., & Christian, L. M. (2014). *Internet, phone, mail, and mixed-mode surveys: The tailored design method* (4th ed.). Hoboken, NJ: John Wiley & Sons.

Dreger, R. M., & Aiken Jr., L. R. (1957). The identification of number anxiety in a college population. *Journal of Educational Psychology*, *48*(6), 344–351. https://doi.org/10.1037/h0045894

Duke, J. I. (1999). Service learning: Taking mathematics into the real world. *The Mathematics Teacher*, *92*(9), 794-796+.

Durmaz, M., & Akkuş, R. (2016). Mathematics anxiety, motivation and the basic psychological needs from the perspective of self-determination theory. *Education and Science*, *41*(183), 111–127. https://doi.org/10.15390/EB.2016.2942

Eccles, J., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L., & Midgley, C. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motives: Psychological and sociological approaches* (pp. 75–146). San Francisco, CA: Freeman.

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology*, *53*(1), 109–132. https://doi.org/10.1146/annurev.psych.53.100901.135153

Ellis, M. M. (2013). Successful community college transfer students speak out. *Community College Journal of Research and Practice*, *37*(2), 73–84. https://doi.org/10.1080/10668920903304914

Evans, P. (2015). Self-determination theory: An approach to motivation in music education. *Musicae Scientiae*, *19*(1), 65–83. https://doi.org/10.1177/1029864914568044

Fast Facts. (n.d.). Retrieved from https://www.uta.edu/uta/about/fastfacts/

Fennema, E., & Sherman, J. A. (1976). Fennema-Sherman mathematics attitudes scales: Instruments designed to measure attitudes toward the learning of mathematics by females and males. *Journal for Research in Mathematics Education*, *7*(5), 324–326. https://doi.org/10.2307/748467

Finlayson, M. (2014). Addressing math anxiety in the classroom. *Improving Schools*, *17*(1), 99–115. https://doi.org/10.1177/1365480214521457

Fisher, R., Perényi, Á., & Birdthistle, N. (2018). The positive relationship between flipped and blended learning and student engagement, performance and satisfaction. *Active Learning in Higher Education*, 1–17. https://doi.org/10.1177/1469787418801702

Flanders, G. R. (2017). The effect of gateway course completion on freshman college student retention. *Journal of College Student Retention: Research, Theory & Practice*, *19*(1), 2–24. https://doi.org/10.1177/1521025115611396

Foley, A. E., Herts, J. B., Borgonovi, F., Guerriero, S., Levine, S. C., & Beilock, S. L. (2017). The math anxiety-performance link: A global phenomenon. *Current Directions in Psychological Science*, *26*(1), 52–58. https://doi.org/10.1177/0963721416672463

Gaffney, A. L. H., & Kercsmar, S. E. (2016). Students' affective learning in a technologically mediated writing and speaking course: A situated learning perspective. *Journal of*

Business and Technical Communication, *30*(3), 322–351. https://doi.org/10.1177/1050651916636371

Gagné, M., & Deci, E. L. (2005). Self-determination theory and work motivation. *Journal of Organizational Behavior*, *26*(4), 331–362. https://doi.org/10.1002/job.322

Gall, M. D., Gall, J. P., & Borg, W. R. (2007). *Educational research: An introduction* (8th ed.). Boston, MA: Pearson.

Ganley, C. M., & Lubienski, S. T. (2016). Mathematics confidence, interest, and performance: Examining gender patterns and reciprocal relations. *Learning and Individual Differences*, *47*(Supplement C), 182–193. https://doi.org/10.1016/j.lindif.2016.01.002

Gardner Institute. (2018). *Gateways to completion*. Retrieved from https://www.jngi.org/gateways-to-completion

Gaspard, H., Dicke, A.-L., Flunger, B., Brisson, B. M., Häfner, I., Nagengast, B., & Trautwein, U. (2015). Fostering adolescents' value beliefs for mathematics with a relevance intervention in the classroom. *Developmental Psychology*, *51*(9), 1226–1240. https://doi.org/10.1037/dev0000028

Geertshuis, S. A. (2019). Slaves to our emotions: Examining the predictive relationship between emotional well-being and academic outcomes. *Active Learning in Higher Education*, *20*(2), 153–166. https://doi.org/10.1177/1469787418808932

Gough, O. P. S. M. F. (1954). Why failures in mathematics? Mathemaphobia: Causes and treatments. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas*, *28*(5), 290–294.

Gravetter, F. J., & Wallnau, L. B. (2013). *Statistics for the behavioral sciences* (9th ed.). Belmont, CA: Wadsworth Cengage Learning.

