A CAUSAL-COMPARATIVE ANALYSIS OF MATHEMATICS SELF-EFFICACY BASED ON GENDER AND MATH ACCELERATION

by

Jacqueline Renee Probst

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Education

Liberty University

2019

A CAUSAL-COMPARATIVE ANALYSIS OF MATHEMATICS SELF-EFFICACY BASED ON GENDER AND MATH ACCELERATION

by

Jacqueline Renee Probst

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Education

Liberty University

2019

APPROVED BY

Vivian O. Jones, Ph.D., Committee Chair

Philip Alsup, Ed.D., Methodologist

ABSTRACT

This study tested the theories of self-efficacy and cognitive-stage that compare gender and degree of mathematics acceleration to mathematics self-efficacy for math students. The participants for this study were 158 Algebra 2 and Precalculus students enrolled at three different private, metropolitan, secondary schools in the same northwestern state during the 2018-2019 school year. A causal-comparative group comparison design was utilized to determine mathematics self-efficacy differences among math students in relation to gender and degree of mathematics acceleration. Student mathematics self-efficacy scores from the Mathematics Self-Efficacy Scale (MSES) were analyzed using a two-way analysis of variance (ANOVA) to compare means and possible interaction between the two independent variables. No statistical significance was found between gender and mathematics self-efficacy or between degree of mathematics acceleration and mathematics self-efficacy.

Keywords: mathematics self-efficacy, social cognitive theory, self-efficacy theory, gender, math acceleration

Dedication

This manuscript is dedicated first to Jesus Christ, who has walked alongside me for this (and every) journey and undoubtedly carried me during the tough parts. To my husband, Tracy, there is no way I could have done any of this without you. Thank you for doing more than your share at home and with the kids, and for never giving me anything but understanding and encouragement when I backed out of family commitments to study, read, and write. The heart and spirit of this work is dedicated to my children: Ethan, Bianca, Spencer, Phoebe, and to Ivy's memory. I hope that, in some small way, I have shown you that any goal is reachable, with a lot of determination, hard work, and support from loved ones. Thank you to my family, friends, and colleagues who listened to my endless ponderings, struggles, and tears throughout the process, and who always responded with patience and words of encouragement.

Acknowledgments

This goal would have seemed unreachable without the preparation and encouragement that I received from so many Liberty professors over the past four years. Most notably, I am grateful to Dr. Jones for helping me to first grasp quantitative statistics and, years later, to navigate the dissertation process as my chair. Dr. Jones, you have inspired me and, with your optimism and encouragement, pulled me through tough spots when I thought about giving up. I could not have done this without you. Dr. Alsup, from the very beginning, you held me and my work to an incredibly high standard. There were times where I was able to improve on what I was sure was my best work solely because of your feedback and questions. Thank you for pushing me and helping me to create a final product that is better than what I could have done without your guidance.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

Analysis of Variance (ANOVA)

Grade Point Average (GPA)

Institutional Review Board (IRB)

Learning-Related Emotion (LRE)

Mathematics Attitude Questionnaire (MAQ)

Mathematics Self-Efficacy Scale (MATH; MSES)

Mathematics Self-Efficacy Scale – Revised (MSES-R)

National Assessment of Educational Progress (NAEP)

National Council of Teachers of Mathematics (NCTM)

National Science Board (NSB)

National Science Foundation (NSF)

No Child Left Behind (NCLB)

Patterns of Adaptive Learning Scale (PALS)

Program for International Student Assessment (PISA)

Science, Technology, Engineering, and Mathematics (STEM)

Sources of Middle School Mathematics Self-Efficacy Scale (SMSMSS)

Trends in International Mathematics and Science Study (TIMSS)

CHAPTER ONE: INTRODUCTION

Overview

Algebra I is being offered earlier, and in more schools, than ever before, bursting through the traditional 9th grade boundary (Hemphill & Hill, 2013). The push to inculcate younger students into the abstract methods of algebra follows closely on the heels of changes in federal legislation and public opinion (Hemphill & Hill, 2013). Mathematics self-efficacy, which is students' perception of their abilities in mathematics, has considerable influence on student motivation and mathematics achievement (Skaalvik, Federici, & Klassen, 2015). Mathematics self-efficacy should, thus, be accounted for in the creation and administration of mathematics acceleration programs. Special attention should be given to the mathematical education of female students, as their tendency toward lower mathematics self-efficacy may lead to underrepresentation of women in STEM degrees and professions (Wang, 2013). This chapter outlines the history, social context, and theoretical framework of the study, the problem and purpose statements, the significance of the study, the research question, and the definitions of key terms.

Background

Student's math acceleration experience and their mathematics self-efficacy can both be evaluated using the frameworks of social cognitive theory and the theory of cognitive development. Separate branches of psychology intertwine within boundaries that are heavily influenced by tradition and public opinion. Informal, personal observations lead to the conclusion that mathematics education is subject to constant and relentless scrutiny, as communities seek to prepare students effectively for the demands of the 21st century.

Historical Overview

Shifts in public opinion about the teaching and learning of mathematics happen every 15-20 years and continue to disrupt consistent implementation of effective mathematics instruction (Larson, 2016). Throughout the 1940s and ‘50s, mathematics education was heavily criticized when it was realized that American recruits during World War II did not have appropriate problem-solving skills. The math gap was brought into stark relief when Russia’s Sputnik started orbiting the planet, dwarfing American efforts up to that time (Larson, 2016; Rosario et al., 2015). In response, the curriculum of New Math was introduced which focused on conceptual understanding rather than rote memorization of isolated skills. Research on its effectiveness found only slight differences between student achievement before and after the arrival of New Math (Larson, 2016).

The 1970s and ‘80s heralded a back-to-basics movement in math education. This era focused on procedural arithmetic skills, the promotion of student mastery through direct instruction, and the widespread use of standardized tests for the measurement of low-level, skill-oriented objectives. Numerous mathematicians argued that the methods were too abstract, confusing, and impractical (Ahlfors et al., 1962).

With the publications of *A Nation at Risk* in 1983 and *What Works* in 1986 the public became informed about, and alarmed by, the waning academic excellence in U.S. schools (Maltese, Tai, & Fan, 2012). The National Council of Teachers of Mathematics (NCTM) began to issue standards for mathematics instruction. With the promulgation of those standards, the focus for math instruction shifted yet again from specific skills to problem solving (Larson, 2016). State standards consistent with the NCTM standards were created in 41 states (McLeod, 2003). The 1990s, however, saw public opinion swing back toward direct instruction, basic procedural skills, practice and memorization (McLeod, 2003).

In the 1990s and 2000s, the conversation about math education continued to focus on standards with a focus on conceptual understanding. The advent of No Child Left Behind (NCLB) legislation, signed into law in 2002, prompted states to respond with 50 different sets of standards, tests, and passing scores. That unwieldy crazy quilt of standards led, almost inevitably, to the 2009 bipartisan initiative of the Common Core. The response to Common Core was withering criticism which was heavy on vitriol and light on facts. The vociferous criticism made the Common Core a high-profile target to blame for all perceived failings of mathematics education (Larson, 2016; Larson & Kanold, 2016). This period of time coincided with the introduction of pre-ninth-grade early Algebra 1 instruction. Prior to the late 1990s, eighth-grade Algebra 1 was reserved for students who were considered gifted in math, however, within a decade, nearly one third of eighth graders in the United States were enrolled in Algebra 1 (Hemphill & Hill, 2013).

Social Context

Mathematics education in America is often scrutinized by the public. International assessments of national mathematics achievement (the Trends in International Mathematics and Science Study (TIMSS) and the Program for International Student Assessment (PISA), to name but two), have recently ranked the United States students near the bottom when compared with other nations (Hemphill & Hill, 2013). In response, many schools and school districts have created formal or informal mathematics acceleration programs with the goal of getting the U.S. more in line with top tier nations such as Taiwan, who introduce Algebra 1 concepts in elementary school (Askew, Hodgen, Hossain, & Bretscher, 2010).

The issue of expanding early access to Algebra 1 is neither easy nor settled. Proponents for early Algebra 1 argue that since the course is necessary for enrollment in higher-level science, technology, engineering, and mathematics (STEM) courses, and since that enrollment affects post-secondary and career opportunities, access to Algebra 1 should be considered an equity and civil rights issue (Stein, Kaufman, Sherman, & Hillen, 2011). Critics of a widespread, early Algebra 1 movement aver that such efforts are not supported by research and may have neutral or negative long-term consequences.

Proponents of accelerated Algebra 1 support policies and legislation referred to as the *Algebra for All* movement, to ensure that every student, regardless of race, socio-economic status, or level of parent education, will have timely access to Algebra 1 (Eddy et al., 2015). Supports point to the research of Watson & McCaroll (2010) to argue that there is a positive correlation between access to higher-level mathematics in high school and both college graduation and employment income (Watson & McCaroll, 2010).

Acceleration of Algebra 1 instruction is one of the most common ways of supporting students who are identified as gifted or high achieving in mathematics. It allows for students to have access to higher-level mathematics in high school, which correlates with desirable college graduation and employment outcomes (Watson & McCarroll, 2010). Mathematics acceleration is supported by research as an effective path for math-gifted students to learn material more efficiently (Robinson, Shore, & Enersen, 2007) and has public support as a way to align the U.S. more closely with countries that continually lead international math achievement rankings (Askew et al., 2010).

Contrariwise, opponents of widespread acceleration maintain that enrollment in eighth-grade Algebra 1 has been shown to have no effect on mathematics achievement in Grade 12

(Rickles, 2013). Further, they contend that the work of Clotfelter, Ladd, & Vigdor (2015) and Hemphill & Hill (2013) demonstrate conclusively that forced acceleration, defined as all students taking Algebra 1 in or before eighth grade, has been shown to reduce the likelihood of students progressing through a college-preparatory curriculum and increase the need for remedial mathematics classes later on.

The mathematical education of young women has come under scrutiny in recent decades. The previously-held belief that female students are not as mathematically competent as their male peers has been disproven in numerous studies (e.g., Lau et al., 2018; Lent, Lopez, & Bieschke, 1991; Pajares & Graham, 1999). Despite the lack of a statistically significant difference in overall mathematical ability, many studies show that girls and women continue to express greater uncertainty about their mathematical abilities (Ganley & Lubienski, 2016; Nix, Perez-Felkner, & Thomas, 2015; Pampaka, Kleanthous, Hutcheson, & Wake, 2011). This decreased level of mathematics self-efficacy, as compared to their male peers, likely contributes to lower participation in math and math-related degree programs and careers (Lent, Lopez,, 1993; Nix et al., 2015; Pampaka et al., 2011; Sahin et al., 2017; Wang, 2013).

Theoretical Framework

Social cognitive theory holds that there is a direct correlation between self-efficacy and behavior (Bandura 1982, 1986, 1997). A person's self-efficacy, or perception of their own abilities, influences their related motivation and effort by influencing an individual's thoughts and emotions during interactions with their environment (Bandura, 1986). High self-efficacy allows for effective management of situations and increased effort and persistence whereas poor self-efficacy causes individuals to spend more time dwelling on their perceived inadequacies and are more likely to give up when facing a challenge (Bandura, 1982).

Self-efficacy represents the amalgamation of four distinct sources: mastery experiences, vicarious experiences, social persuasion, and physiological states (Bandura, 1997). It differs from self-concept in that it does not consider degree of strength in a specific area, only overall ability (Skaalvik, 1997). This structural definition of self-efficacy has been confirmed numerous times in more recent studies since Bandura published the theory (Usher & Pajares, 2009).

Domain-specific self-efficacy, as is the case with academic studies, is a strong positive predictor of motivation and behavior in the specific discipline (Klassen & Usher, 2010; Toland & Usher, 2016). Self-efficacy for a specific subject, such as mathematics, will heavily influence what students choose to do with the knowledge and skills they have acquired (Pajares & Kranzler, 1995). Several studies have reported significant positive correlations and strong direct effects between higher mathematics self-efficacy and various mathematics outcomes such as achievement, post-secondary studies, and career choice (Hackett & Betz, 1989, Pajares & Miller, 1994).

Piaget's (1958) theory of cognitive development illuminates the effects that math acceleration programs may have on mathematics self-efficacy. The theory posits a process of cognitive growth by which children enter a series of stages: the sensorimotor stage, the preoperational stage, the concrete operational stage, and the formal operational stage. Cognitive acquisition develops over time and each stage represents a milestone at which the way an individual thinks and interacts with the world changes. Growth is transitional in nature and is initially demonstrated only part of the time. Stabilization eventually occurs and the new cognitive stage is clearly exhibited consistently in a variety of situations (Piaget, 1958).

The standard curriculum of a rigorous Algebra 1 class requires students to reason abstractly to fully absorb and integrate the new material and to make successful connections to previous learning. According to Piaget (1973), it is only upon entering the formal operational stage that individuals can reason abstractly without relying on concrete content as a support. Thus, it is necessary for students to be operating in the formal operational stage at the time they are enrolled in Algebra 1. Piaget (1969) originally associated the concrete operational stage with children roughly seven to 11 years of age and the formal operational stage with children ages 11-15. These age ranges have been pushed back by Piaget's later research and, too, by recent brain imaging studies that suggest certain brain regions, key to abstract mathematical reasoning, may not mature until late adolescence (Susac, Bubic, Vrbanc, & Planinic, 2014).

Problem Statement

Research has yielded mixed results when it comes to the benefits of widespread eighth-grade Algebra 1 and is relatively silent on the outcomes of students who enroll in Algebra 1 before Grade 8. If students enroll in Algebra 1 before they are developmentally ready to reason abstractly, they may experience negative consequences such as gaps in conceptual understanding (Clotfelter et al., 2015; Hodgen, Kuchemann, Brown, & Coe, 2010; Spielhagen, 2010). When such gaps in understanding develop during their first exposure to Algebra 1, students experience a decrease in their feelings of adequacy and enjoyment and are less likely to continue their study of mathematics altogether (Hodgen et al, 2010). These variables are also specifically of interest in the mathematical education of young women, as they are currently and historically underrepresented in certain STEM fields, including mathematics (Miller, Eagly, & Linn, 2015; National Science Foundation, 2017). Even in the absence of any statistically significant difference in mathematical ability, numerous studies have found gender to be an important factor in student mathematics self-efficacy, with male students expressing higher levels of mathematics self-efficacy than their female peers (Ferla, Valcke, & Cai, 2009; Goetz, Bieg, Ludtke, Pekrun,

& Hall, 2013; Joët, Usher, & Bressoux, 2011; Lent et al., 1993; Pajares & Miller, 1994; Skaalvik et al, 2015; Williams & Williams, 2010).