Green, J., Liem, G. A. D., Martin, A. J., Colmar, S., Marsh, H. W., & McInerney, D. (2012). Academic motivation, self-concept, engagement, and performance in high school: Key processes from a longitudinal perspective. *Journal of Adolescence*, *35*(5), 1111–1122. https://doi.org/10.1016/j.adolescence.2012.02.016

Griffith, J. D., Adams, L. T., Gu, L. L., Hart, C. L., & Nichols-Whitehead, P. (2012). Students' attitudes toward statistics across the disciplines: A mixed-methods approach. *Statistics Education Research*, *11*(2), 45–56.

Guiffrida, D. A., Lynch, M. F., Wall, A. F., & Abel, D. S. (2013). Do reasons for attending college affect academic outcomes?: A test of a motivational model from a self-determination theory perspective. *Journal of College Student Development*, *54*(2), 121–139. https://doi.org/10.1353/csd.2013.0019

Guo, J., Marsh, H. W., Parker, P. D., Morin, A. J. S., & Yeung, A. S. (2015). Expectancy-value in mathematics, gender and socioeconomic background as predictors of achievement and aspirations: A multi-cohort study. *Learning and Individual Differences*, *37*, 161–168. https://doi.org/10.1016/j.lindif.2015.01.008

Gupta, S., Harris, D. E., Carrier, N. M., & Caron, P. (2006). Predictors of student success in entry-level undergraduate mathematics courses. *College Student Journal*, *40*(1), 97–108.

Hadlock, C. R. (Ed.). (2005). *Mathematics in service to the community*. Washington, D.C.: Mathematical Association of America.

Hall, J. M., & Ponton, M. K. (2005). Mathematics self-efficacy of college freshman. *Journal of Developmental Education*, *28*(3), 26–32.

Hammond, J. A., Bithell, C. P., Jones, L., & Bidgood, P. (2010). A first year experience of student-directed peer-assisted learning. *Active Learning in Higher Education*, *11*(3), 201–212. https://doi.org/10.1177/1469787410379683

Harackiewicz, J. M., Smith, J. L., & Priniski, S. J. (2016). Interest matters: The importance of promoting interest in education. *Policy Insights from the Behavioral and Brain Sciences*, *3*(2), 220–227. https://doi.org/10.1177/2372732216655542

Harris, K. S., & Rogers, G. E. (2008). Soft skills in the technology education classroom: What do students need. *Technology Teacher*, *68*(3), 19–24.

Heckman, J. J., & Kautz, T. (2012). Hard evidence on soft skills. *Labour Economics*, *19*(4), 451–464. https://doi.org/10.1016/j.labeco.2012.05.014

Hembree, R. (1990). The nature, effects, and relief of mathematics anxiety. *Journal for Research in Mathematics Education*, *21*(1), 33–46. https://doi.org/10.2307/749455

Henrich, A., Sloughter, J. M., Anderson, J., & Bahuaud, E. (2016). Addressing negative math attitudes with service-learning. *PRIMUS: Problems, Resources, and Issues in Mathematics Undergraduate Studies*, *26*(8), 788–802. https://doi.org/10.1080/10511970.2016.1174967

Hoffman, B., & Spatariu, A. (2008). The influence of self-efficacy and metacognitive prompting on math problem-solving efficiency. *Contemporary Educational Psychology*, *33*(4), 875–893. https://doi.org/10.1016/j.cedpsych.2007.07.002

Hout, M. (2012). Social and economic returns to college education in the United States. *Annual Review of Sociology*, *38*(1), 379–400. https://doi.org/10.1146/annurev.soc.012809.102503

Hulleman, C. S., Godes, O., Hendricks, B. L., & Harackiewicz, J. M. (2010). Enhancing interest and performance with a utility value intervention. *Journal of Educational Psychology*, *102*(4), 880–895. https://doi.org/10.1037/a0019506

Hydorn, D. L. (2007). Community service-learning in statistics: Course design and assessment. *Journal of Statistics Education*, *15*(2), 1–8.

Johnson, D. W., Johnson, R. T., & Smith, K. A. (1991). *Cooperative learning: Increasing college faculty instructional productivity* (ASHE-ERIC Higher Education Report No. 4). Washginton D.C.: George Washington University.

Johnson, J. H., & Sarason, I. G. (1978). Life stress, depression and anxiety: Internal-external control as a moderator variable. *Journal of Psychosomatic Research*, *22*(3), 205–208. https://doi.org/10.1016/0022-3999(78)90025-9

Johnston, S., & McGregor, H. (2005). Recognizing and supporting a scholarship of practice: Soft skills are hard! *Asia-Pacific Journal of Cooperative Education*, *6*(1), 1–6.

Jones, S. (2003). *Introduction to service-learning toolkit: Readings and resources for faculty* (2nd ed.). Boston, MA: Campus Compact.

Justicia-Galiano, M. J., Martín-Puga, M. E., Linares, R., & Pelegrina, S. (2017). Math anxiety and math performance in children: The mediating roles of working memory and math self-concept. *British Journal of Educational Psychology*, *87*(4), 573–589. https://doi.org/10.1111/bjep.12165

Junita, D., Suarman, S., & Kartikowati, S. (2018). Accomplishment motivation and soft skill related to learning achievement. *Journal of Educational Sciences*, *2*(2), 83–89.

Kaiser, H. F. (1960). The application of electronic computers to factor analysis. *Educational and Psychological Measurement*, *20*(1), 141–151. https://doi.org/10.1177/001316446002000116

Kilgour, P. W., Reynaud, D., Northcote, M. T., & Shields, M. (2015). Role-playing as a tool to facilitate learning, self-reflection and social awareness in teacher education. *International Journal of Innovative Interdisciplinary Research*, *2*(4), 8–20.

Kitsantas, A., Cheema, J., & Ware, H. W. (2011). Mathematics achievement: The role of homework and self-efficacy beliefs. *Journal of Advanced Academics*, *22*(2), 310–339. https://doi.org/10.1177/1932202X1102200206

Koch, A. K., & Pistilli, M. D. (2012, September 27). *Analytics and gateway courses: Understanding and overcoming roadblocks to college completion*. Presentation retrieved from https://www.insidehighered.com/audio/2012/09/27/analytics-and-gateway-courses

Kraebber, S. L., & Greenan, J. P. (2012). The relationship between self-concept and self-ratings of generalizable skills of students in postsecondary career and technical programs. *Journal of Career and Technical Education*, *27*(1), 15–33.

Kusurkar, R. A., Ten Cate, Th. J., Vos, C. M. P., Westers, P., & Croiset, G. (2013). How motivation affects academic performance: A structural equation modelling analysis. *Advances in Health Sciences Education*, *18*(1), 57–69. https://doi.org/10.1007/s10459-012-9354-3

Laskey, M. L., & Hetzel, C. J. (2010). *Self-regulated learning, metacognition, and soft skills: The 21st century learner*. Retrieved from https://eric.ed.gov/?id=ED511589

Lazarus, M. (1974). Mathophobia: Some personal speculations. *National Elementary Principal*, *53*(2), 16-22.

Lee, J. M., Contreras, F., McGuire, K. M., Flores-Ragade, A., Rawls, A., Edwards, K., & Menson, R. (2011). *The college completion agenda: 2011 progress report* (Report No. ED524574). New York, NY: College Board Advocacy & Policy Center.

León, J., Núñez, J. L., & Liew, J. (2015). Self-determination and STEM education: Effects of autonomy, motivation, and self-regulated learning on high school math achievement. *Learning and Individual Differences*, *43*, 156–163. https://doi.org/10.1016/j.lindif.2015.08.017

Li, D., Uvah, J. A., & Li, K. (2017). Improving college students' performance in mathematics gatekeeper courses using Confucius philosophies—A case study. *US-China Education Review A*, *7*(8), 374–384. https://doi.org/10.17265/2161-623X/2017.08.002

Lopez, C., & Jones, S. J. (2017). Examination of factors that predict academic adjustment and success of community college transfer students in STEM at 4-year institutions. *Community College Journal of Research and Practice*, *41*(3), 168–182. https://doi.org/10.1080/10668926.2016.1168328

Lunsford, M. L., Poplin, P. L., & Pederson, J. G. (2018). From research to practice: Using assessment and early intervention to improve student success in introductory statistics. *Journal of Statistics Education*, *26*(2), 125–134. https://doi.org/10.1080/10691898.2018.1483785

Lyons, I. M., & Beilock, S. L. (2012). When math hurts: Math anxiety predicts pain network activation in anticipation of doing math. *PLOS ONE*, *7*(10), 1–6. https://doi.org/10.1371/journal.pone.0048076

Majid, S., Liming, Z., Tong, S., & Raihana, S. (2012). Importance of soft skills for education and career success. *International Journal for Cross-Disciplinary Subjects in Education*, *2*(2), 1037–1042.

Malik, S. (2015). Undergraduates' statistics anxiety: A phenomenological study. *The Qualitative Report*, *20*(2), 120–133.

Maloney, E. A., & Beilock, S. L. (2012). Math anxiety: Who has it, why it develops, and how to guard against it. *Trends in Cognitive Sciences*, *16*(8), 404–406. https://doi.org/10.1016/j.tics.2012.06.008

Matteson, M. L., Anderson, L., & Boyden, C. (2016). "Soft skills": A phrase in search of meaning. *Portal: Libraries and the Academy*, *16*(1), 71–88. https://doi.org/10.1353/pla.2016.0009

May, D. K. (2009). *Mathematics self-efficacy and anxiety questionnaire* [Doctoral thesis]. University of Georgia, Athens, GA.