Spielhagen (2010) found that students who are not chosen for the accelerated Algebra 1 track are, later, less enthusiastic about their mathematics experiences and end up taking fewer math classes overall. The experience of chosen/not chosen may increase the self-efficacy of one student, while decreasing the self-efficacy of another (Usher & Pajares, 2009). If the selection of some students for acceleration programs gives other students the perception that they are not good at mathematics (because they were not chosen to be part of an acceleration program), this single experience might be increasing the self-efficacy of the students chosen for the acceleration program while decreasing the self-efficacy of the students who were not chosen. Previous studies have noted that premature mathematics acceleration often leads to deficits in later math courses, such as Algebra 2 and Precalculus (Hemphill & Hill, 2013; Rickles, 2013). To succeed in mathematics, a student must persist and, as self-efficacy is the strongest predictor of persistence (Skaalvik et al., 2015), a correlation between math acceleration and mathematics self-efficacy seems quite possible. This would be consistent with the findings of Schunk and Pajares (2002) who established a correlation between ability groupings and decreased self-efficacy of those individuals relegated to lower groups. The problem is that any potential correlation between degree of mathematics acceleration and mathematics self-efficacy has not been investigated; any potential relationship would be of interest to parents, math educators, and school administrators.

Purpose Statement

The purpose of this causal-comparative study was to compare the effect of degree of mathematics acceleration and gender on mathematics self-efficacy. The independent variables were gender and degree of mathematics acceleration, which was defined as the year when the student first enrolled in Algebra 1. The degree of mathematics acceleration was defined in accordance with Hemphill and Hill's (2013) assertion that ninth grade is the traditional timing for Algebra 1. The dependent variable of the study was mathematics self-efficacy, defined as students' perception of their abilities in mathematics (Skaalvik, Federici, & Klassen, 2015). Mathematics self-efficacy was determined by the students' scores on the Mathematics Self-Efficacy Scale (MSES) (Betz & Hackett, 1983). The participants of the study were 158 Algebra 2 and Precalculus students at private metropolitan schools in a northwestern state. At the time of data collection, these students were only 1.5-2.5 years removed from their Algebra 1 experience, which reduced the number of outside factors that may have affected the dependent variable of mathematics self-efficacy.

Significance of the Study

This study seeks to add to the current body of knowledge in the area of mathematics self-efficacy and how it may be related to gender and how quickly students accelerate through their mathematics courses. Domain-specific self-efficacy measures, such as in the context of secondary mathematics, are strong positive predictors of academic behavior and motivation in that same domain (Klassen & Usher, 2010; Toland & Usher, 2016). This has been demonstrated in the specific context of mathematics, with positive correlations observed between mathematics self-efficacy and positive academic behaviors and achievement in mathematics (Bonne & Johnston, 2016; Higbee & Thomas, 1999; Skaalvik et al., 2015). Therefore, it is appropriate for educators to be concerned with how their actions and instructional decisions affect the mathematics self-efficacy of their students (Bonne & Johnston, 2016).

This study aims higher and farther; another goal is to add to the body of knowledge regarding the correlation between mathematics self-efficacy and gender in mathematics education. Mathematics self-efficacy has been identified as a key factor affecting whether women choose to pursue STEM degree fields and careers (Nix et al., 2015; Wang, 2013). Men are currently choosing to pursue mathematics after high school at three times the rate of their female peers (NSF, 2017). Since mathematics self-efficacy influences this decision, it follows that better understanding of mathematics self-efficacy in female students may lead to improvements in pedagogy, yielding a higher percentage of women pursuing math and math-related fields after high school.

Understanding the relationship between mathematics self-efficacy and acceleration programs will allow K-12 mathematics educators and administrators to implement and administer mathematics acceleration programs appropriately and effectively. If there is a correlation between accelerated Algebra 1 and student mathematics self-efficacy, this paper will be a call to action for additional research. Future investigators will have to determine how to maximize mathematics self-efficacy for students who participate in mathematics acceleration programs as well as for those who do not. Educators and administrators at elementary and secondary levels should be aware of such a correlation in order to create and administer mathematics acceleration programs that maintain or increase self-efficacy levels for all students.

Research Questions

RQ1: Is there a statistically significant difference between the mathematics self-efficacy scores of math students who are 0, 1, or 2 years accelerated in mathematics?

RQ2: Is there a statistically significant difference between the mathematics self-efficacy scores of male and female math students?

RQ3: Is there a statistically significant interaction among the mathematics self-efficacy scores of male and female math students who 0, 1, or 2 years accelerated in mathematics?

Definitions

1. *Learning-Related Emotions* – The affective aspect of the learning process which can affect student academic behavior (Pekrun, 2006, 2017; Pekrun, Goetz, Titz, & Perry, 2002)
2. *Math acceleration* – The process of enrolling students Algebra 1 prior to Grade 9, which has been the traditional timing until recent years (Hemphill & Hill, 2013).
3. *Mathematics self-efficacy* – An individual's beliefs or perceptions regarding their abilities in mathematics, which cannot be generalized across grade levels or to other subjects (May, 2009; Usher & Pajares, 2009).
4. *Mindset* – The term coined by Stanford professor Carol Dweck (2016) to represent how individuals view their own intelligence. *Fixed mindset*, previously referred to in research as *entity theory*, in which an individual believes that their intellectual abilities are fixed an unable to be changed. In contrast, *growth mindset*, previously referred to as *incremental theory*, refers to the belief that one's intelligence can be increased through effort.
5. *Reciprocal determinism* – Personal agency and environmental input combine to determine behavior, as posited in Bandura's (1986, 1997) social cognitive theory.
6. *Self-efficacy* – An individual's beliefs about his or her own abilities, which addresses the question "Can I do it?" (Skaalvik, 1997).

CHAPTER TWO: LITERATURE REVIEW

Overview

This study is anchored in cognitive and learning theories, as well as growing bodies of literature supporting their importance. This chapter provides an overview of all relevant aspects of both Bandura's self-efficacy theory (1982, 1986, 1997) and Piaget's theory of cognitive development (1958, 1969, 1970, 1973). Major studies in the specific areas of academic self-efficacy and mathematics self-efficacy are also included, along with studies addressing the processes, causes, and effects of mathematics acceleration programs in schools. This body of literature serves as the foundation for a comparison between the mathematics self-efficacy of secondary math students and both their gender and degree of mathematics acceleration.

Theoretical Framework

Self-Efficacy Theory

Within the larger context of social cognitive theory, self-efficacy theory explains that an individual's motivation, behavior, and performance are influenced by their perceived self-efficacy, their judgments of their own ability to successfully perform a specific behavior or task (Bandura, 1982, 1986, 1997). Self-efficacy addresses questions like "Can I do it?" which is different from other psychological concerns, such as self-concept, which addresses questions such as "Am I good at it?" (Skaalvik, 1997). An individual's self-efficacy will influence their thought patterns and emotional reactions as they interact with the environment (Bandura, 1982). The influence of self-efficacy cannot be overstated; it shapes one's life course by influencing the activities and behaviors people willingly engage in (Bandura, 2001). Self-efficacy theory has numerous applications within diverse settings such as healthcare and academics (Bandura, 1986).

An individual's overall self-efficacy is the result of four distinct sources. The most powerful of these sources is the interpretation of previous attainments, or *mastery experiences*. The other sources are a person's *vicarious experiences*, or observations of others, *social persuasion*, feedback from others such as parents or teachers, and their *emotional and physiological states* (Bandura, 1997). Each of these factors has been consistently confirmed in more recent studies (Usher & Pajares, 2009).

The effects of self-efficacy. Self-efficacy affects an individual's motivation, effort, and overall performance. For a person to function competently, an individual requires skill leavened with self-efficacy (Bandura, 1986). High self-efficacy usually leads to positive outcomes. Individuals with high self-efficacy are more likely persist in the face of obstacles – greater self-efficacy will usually lead to greater effort, further development of skills, and greater overall success (Bandura, 1986). Once self-efficacy is firmly established, occasional failures will not significantly decrease it; these failures will be attributed to a lack of sufficient effort, rather than a lack of ability (Bandura, 1986). While high self-efficacy is usually associated with positive outcomes, it is possible for an individual to overestimate his or her capabilities. When that occurs, the individual may undertake activities beyond their current reach, leading to difficulties and needless failure (Bandura, 1986).

While increased self-efficacy usually leads to an increase of positive outcomes, decreased self-efficacy often leads to negative outcomes and the foreclosure of future opportunities. Individuals with low self-efficacy are not spurred to greater achievement in the face of obstacles. Instead, they are often overcome with doubt and what they perceive to be their own inadequacies, leading to the inability to manage their situation (Bandura, 1982). Low self-efficacy often leads to avoidance of activities, a self-limiting behavior; trying and failing is interpreted as evidence of a lack of skill or knowledge (Bandura, 1986).

Reciprocal determinism. An integral component of social cognitive theory is the model of reciprocal determinism, which posits that personal agency and environmental input both determine individual behavior (Bandura 1986, 1997). In the specific context of self-efficacy, this claim can be interpreted as self-efficacy serving as both cause and effect of achievement (Bandura, 1997). Marsh (1990) promoted the mutual reinforcement of self-beliefs and achievement as the reciprocal effects model, while Schunk and Zimmerman (2007) later presented the relationship between cognition, behavior, and environment as the triadic reciprocal model. Both models were consistent with Bandura's previous theory of reciprocal determinism and only expanded upon details regarding the involved factors and interactions.

Many recent studies have confirmed the theory of reciprocal determinism through longitudinal investigations of high school and university students (Parker, Marsh, Ciarrochi, Marshall, & Abduljabbar, 2014; Retelsdorf, Koller, & Moller, 2014). When multiple measurements of both self-efficacy and achievement are staggered over a number of years, positive results in both a self-efficacy → achievement → self-efficacy pattern and an achievement → self-efficacy → achievement pattern were identified (Hwang, Choi, Lee, Culver, & Hutchison, 2016). Villafañe, Xu, & Raker (2016) confirmed the reciprocal relationship between self-efficacy and achievement in the specific academic domain of organic chemistry. Schöber, Schütte, Köller, McElvany, and Gebauer, (2018) were able to confirm that the reciprocal relationship reliably exists within the specific context of mathematics. By using the results of the Program for International Student Assessment, Williams and Williams (2010) were able to identify that the reciprocal relationship between mathematics self-efficacy and mathematics achievement exists globally and not just in the United States.

Additional research seems to suggest that the reciprocal relationship between self-efficacy and achievement may be stronger in mathematics than in reading (Jansen, Lüdtke, & Schroeders, 2016). More research is necessary in a variety of academic disciplines to determine whether the reciprocal relationship between self-efficacy and achievement is reliably present in other discrete domains.

Mediating factors. Rather than identifying a direct relationship between self-efficacy and achievement, Bandura (2006) explained the relationship as self-efficacy affecting self-regulation processes, which include, but are not limited to, goal setting, self-monitoring, self-evaluation, and self-reaction. When individuals are effective at self-regulation during the learning process, they can successfully plan, monitor, and evaluate their own learning in order to adapt their own strategies as they deem necessary (Pekrun, Goetz, Titz, & Perry, 2002). It is, then, these self-regulation processes that yield positive academic outcomes including achievement. Individuals with high academic self-efficacy are confident in their ability to plan, organize, and then complete their academic work (Bandura, 1997). While many studies consider direct effects of self-efficacy on achievement in the context of reciprocal determinism, other studies have investigated possible and specific mediating factors that bridge the gap between academic self-efficacy and academic outcomes. Jung, Zhou, & Lee (2017) posited that effort plays a role in the effect that academic self-efficacy has on achievement, however the specific role is still unclear. This explanation is similar to other studies that have identified intrinsic motivation and interest as mediating factors in the reciprocal relationship between academic self-efficacy and achievement (Ganley & Lubienski, 2016; Honicke & Broadbent, 2016).

In adolescence, emotions are strongly linked to achievement (Pekrun, 2017). Learning-related emotions (LREs) represent the affective experiences of students during their academic journeys and have also been investigated within the reciprocal relationship between academic self-efficacy and academic achievement that exist in the form of feedback loops (Pekrun, 2006; Pekrun et al., 2002). Academic emotions are specific to each academic domain and in the context of learning, these emotions provide motivational energy in addition to focusing attention and modulating thinking (Pekrun et al., 2002). Numerous studies have shown that desirable LREs, such as enjoyment and satisfaction, are associated with increased effort and interest, and are also significant predictors of academic performance, leading to positive feedback loops; undesirable LREs, such as boredom and disappointment, reduced task-related attention and led to decreased performance and negative feedback loops (Pekrun, 2006; Pekrun, 2017; Putwain, Sander, & Larkin, 2013). Experiencing confusion while working on a challenging problem can increase motivation, but only if the student has the confidence that he or she is able to eventually solve the problem (Pekrun, 2017). Academic self-efficacy has been shown to be a predictor of LREs, therefore influencing achievement. The relationships between academic self-efficacy, LREs, and achievement are also reciprocal in nature. LREs influence future achievement and the perceived outcomes of academic endeavors can affect future LREs, academic self-efficacy, and performance. The time it takes for one variable to significantly affect another is not clear (Pekrun et al., 2002; Putwain et al., 2013) and feedback loops may cycle as quickly as fractions of seconds or as slowly as weeks, months, or even years (Pekrun, 2006).