McNair, T. B., Bensimon, E., Cooper, M. A., McDonald, N., & Major, Jr, T. (2016). *Becoming a student-ready college: A new culture of leadership for student success*. San Francisco, CA: John Wiley & Sons.

Mertler, C. A., & Reinhart, R. V. (2017). *Advanced and multivariate statistical methods: Practical application and interpretation* (6th ed.). New York, NY: Routledge.

Metje, N., Frank, H. L., & Croft, P. (2007). Can't do maths—Understanding students' maths anxiety. *Teaching Mathematics and Its Applications: An International Journal of the IMA*, *26*(2), 79–88. https://doi.org/10.1093/teamat/hrl023

Mission, Vision, and Values. (2020). Retrieved from https://www.uta.edu/strategicplan/about/mission.php

Mohr-Schroeder, M. J., Jackson, C., Cavalcanti, M., Jong, C., Craig Schroeder, D., & Speler, L. G. (2017). Parents' attitudes toward mathematics and the influence on their students' attitudes toward mathematics: A quantitative study. *School Science and Mathematics*, *117*(5), 214–222. https://doi.org/10.1111/ssm.12225

Mulhern, F., & Rae, G. (1998). Development of a shortened form of the Fennema-Sherman mathematics attitudes scales. *Educational and Psychological Measurement*, *58*(2), 295–306. https://doi.org/10.1177/0013164498058002012

Murayama, K., Pekrun, R., Lichtenfeld, S., & Hofe, R. vom. (2013). Predicting long-term growth in students' mathematics achievement: The unique contributions of motivation and cognitive strategies. *Child Development*, *84*(4), 1475–1490. https://doi.org/10.1111/cdev.12036

Nealy, C. (2005). Integrating soft skills through active learning in the management classroom. *Journal of College Teaching & Learning*, *2*(4), 1–6. https://doi.org/10.19030/tlc.v2i4.1805

Niemiec, C. P., & Ryan, R. M. (2009). Autonomy, competence, and relatedness in the classroom: Applying self-determination theory to educational practice. *Theory and Research in Education*, *7*(2), 133–144. https://doi.org/10.1177/1477878509104318

Pajares, F. (1996). Self-efficacy beliefs in academic settings. *Review of Educational Research*, *66*(4), 543–578. https://doi.org/10.3102/00346543066004543

Pajares, F., & Graham, L. (1999). Self-efficacy, motivation constructs, and mathematics performance of entering middle school students. *Contemporary Educational Psychology*, *24*(2), 124–139. https://doi.org/10.1006/ceps.1998.0991

Pajares, F., & Miller, M. D. (1994). Role of self-efficacy and self-concept beliefs in mathematical problem solving: A path analysis. *Journal of Educational Psychology*, *86*(2), 193–203. https://doi.org/10.1037/0022-0663.86.2.193

Pantziara, M., & Philippou, G. N. (2015). Students' motivation in the mathematics classroom. Revealing causes and consequences. *International Journal of Science and Mathematics Education*, *13*(2), 385–411. https://doi.org/10.1007/s10763-013-9502-0

Pereira, O. P., & Costa, C. A. A. T. (2017). The importance of soft skills in the university academic curriculum: The perceptions of the students in the new society of knowledge. *International Journal of Business and Social Research*, *7*(3), 25–34. https://doi.org/10.18533/ijbsr.v7i6.1052

Perry, A. B. (2004). Decreasing math anxiety in college students. *College Student Journal*, *38*(2), 321–325.

Peters, M. L. (2013). Examining the relationships among classroom climate, self-efficacy, and achievement in undergraduate mathematics: A multi-level analysis. *International Journal of Science and Mathematics Education*, *11*(2), 459–480. https://doi.org/10.1007/s10763-012-9347-y

Phelps, A. L., & Dostilio, L. (2008). Studying student benefits of assigning a service-learning project compared to a traditional final project in a business statistics class. *Journal of Statistics Education*, *16*(3). https://doi.org/10.1080/10691898.2008.11889574

Powell, E. D. (2013). *Predicting college students' first year success: Should soft skills be taken into consideration to more accurately predict the academic achievement of college freshmen?* [Doctoral thesis]. Middle Tennessee State University, Murfreesboro, TN. Retrieved from https://jewlscholar.mtsu.edu/handle/mtsu/3661

Prince, M. (2004). Does active learning work? A review of the research. *Journal of Engineering Education*, *93*(3), 223–231. https://doi.org/10.1002/j.2168-9830.2004.tb00809.x

Ramirez, G., Gunderson, E. A., Levine, S. C., & Beilock, S. L. (2013). Math anxiety, working memory, and math achievement in early elementary school. *Journal of Cognition and Development*, *14*(2), 187–202. https://doi.org/10.1080/15248372.2012.664593

Redmond-Sanogo, A., Angle, J., & Davis, E. (2016). Kinks in the STEM pipeline: Tracking STEM graduation rates using science and mathematics performance. *School Science and Mathematics*, *116*(7), 378-388.