The development of self-efficacy. Self-efficacy, regardless of accuracy, is based on four principal sources of information: mastery experiences, vicarious experiences, social persuasions, and emotional and physiological states; mastery experiences are the most influential (Badura, 1986, 1997; Bandura, Adams, & Beyer, 1977). An individual's perceived self-efficacy is raised as the result of successes and lowered by repeated failures, especially when the failures occur early on and are not the result of a lack of effort (Bandura, 1986). Just as authentic mastery experiences affect self-efficacy, to a lower degree so do the comparisons that an individual makes between them and others. The perception of triumph over others raises self-efficacy, while it is decreased by the perception of being outperformed by a colleague, peer, or acquaintance (Bandura, 1986). While some individuals are able to quickly recover their sense of self-efficacy, others cannot do so and lose confidence in their abilities altogether (Bandura, 1986).

The development of self-efficacy during childhood is especially unstable. Since children possess only limited cognitive skills and experience, it is not possible for them to accurately gauge their cognitive and behavioral capabilities (Bandura, 1986). Children have difficulty processing multiple sources of efficacy information and differentiating non-ability factors and inappropriate social comparisons, which results in a dependency upon immediate outcomes (Bandura, 1986).

The role of schools in the development of self-efficacy. Childhood is the crucial period for the development of self-efficacy and the school serves as the primary setting (Bandura, 1986). Considering the numerous positive short- and long-term outcomes associated with high self-efficacy, educators should be concerned with how their practices affect self-efficacy, in addition to skill development. When educational practices are effective in both skill development and the formation of strong self-efficacy, children are well-equipped for the future and can learn on their own initiative (Bandura, 1986). The reality, however, is that many school practices are inadvertently detrimental to the self-efficacy of children. Practices such as lockstep sequences of instruction, ability grouping, and competitive practices are likely to negatively impact the self-efficacy of the many for the sake of the self-efficacy of the few (Bandura, 1986). The decreasing of self-efficacy in the school environment is detrimental to the goal of academic achievement. The fact that it is unintentional is of no importance. If students feel they are incapable of academic excellence, they are unlikely to strive for rewards that require a seemingly unattainable level of performance, including certain college and career options (Bandura, 1986). This is especially true for female students, who more often have a lower sense of mathematical self-efficacy and tend to decide against pursuing any science-based college majors; schools must support young women to believe strongly in their abilities for them to pursue nontraditional career paths (Bandura, 1986).

Theory of Cognitive Development

Throughout most of the 20th century, Jean Piaget developed and refined his theory of cognitive development (Inhelder & Piaget, 1958, 1969; Piaget 1970, 1973, 1977). His theory focused on four stages of development, each defined by the specific ways that individuals understand and relate to what is happening around them. The first stage, the sensorimotor stage, describes how an infant understands the world. Characteristics of the sensorimotor stage include the progressive acquisition of object permanence and the ability to link numbers to objects (Ojose, 2008; Piaget, 1977). The second stage of cognitive development, the preoperational stage, marks the time of increased language ability, symbolic thought, and minimal rational thought and logic (Ojose, 2008). From the preoperational stage, children transition into the concrete operational stage, a period of significant cognitive growth. It is during this period that language, basic logic, and other skills increase rapidly (Ojose, 2008; Piaget, 1977). During the final stage of cognitive development, the formal operations stage, adolescents gain the ability to generalize and evaluate logical arguments through clarification, inference, evaluation, and application. It is during the formal operations stage that the development of abstract reasoning occurs (Ojose, 2008; Piaget, 1977).

The formal operational stage. The formal operational stage, which adolescents enter sometime between the ages of 11 and 15, is critical in allowing individuals to move past the necessity of the concrete and into an understanding of reality within a group of possible transformations (Piaget, 1969). Before entering the formal operational stage, children can perform operations related to grouping and reversibility, however individual skills cannot be integrated into a formal logic. Abstract reasoning is not possible before the age of 11 or 12; this ability does not reach its equilibrium until around 14-15 years of age (Inhelder & Piaget, 1958; Piaget, 1973). While entry into the formal operational stage is not a direct consequence of puberty, the appearance of formal thought is the manifestations of cerebral transformations which do relate to the maturation of the nervous system during this time of significant physical development (Inhelder & Piaget, 1958). It is also during this stage that adolescents gain the ability to think metacognitively and reason hypothetically (Ojose, 2008). This change in cognitive ability allows for complex induction and the ability to prove transformations and the effectiveness of related factors and processes (Piaget, 1969).

Implications for mathematics education. Algebra 1 is usually the first course in which students experience abstract mathematical reasoning. This transition to abstract mathematical cognition and symbolic language is necessary for later success in both math and science (Susac, Bubic, Vrbanc, & Planinic, 2014). Inhelder and Piaget (1958) first hypothesized that this type of mathematical reasoning cannot take place until adolescents have achieved the formal operational stage (likely after age 12); before that point, logic is applied only to concrete objects, which is not enough to properly develop the skills related to Algebra 1. This transition in mathematical ability from the concrete operation stage to the formal operational stage often lasts until the age of 15-16, which has been confirmed through recent research in education and neuroscience (Ghazi, 2014; Susac et al., 2014).

Algebra is communicated through symbolism, which demands abstraction (Piaget, 1970). Abstract reasoning requires the ability to reason on pure hypotheses (the absence of concrete objects) to arrive at a coherent deduction (Piaget, 1973). Such is the case when a student must solve a formula for an unknown value based on the relationships it has with other values (Inhelder & Piaget, 1958). In mathematics, everything is interconnected, as it is an entirely deductive discipline. If a student has failed along the way, he or she may not be able to understand what follows, leading to unnecessary doubt of ability (Piaget, 1970).

Related Literature

Academic Self-Efficacy

Academic self-efficacy refers to an individual's beliefs about their domain-specific competencies in a discrete academic subject, their context-specific study behaviors, and their confidence in achieving specific academic outcomes within that subject (Hoigaard, Kovač, Øverby, & Haugen, 2015; Putwain et al., 2013). In the context of an academic class, a student's self-efficacy will partially determine what they choose to do with the knowledge and skills that they have acquired. Academic self-efficacy is a particularly important form of self-efficacy in adolescence (Rocchino, Dever, & Telesford, 2017). Measures of domain-specific self-efficacy, such as in the context of academic disciplines, are strong positive predictors of academic behavior and motivation in that same domain as well as later decisions regarding educational and career options (Bandura, Barbaranelli, Caprara, & Pastorelli, 1996; Klassen & Usher, 2010;

Toland & Usher, 2016). Academic self-efficacy most notably affects academic achievement, as measured by assessments. Motivational and psychological outcomes are also positively affected (Atik & Atik, 2017; Drago, Rheinheimer, & Detweiler, 2018; Hoigaard et al., 2015; Huang, 2013; Talsma, Schuz, Schwarzer, & Norris, 2018). These outcomes influence students with higher levels of self-efficacy to consider more options in their post-secondary studies and career choices (Bandura et al., 1996; Hacket & Betz, 1989; Pajares & Miller, 1994).

Academic self-efficacy and academic self-concept. Academic self-efficacy and academic self-concept are distinct, yet related, psychological constructs, even when considered in the context of the same domain (Ferla et al., 2009). While academic self-efficacy is usually representative of a student's self-perceived confidence to perform well on a specific academic task, self-concept relates more to the student's self-perception within a given academic area at a more general level (Bong & Skaalvik, 2003; Ferla et al., 2009; Schunk, 1991). A student's academic self-concept strongly influences his or her academic self-efficacy beliefs, however academic self-efficacy does not influence academic self-concept. As academic self-concept is oriented to the past, it is relatively stable and a good predictor for affective-motivational variables. Academic self-efficacy, however, is future-oriented, as well as content- and task-specific, which makes it a better direct predictor for academic achievement (Bong & Skaalvik, 2003; Ferla et al., 2009). Both academic self-efficacy and academic self-concept have been found to play similar roles in mediating variables such as gender, prior knowledge, and cognitive skills on positive outcomes such as achievement (Ferla et al., 2009; Pajares & Kranzler, 1995).

Academic self-efficacy and achievement. The relationship between academic self-efficacy and achievement has been studied extensively, likely due to its application in educational instruction and interventions. Academic self-efficacy has a consistently positive and significant correlation with academic success for individuals over a wide range of ages and learning environments (Honicke & Broadbent, 2016). Academic self-efficacy has the power to predict student achievement as much as, or even more than, previous academic performance and identified mental ability (Pajares & Kranzler, 1995).

A common interpretation of academic success in previous studies relating to academic self-efficacy is the measurement of student Grade Point Average (GPA). Academic self-efficacy has positive and significant effects on GPA (Drago et al., 2018; Larson, Stephen, Bonitz, & Wu, 2014). Klassen and Usher (2010) estimate that academic self-efficacy accounts for approximately 25% of the variance in student academic outcomes while Richardson, Bond, and Abraham (2012) suggest that academic self-efficacy accounts for 9% of the variance in university students' GPA specifically, and predicting overall credit accumulation generally. The academic success of students with higher levels of academic self-efficacy is further supported by the fact that they are also more likely to persist with academic difficulties and make changes as needed to improve their own learning strategies in response to failure (Mega, Ronconi, & De Beni, 2013). They are also rated by their teachers as exhibiting more effort in the classroom environment, leading, again, to higher achievement scores on standardized tests (Gall et al., 2014).

Academic self-efficacy and resilience. In addition to academic achievement, resilience is significantly and positively correlated with academic self-efficacy; students with increased self-efficacy are likely to persist when faced with obstacles (Bandura, 1997; Cassidy, 2015; Larson et al., 2014; Pajares & Kranzler, 1995). Academic self-efficacy is necessary for students to be able to effectively deal with obstacles and setbacks during their academic careers, which makes it important for students who are at risk for failing and dropping out of school (Amitay &

Gumpel, 2015; Mann, Smith, & Kristjansson, 2015; Peguero & Shaffer, 2015). It follows that structuring the learning environment to improve students' academic self-efficacy may be an effective strategy to decrease levels of failure and dropout (Forrest-Bank & Jenson, 2015; Rocchino et al., 2017).

Academic self-efficacy and other correlates. While high levels of academic self-efficacy have been shown to have a positive correlation with academic achievement and with resilience, there is a growing body of literature related to other positive effects of increased academic self-efficacy. One such correlate, reduced procrastination, is behavior-related, while several other identified correlates are internal, such as anxiety and depression.

The relationship between self-esteem and procrastination behavior has previously been studied and academic self-efficacy seems to fully mediate the relationship between self-esteem and academic procrastination (Pajares & Valiante, 2002; Klassen, Krawchuck, & Rajani, 2008; Klassen et al., 2010). This is valuable knowledge in designing curriculum and instructional strategies, as procrastination is an undesirable student behavior associated with numerous negative outcomes (Batool, Khusheed, & Jahangir, 2017).

Academic self-efficacy has been found to have significant and negative correlations with negative internalizing behaviors in adolescents including anxiety, and depression (Rocchino et al., 2017). The school experience can cause significant stress for students. Academic self-efficacy can reduce that stress via its relationship with academic achievement (Huang, 2013). Anxiety, which is a concern in the context of academic performance, is largely related to academic self-efficacy (Bandura, 1986). Academic self-efficacy has been identified as the most significant area of self-efficacy in the prediction of adolescent anxiety and depression; high self-efficacy can reduce the likelihood of students experiencing these detrimental feelings (Bandura, Caprara, Barbaranelli, Gerbino, & Pastorelli, 2003; Muris, 2002).

Encouraging academic self-efficacy. Educators can influence academic self-efficacy because it is incredibly malleable during adolescence (Pajares, 1996; Schunk & Pajares, 2009). Understanding the effects that high academic self-efficacy has on an array of positive outcomes is essential for educators to increase their students' academic self-efficacy. The natural implementation of the knowledge gleaned from the area of academic self-efficacy is designing and implementing school interventions with the goal of increasing academic performance (Talsma et al., 2018). Curriculum and instruction can be structured in a way that promote a student's academic self-efficacy and overall academic performance (Honicke & Broadbent, 2016). Guided mastery, the process of setting up students for success by gradually reducing required scaffolding in authentic performance experiences is an example of a strategy that educators can use to promote academic self-efficacy (Pajares & Schunk, 2001). Guided mastery lies at the intersection of academic self-efficacy and provides students the opportunity for mastery experiences, the most influential factor of self-efficacy (Badura, 1986, 1997; Bandura et al., 1977).

Mathematics Self-Efficacy

The National Science Board (NSB) (2018) reported that less than half of fourth, eighth, and twelfth grade students reached proficiency in mathematics, as measured by the National Assessment of Educational Progress (NAEP). In 2015, American secondary students ranked 40th in math when compared to other countries; scores in science and reading were 25th and 23rd, respectively. Related to this concern is the fact that the United States, a global leader in technology, is currently producing an inadequate number of STEM graduates, as compared to other developed countries (Chen & Soldner, 2013; Sass, 2015); mathematics, engineering and physics are of specific concern (Boe, Henriksen, Lyons, & Schreiner, 2011). This skills gap was a significant contributor to fact that nearly 6-million U.S. jobs were unfilled at the end of 2017 (U.S. Congress Joint Economic Committee, 2018). Only about one-third of 2014 college graduates in the U.S. received STEM degrees, compared to Japan, where over 50% of university graduates received STEM degrees, and to China, where nearly 50% of university graduates received STEM degrees (NSB, 2018). A significant amount of research has examined these concerns, with emphasis on their causal factors and the search for solutions (Sahin, Ekmekci, & Waxman, 2017).

Mathematics self-efficacy has been identified as a factor that may address both the lack of mathematics proficiency found in U.S. students, as well as their lack of interest in pursuing STEM fields (Rice, Barth, Guadagno, Smith, & McCallum, 2013; van Aalderen-Smeets & Walma van der Molen, 2018). The importance of mathematics self-efficacy is also the result of the esteem that mathematics holds in American academic curriculum, as well as its role in high-stakes standardized testing and college admissions (Pajares & Graham, 1999). Research relating to mathematics self-efficacy has mostly focused on the elementary, middle, and high school years, which have been identified as critical times leading to outcomes of interest and success in STEM fields (Tai, Liu, Maltese, & Fan, 2006; Wang, 2013). As opposed to other predictors of achievement such as socioeconomic status, mathematics self-efficacy in adolescence is quite malleable (Cheema & Kitsantas, 2014); it can be influenced by experience, social environment and implicit beliefs (van Aalderen-Smeets & Walma van der Molen, 2018).