Reeve, J. (2002). Self-determination theory applied to educational settings. In *Handbook of self-determination research* (pp. 183–203). Rochester, NY: University of Rochester Press.

Reis, H. T., Sheldon, K. M., Gable, S. L., Roscoe, J., & Ryan, R. M. (2000). Daily well-being: The role of autonomy, competence, and relatedness. *Personality and Social Psychology Bulletin*, *26*(4), 419–435. https://doi.org/10.1177/0146167200266002

Robbins, S. B., Lauver, K., Le, H., Davis, D., Langley, R., & Carlstrom, A. (2004). Do psychosocial and study skill factors predict college outcomes? A meta-analysis. *Psychological Bulletin*, *130*(2), 261–288. https://doi.org/10.1037/0033-2909.130.2.261

Roberts, D. (2019). Higher education lectures: From passive to active learning via imagery? *Active Learning in Higher Education*, *20*(1), 63–77. https://doi.org/10.1177/1469787417731198

Robles, M. M. (2012). Executive perceptions of the top 10 soft skills needed in today's workplace. *Business Communication Quarterly*, *75*(4), 453–465. https://doi.org/10.1177/1080569912460400

Ryan, R. M., & Deci, E. L. (2000a). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist*, *55*(1), 68–78. pdh. https://doi.org/10.1037/0003-066X.55.1.68

Ryan, R. M., & Deci, E. L. (2000b). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology*, *25*(1), 54–67. https://doi.org/10.1006/ceps.1999.1020

Salazar, L. R. (2018). Examining the relationship between math self-efficacy and statistics motivation in the introductory business statistics course: Self-compassion as a mediator. *Decision Sciences Journal of Innovative Education*, *16*(2), 140–160. https://doi.org/10.1111/dsji.12149

Sax, L. J., Astin, A. W., & Avalos, J. (1999). Long-term effects of volunteerism during the undergraduate years. *The Review of Higher Education*, *22*(2), 187–202.

Scarpello, G. (2007). Helping students get past math anxiety. *Techniques: Connecting Education and Careers*, *82*(6), 34–35.

Schulteis, M. S. (2013). Serving hope: Building service-learning into a non-major mathematics course to benefit the local community. *PRIMUS: Problems, Resources, and Issues in Mathematics Undergraduate Studies*, *23*(6), 572–584.

Schulz, B. (2008). The importance of soft skills: Education beyond academic knowledge. *Journal of Language and Communication*, *2*(1), 146–154.

Schunk, D. H., Meece, J. R., & Pintrich, P. R. (2012). *Motivation in education: Theory, research, and applications* (4th ed.). Upper Saddle River, NJ: Pearson Higher Ed.

Shechter, O. G., Durik, A. M., Miyamoto, Y., & Harackiewicz, J. M. (2011). The role of utility value in achievement behavior: The importance of culture. *Personality and Social Psychology Bulletin*, *37*(3), 303–317. https://doi.org/10.1177/0146167210396380

Sheldon, K. M., & Krieger, L. S. (2007). Understanding the negative effects of legal education on law students: A longitudinal test of self-determination theory. *Personality and Social Psychology Bulletin*, *33*(6), 883–897. https://doi.org/10.1177/0146167207301014

Shores, K., Kim, H. E., & Still, M. (2020). Categorical inequality in Black and White: Linking disproportionality across multiple educational outcomes. *American Educational Research Journal*, 1-43. https://doi.org/10.3102/0002831219900128

Simzar, R. M., Martinez, M., Rutherford, T., Domina, T., & Conley, A. M. (2015). Raising the stakes: How students' motivation for mathematics associates with high- and low-stakes test achievement. *Learning and Individual Differences*, *39*, 49–63. https://doi.org/10.1016/j.lindif.2015.03.002

Singh, K., Granville, M., & Dika, S. (2002). Mathematics and science achievement: Effects of motivation, interest, and academic engagement. *The Journal of Educational Research*, *95*(6), 323–332. https://doi.org/10.1080/00220670209596607

Smith, K. A. (1996). Cooperative learning: Making "groupwork" work. *New Directions for Teaching and Learning*, *1996*(67), 71–82. https://doi.org/10.1002/tl.37219966709

Speck, B. W. (2001). Why service-learning? *New Directions for Higher Education*, *2001*(114), 3–13.