Several studies have reported significant and positive correlations and strong direct effects between math self-efficacy and various desirable mathematics outcomes (e.g., Bonne &

Johnston, 2016; Cheema, 2018; Cheema & Kitsantas, 2014; Parker et al., 2014; Skaalvik, Federici, & Klassen, 2015). Self-efficacy has become a key element in the argument for the consideration of psychological factors in the context of mathematics education. Studies that have focused on the correlation between self-efficacy and mathematics achievement have reported a consistent, positive correlation (Bonne & Johnston, 2016). Skaalvik et al. (2015) found that self-efficacy is the strongest predictor of persistence and intrinsic motivation when one is engaged in a difficult problem-solving situation. In contrast, students who have poor mathematics self-efficacy experience decreased levels of motivation, which often results in low achievement. An increase in positive emotions and self-efficacy increases student mathematics achievement rather than decreases it (Higbee & Thomas, 1999). There is, therefore, value in the intentional focus of mathematics educators on their students' psychological experience. This focus can be effectively expressed through actions and instruction that encourages student self-efficacy (Bonne & Johnston, 2016). It is important to note that a student's mathematics self-efficacy is context-specific. The relationship between subject and self-efficacy cannot be generalized to other subjects or across grade levels (Usher & Pajares, 2009).

Mathematics self-efficacy outcomes. Continued lackluster performance in international mathematics achievement rankings and increased attention on high-stakes testing in recent years has put a spotlight on mathematics achievement. It is, therefore, not surprising that the bulk of mathematics self-efficacy research has focused on its relationship to mathematics achievement. Research findings consistently support a strong positive relationship between the two variables (Ayotola & Adedji, 2009; Bonne & Johnston, 2016; Erturan & Jansen, 2015; Galey & Lubienski, 2016; Pantziara & Philippou, 2015; Parker et al., 2014; Skaalvik et al., 2015). This relationship has been validated both at the beginning of academic years as well as at the end (Pajares &

Graham, 1999; Roick & Ringeisen, 2018) and has been shown to be stronger than the relationship between general self-concept and mathematics achievement (Pajares & Miller, 1994). In addition to being positively correlated with future achievement, the correlation between mathematics self-efficacy and prior achievement in mathematics has also been shown to be positive and significant (Cheema & Kitsantas, 2014; Pampaka et al., 2011); this finding of two-dimensional relationship may be evidence of reciprocal determinism within the specific domain of mathematics.

In their study which utilized data from the Program for International Student Assessment (PISA) 2003 survey representing over 4,000 15-year olds across the United States, Cheema and Kitsantas (2014) found that an increase of 1 standard deviation in math self-efficacy resulted in an increase of 0.35 standard deviations in mathematics achievement. Using 2012 PISA data, Kalaycioğlu (2015) was able to expand the study population to include students tested in England, Greece, Hong Kong, the Netherlands, Turkey, as well as the United States. Mathematics self-efficacy was identified as the most important predictor of mathematics achievement for all countries involved in the study. Other predictors of math achievement, such as socioeconomic status and anxiety toward mathematics, varied in importance among countries. The same 2012 PISA data revealed a strong, positive correlation between mathematics self-efficacy and mathematics literacy among Greek high school students (Cheema, 2018). This relationship was consistent even after controlling for other variables such as gender, parental education, availability of school resources at home, and school-level differences such as school type, student-teacher ratio, and school-level socioeconomic status. Using a sample of 5,200 American students, Kitsantas, Cheema, and Ware (2011) found that mathematics self-efficacy was able to predict nearly half of the variation in mathematics achievement. Mathematics self-efficacy had the strongest effect on mathematics achievement for all countries; its effect was larger than that of both socioeconomic status and math anxiety. It is possible that the effect on achievement may also be the result of the positive and significant relationship between mathematics self-efficacy and rate of change in math performance; higher levels of mathematics self-efficacy have been associated with a faster rate of improvement in mathematics over time (Galla, Wood, Tsukayama, Har, Chiu, & Langer, 2014). Mathematics self-efficacy is an important predictor of achievement in mathematics. Assessing students' mathematics self-efficacy can be an insightful process for mathematics educators, school counselors, and administrators (Bandura, 1997; Pajares & Kranzler, 1995; Pampaka et al., 2011; Schunk, 1991).

In addition to mathematics achievement, mathematics self-efficacy has also been positively correlated with numerous other desirable outcomes. Mathematics self-efficacy has been found to better predict a student's academic and career choices than does their past mathematics performance (Hackett & Betz, 1989). Students with higher mathematics self-efficacy go on to pursue higher levels of STEM degrees and careers (Lent, Lopez, & Bieschkle, 1993; Nix et al., 2015; Pampaka et al., 2011; Sahin et al., 2017; Wang, 2013); mathematics self-efficacy was a higher predictor of advanced studies in mathematics than was previous achievement in mathematics (Pampaka, 2011). Levels of mathematics self-efficacy during adolescence have been shown to predict future participation in STEM courses, even when prior achievement is controlled (Pajares & Kranzler, 1995; Parker et al., 2014).

The ability to self-regulate the learning process is positively and significantly correlated with mathematics self-efficacy (Usher, 2009); it is the strongest predictor of both intrinsic motivation, persistence during problem solving, and help-seeking behavior. This is true even when controlled for academic performance and teacher emotional support. Students with poor mathematics self-efficacy, however, experience lower levels of motivation which results in lower mathematics achievement (Skaalvik et al., 2015). Further, higher levels of mathematics self-efficacy increased students' interest in mathematics (Pantziara & Philippou, 2015), increased classroom engagement (Pajares & Graham, 1999), and decreased the likelihood of dropping a mathematics course (Pampaka et al., 2011).

Encouraging mathematics self-efficacy. Several promising strategies have been posited by researchers as effective options to increase mathematics self-efficacy during adolescence. Teachers providing students with perceived mastery experiences to positively affect their students' mathematics self-efficacy in mathematical tasks is a common recommendation from researchers (Bonne & Johnston, 2016; Pantziara & Philippou, 2015). This suggestion directly relates to self-efficacy theory, in which Bandura (1997) identified mastery experiences as one of the primary sources of self-efficacy. Perceived mastery experiences are powerful influences of students' mathematics self-efficacy because the experiences provide students with success in challenging assignments. Their perceived success boosts their self-efficacy beliefs (Usher & Pajares, 2009). The cycle is real, significant and, most importantly, begins with students' perceptions of their own mathematics abilities and success.