Standage, M., Gillison, F. B., Ntoumanis, N., & Treasure, D. C. (2012). Predicting students' physical activity and health-related well-being: A prospective cross-domain investigation of motivation across school physical education and exercise settings. *Journal of Sport and Exercise Psychology*, *34*(1), 37–60. https://doi.org/10.1123/jsep.34.1.37

Steiner, L., Sundström, A. C., & Sammalisto, K. (2013). An analytical model for university identity and reputation strategy work. *Higher Education*, *65*(4), 401–415. https://doi.org/10.1007/s10734-012-9552-1

Stevens, R. (2015). Role-play and student engagement: Reflections from the classroom. *Teaching in Higher Education*, *20*(5), 481–492. https://doi.org/10.1080/13562517.2015.1020778

Stinson, D. (2004). Mathematics as "gate-keeper" (?): Three theoretical perspectives that aim toward empowering all children with a key to the gate. *The Mathematics Educator*, *14*(1), 8–18.

Stone, J. R. (2005). The neglected majority—Revisited. *Journal of Career and Technical Education*, *21*(2), 67–81.

Suárez-Pellicioni, M., Núñez-Peña, M. I., & Colomé, À. (2016). Math anxiety: A review of its cognitive consequences, psychophysiological correlates, and brain bases. *Cognitive, Affective, & Behavioral Neuroscience*, *16*(1), 3–22. https://doi.org/10.3758/s13415-015-0370-7

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics* (7th ed., Vol. 5). Boston, MA: Pearson Education.

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education*, *2*, 53–55. https://doi.org/10.5116/ijme.4dfb.8dfd

Tews, M. J., Jackson, K., Ramsay, C., & Michel, J. W. (2015). Fun in the college classroom: Examining its nature and relationship with student engagement. *College Teaching*, *63*(1), 16–26. https://doi.org/10.1080/87567555.2014.972318

Tobias, S. (1978). *Overcoming math anxiety*. Boston, MA: Houghton Mifflin.

Tobias, S., & Weissbrod, C. (1980). Anxiety and mathematics: An update. *Harvard Educational Review*, *50*(1), 63–70.

Turki, F. J., Jdaitawi, M., & Sheta, H. (2017). Fostering positive adjustment behaviour: Social connectedness, achievement motivation and emotional-social learning among male and female university students. *Active Learning in Higher Education*, *19*(2), 145–158. https://doi.org/10.1177/1469787417731202

U.S. Department of Education. Institute of Education Sciences, National Center for Education Statistics. (2018). *Digest of education statistics: Postsecondary education* (NCES 2017-094). Retrieved from https://nces.ed.gov/programs/digest/d16/ch_3.asp

U.S. Department of Education. Institute of Education Sciences, National Center for Education Statistics. (2019). *The condition of education 2019: Fast facts* (NCES 2019-144). Retrieved from https://nces.ed.gov/fastfacts/display.asp?id=40

Usher, E. L., & Pajares, F. (2008). Sources of self-efficacy in school: Critical review of the literature and future directions. *Review of Educational Research*, *78*(4), 751–796. https://doi.org/10.3102/0034654308321456

Valås, H., & Søvik, N. (1994). Variables affecting students' intrinsic motivation for school mathematics: Two empirical studies based on Deci and Ryan's theory on motivation. *Learning and Instruction*, *3*(4), 281–298. https://doi.org/10.1016/0959-4752(93)90020-Z

Vallerand, R. J., Fortier, M. S., & Guay, F. (1997). Self-determination and persistence in a real-life setting: Toward a motivational model of high school dropout. *Journal of Personality and Social Psychology*, *72*(5), 1161–1176. https://doi.org/10.1037/0022-3514.72.5.1161

Vansteenkiste, M., Lens, W., & Deci, E. L. (2006). Intrinsic versus extrinsic goal contents in self-determination theory: Another look at the quality of academic motivation. *Educational Psychologist*, *41*(1), 19–31. https://doi.org/10.1207/s15326985ep4101_4

Vecchione, M., Alessandri, G., & Marsicano, G. (2014). Academic motivation predicts educational attainment: Does gender make a difference? *Learning and Individual Differences*, *32*, 124–131. https://doi.org/10.1016/j.lindif.2014.01.003

Wang, Z., Lukowski, S. L., Hart, S. A., Lyons, I. M., Thompson, L. A., Kovas, Y., Mazzocco, M. M. M., Plomin, R., & Petrill, S. A. (2015). Is math anxiety always bad for math learning? The role of math motivation. *Psychological Science*, *26*(12), 1863–1876. https://doi.org/10.1177/0956797615602471

Warren, J. L. (2012). Does service-learning increase student learning?: A meta-analysis. *Michigan Journal of Community Service Learning*, *18*(2), 56–61.

Wats, M., & Wats, R. K. (2009). Developing soft skills in students. *International Journal of Learning*, *15*(12), 1–10.

Wexler, E. (2016, May 16). When service learning doesn't really serve. *Inside Higher Ed*. Retrieved from https://www.insidehighered.com/news/2016/05/16/new-book-argues-service-learning-doesn%E2%80%99t-prioritize-students

Wigfield, A., & Eccles, J. S. (2000). Expectancy–value theory of achievement motivation. *Contemporary Educational Psychology*, *25*(1), 68–81. https://doi.org/10.1006/ceps.1999.1015

Wilson, S. A. (2014). "Fail at maths and you fail at life": Learned barriers to equal opportunities. *International Public Health Journal*, *6*(2), 147–160.

Wismath, S. L., & Worrall, A. (2015). Improving university students' perception of mathematics and mathematics ability. *Numeracy*, *8*(1), 1–17. http://dx.doi.org/10.5038/1936-4660.8.1.9

Wong, M. M., & Csikszentmihalyi, M. (1991). Motivation and academic achievement: The effects of personality traits and the duality of experience. *Journal of Personality*, *59*(3), 539–574. https://doi.org/10.1111/j.1467-6494.1991.tb00259.x

Wood, L. N., & Breyer, Y. A. (2017). Success in higher education. In L. N. Wood & Y. A. Breyer (Eds.), *Success in higher education: Transitions to, within and from university* (pp. 1–19). Singapore: Springer. https://doi.org/10.1007/978-981-10-2791-8_1

Wright, M. C., Bergom, I., & Bartholomew, T. (2019). Decreased class size, increased active learning? Intended and enacted teaching strategies in smaller classes. *Active Learning in Higher Education*, *20*(1), 51–62. https://doi.org/10.1177/1469787417735607

Wright, M. C., McKay, T., Hershock, C., Miller, K., & Tritz, J. (2014). Better than expected: Using learning analytics to promote student success in gateway science. *Change: The Magazine of Higher Learning*, *46*(1), 28–34. https://doi.org/10.1080/00091383.2014.867209

Wu, M., & Greenan, J. P. (2003). The effects of a generalizable mathematics skills instructional intervention on the mathematics achievement of learners in secondary CTE programs. *Journal of Industrial Teacher Education*, *40*(2). Retrieved from https://scholar.lib.vt.edu/ejournals/JITE/v40n2/wu.html

Xu, Y., Hartman, S., Uribe, G., & Mencke, R. (2001). The effects of peer tutoring on undergraduate students' final examination scores in mathematics. *Journal of College Reading and Learning*, *32*(1), 22–31. https://doi.org/10.1080/10790195.2001.10850123

Yong, A. G., & Pearce, S. (2013). A beginner's guide to factor analysis: Focusing on exploratory factor analysis. *Tutorials in Quantitative Methods for Psychology*, *9*(2), 79–94. https://doi.org/10.20982/tqmp.09.2.p079

Yorio, P. L., & Ye, F. (2012). A meta-analysis on the effects of service-learning on the social, personal, and cognitive outcomes of learning. *Academy of Management Learning & Education*, *11*(1), 9–27. https://doi.org/10.5465/amle.2010.0072

Young, C. B., Wu, S. S., & Menon, V. (2012). The neurodevelopmental basis of math anxiety. *Psychological Science*, *23*(5), 492–501. https://doi.org/10.1177/0956797611429134

Zientek, L. R., Schneider, C. L., & Onwuegbuzie, A. J. (2014). Instructors' perceptions about student success and placement in developmental mathematics courses. *The Community College Enterprise*, *20*(1), 66–83.

Zimmerman, B. J., Bandura, A., & Martinez-Pons, M. (1992). Self-motivation for academic attainment: The role of self-efficacy beliefs and personal goal setting. *American Educational Research Journal*, *29*(3), 663–676. https://doi.org/10.2307/1163261

Zulkosky, K. (2009). Self-efficacy: A concept analysis. *Nursing Forum*, *44*(2), 93–102.

Zwick, R., & Sklar, J. C. (2005). Predicting college grades and degree completion using high school grades and SAT scores: The role of student ethnicity and first language. *American Educational Research Journal*, *42*(3), 439–464. https://doi.org/10.3102/00028312042003439

APPENDICES

Appendix A

Survey Deployed in Spring 2019

In order to understand what you think and feel about your college mathematics courses, please respond to each of the following statements. If there are any questions that you do not wish to answer, please select "No Response."

Section I - Statements related to Student Demographics and Background

1. What is your gender? No Response Male Female
2. What is your ethnicity?

   No Response Hispanic/Latino Asian/Pacific Islander Black/African American

   White/Non-Hispanic Native American/Indian Other
3. How old are you?

   No Response _______________
4. How many mathematics classes did you take in high school?

   No Response _______________
5. What was the highest mathematics course you took in high school?

   No Response _______________
6. What was your average grade in your mathematics classes in high school?

   No Response _______________
7. What was your score on the math section of the SAT?

   No Response _______________
8. What is your major?

   No Response _______________

Section II - Statements related to Student Beliefs and Perceptions

Please respond to each statement with one of the following or select No Response:

Completely disagree, Mostly disagree, Somewhat agree/disagree, Mostly agree, Completely agree

1. I feel confident enough to ask questions in my math class.
2. I get nervous when asking questions in my math class.
3. I am afraid to give an incorrect answer during my statistics class.
4. I feel stressed when listening to math or statistics instructors in class.
5. I get tense when I prepare for a math or statistics test.
6. I feel confident when taking a mathematics test.
7. I get nervous when I have to use math or statistics outside of school.
8. I feel confident when using statistics outside of school.
9. I worry that I will not be able to use math or statistics in my future career when needed.
10. I believe I will be able to use math or statistics in my future career when needed.
11. I believe statistical skills are useful in the real-world.
12. I do not see the value of mathematics in real-life.
13. I believe I am the type of person who can do mathematics.
14. I worry I will not be able to understand statistics.
15. I believe I can understand the content in a math or statistics course.
16. Understanding the course content in a math or statistics course is important to me.
17. It is important to me to do well in a math or statistics course.
18. I believe I can get an “A” when I am in a mathematics course.
19. I worry that I will not be able to get an “A” in my statistics course.
20. I worry that I will not be able to get a good grade in my mathematics course.
21. I believe working with the local community is important.
22. Participating in community activities is stressful.
23. I feel confident when speaking in public.
24. I get nervous when I speak to people I do not know.
25. I am comfortable giving presentations in front of the class.
26. I believe I work effectively with others.
27. Working on a team makes me nervous.

Appendix B

Institutional Review Board Study Approval Letter

UNIVERSITY OF TEXAS ARLINGTON | OFFICE OF RESEARCH ADMINISTRATION REGULATORY SERVICES

December 17, 2018

Shanna Banda
Mathematics
The University of Texas at
Arlington Box 19408

Protocol Number: 2019-0060
Protocol Title: *Service-Learning in Elementary Statistical Analysis*

APPROVAL OF MINIMAL RISK HUMAN SUBJECTS RESEARCH WITHOUT FEDERAL FUNDING

The University of Texas Arlington Institutional Review Board (UTA IRB) or designee has reviewed your protocol and made the determination that this research study involving human subjects is approved in accordance with UT Arlington's Standard Operating Procedures (SOPs) for minimal risk research. You are therefore authorized to begin the research as of **December 17, 2018.**

Note that this project is not covered by UTA's Federalwide Assurance (FWA) and the researcher has indicated it will not receive federal funding. You must inform Regulatory Services immediately if the project may or will receive federal funding in the future, as this will require that the protocol be re-reviewed in accordance with the federal regulations for the protection of human subjects.

As Principal Investigator of this IRB approved study, the following items are your responsibility throughout the life of the study:

UNANTICIPATED ADVERSE EVENTS
Please be advised that as the Principal Investigator, you are required to report local adverse (unanticipated) events to The UT Arlington Office of Research Administration; Regulatory Services within 24 hours of the occurrence or upon acknowledgement of the occurrence.

INFORMED CONSENT DOCUMENT
The IRB approved version of the informed consent document (ICD) must be used when prospectively enrolling volunteer participants into the study. Unless otherwise determined by

the IRB, all signed consent forms must be securely maintained on the UT Arlington campus for the duration of the study plus a minimum of three years after the completion of all study procedures (including data analysis). The complete study record is subject to inspection and/or audit during this time period by entities including but not limited to the UT Arlington IRB, Regulatory Services staff, OHRP, FDA, and by study sponsors (as applicable).

MODIFICATIONS TO THE APPROVED PROTOCOL

All proposed changes must be submitted via the electronic submission system and approved prior to implementation, except when necessary to eliminate apparent immediate hazards to the subject. Modifications include but are not limited to: Changes in protocol personnel, changes in proposed study procedures, and/or updates to data collection instruments. Failure to obtain prior approval for modifications is considered an issue of non-compliance and will be subject to review and deliberation by the IRB which could result in the suspension/termination of the protocol.

ANNUAL CHECK-IN EMAIL / STUDY CLOSURE

Although annual continuing review is not required for this study, you will receive an email around the anniversary date of your initial approval date to remind you of these responsibilities. Please notify Regulatory Services once your study is completed to begin the required 3-year research record retention period.

HUMAN SUBJECTS TRAINING

All investigators and personnel identified in the protocol must have documented Human Subjects Protection (HSP) training on file prior to study approval. HSP completion certificates are valid for 3 years from completion date; the PI is responsible for ensuring that study personnel maintain all appropriate training(s) for the duration of the study.

CONTACT FOR QUESTIONS

The UT Arlington Office of Research Administration; Regulatory Services appreciates your continuing commitment to the protection of human research subjects. Should you have questions or require further assistance, please contact Regulatory Services at regulatoryservices@uta.edu or 817-272-3723.