Specific classroom interventions have also been researched and found to be effective. Brisson et al. (2017) implemented an intervention based on the relevance of mathematics. Grade 9 students were asked to reflect in writing about quotations presented to them focused on the utility of mathematics. They were also presented with specific examples about how mathematics is used in a variety of situations and careers and the required time for the activity and written responses was only 90 minutes in class with two reinforcement tasks at home. Significant increases were observed in self-efficacy, test scores, and teacher-observed effort for several months following the intervention (Brisson et al., 2017).

In their study focusing on increasing mathematics self-efficacy in elementary students, Bonne & Johnston (2016) focused on classroom instructional practices promoting regular, evidence-based feedback of progress in relation to specific goals. The feedback was related to both domain-specific and task-specific situations; the pedagogical strategy served as an application of Bandura's (1997) view of the important of students' perceived mastery experiences. The classroom-based intervention yielded significant increases in both mathematics self-efficacy and achievement (Bonne & Johnston). This implementation furthered the previous work of Siegle and McCoach (2007).

Mathematical mindset. While providing students perceived mastery experiences in the classroom has been explored to a great extent and is directly related to self-efficacy theory, other sources of mathematics self-efficacy have been introduced and have been investigated in recent studies. Bandura (1993) claimed that self-efficacy can be positively influenced by learning environments that encourage the idea that learning can be acquired. The implicit beliefs that students have about their own learning potential have been explored in depth by researchers Carol Dweck and Jo Boaler, both of Stanford University, along with their colleagues (Boaler, 2013; Boaler, Dieckmann, Pérez-Núñez, Sun, & Williams, 2018; Boaler & Sengupta-Irving, 2006; Dweck 2000, 2007, 2016; Mangels, J. A., Butterfield, B., Lamb, J., Good, C., & Dweck, C. S., 2006). These underlying core beliefs that students hold regarding the growth potential of their own intelligence are separate from their actual abilities and not articulated in students' minds, yet create a psychological framework guiding their beliefs of their own abilities. Students either hold an *entity theory*, also referred to as a *fixed mindset*, or they hold an *incremental* *theory*, also referred to as a *growth mindset*. An entity theory supposes that a student's intellectual abilities and capabilities are fixed and unable to be changed, whereas an incremental theory shifts intelligence to being, at least partially, within a student's control. It assumes that while there are differences in natural intelligence, each individual has the ability to increase their intelligence through effort (Boaler, 2013). Students who hold entity beliefs focus more on external performance criteria and are more likely to withhold effort and give up in when faced with challenges and failures; they view these situations as proof of their lack of ability (Usher, 2009), which decreases their self-efficacy; the same situations do not damage the self-efficacy of students who hold incremental beliefs, as they view failure as the result of a lack of effort, which they have control over (Dweck, 2000). This difference can be found even at the neuronal level, where students who hold an entity mindset and experience setbacks do not process feedback from the experiences as effectively due to less sustained memory-related activity and reduced effortful encoding of the feedback information (Mangels et al., 2006). The effect that entity beliefs have on mathematics self-efficacy may become even more pronounced during the high school years, as the increasingly challenging nature of the material has been shown to decrease students' mathematics self-efficacy (Chen & Zimmerman, 2007).

As would be an expected from these previous studies, van Aalderen-Smeets & Walma van der Molen (2018) found that implicit beliefs do influence students' decisions to pursue further STEM studies and careers. Intentionally explaining the significance of, and then influencing, incremental implicit beliefs during the secondary school years is a logical approach to increasing STEM participation (Parker, Lüdtke, Trautwein, & Roberts, 2012; van Aalderen-Smeets & Walma van der Molen (2018). Implementing classroom and online interventions which focused on teaching students about the brain processes related to learning mathematics, as well as how implicit beliefs shape their response to challenge, resulted in increased mathematics self-efficacy post-intervention (Boaler, 2013, 2018; Bonne & Johnston, 2016).

The role of support. Students' mathematics self-efficacy seems to also be affected by support levels from peers, teachers, and parents. Teacher support has been found to have a significant, positive, and direct effect on academic self-efficacy and positive academic emotions for students as young as elementary-school age (Liu et al., 2018). As students transition to secondary school and enroll in more challenging mathematics classes, they perceive decreased teacher support and increased competition with their peers; these changes in school climate may contribute to the decline in students' mathematics self-efficacy (Rice et al., 2013). Wilkins and Ma (2003) also observed this decline in attitude but found that higher parental support was associated with a less dramatic decline. Parental and teacher support has been found to be most effective when it encourages students from the perspective of a growth mindset, focusing on process, rather than personal characteristics (Brummelman, Thomaes, Orobio de Castro, Overbeek, & Bushman, 2014; van Aalderen-Smeets & Walma van der Molen, 2018). Bandura (1997) posited that self-efficacy beliefs, especially for younger children, can be even more influenced, either positively or negatively, by peers more than parents. This is especially true when the support comes from peers who students perceive as similar in key ways such as age and ability (Lau et al., 2018; Rice et al., 2013).

Gender and mathematics self-efficacy. In the United States, women have been historically underrepresented in the STEM fields (Miller, Eagly, & Linn, 2015; National Science Foundation, 2017). Careers and academic subjects in the STEM fields have typically been stereotyped as masculine in the United States and globally, which has prompted significant national effort toward encouraging female students to pursue STEM studies and careers (Miller et al., 2015; Rice et al., 2013). While more than half of all bachelor's degrees and about half of all STEM bachelor's degrees are now conferred to women each year in the United States, most women in STEM fields major in the biological, agricultural, psychological and social sciences (NSB, 2018). The lack of women entering the field of mathematics is cause for concern, as the National Science Foundation (NSF) (2017) reports that men are currently entering university mathematics programs at three times the rate of women. Self-efficacy plays a role in whether female students choose to pursue STEM degree fields and careers (Nix et al., 2015; Wang, 2013). Since there is no difference between male and female students as to how mathematics self-efficacy influences STEM intent, it follows that improving female students' mathematics self-efficacy may help increase the number of female students who choose to pursue the study of mathematics and other STEM fields (Wang, 2013).

The trope of biological differences being related to mathematical abilities is not valid. While questions about the relationship between gender and mathematics ability has festered for years, recent studies have consistently shown that there is no difference in mathematical ability between male and female students in secondary school (e.g., Ayotola & Adedeji, 2009; Boaler & Sengupta-Irving, 2006; Pajares & Kranzler, 1995; Skaalvik et al., 2015). In situations where an achievement gap was identified, it was small and, in many cases, insignificant (NSB, 2018). Self-efficacy, not achievement, appears to be the factor with the most potential influence to promote the involvement of women in mathematics.

Despite a demonstrated lack of difference in mathematical competency, male students most often express higher levels of mathematics self-efficacy than their female peers in studies evaluating the psychological construct (Ferla et al., 2009; Goetz et al., 2013; Joët et al., 2011; Lent et al., 1993; Pajares & Miller, 1994; Skaalvik et al., 2015; Usher, Ford, Li, & Weidner, in press; Williams & Williams, 2010). The relationship holds true even when male students express expending less effort in their studies of mathematics than their female peers (Chen & Zimmerman, 2007). Galla et al. (2014) hypothesized that individual academic self-efficacy may be responsible for any identified differences between the academic performances of male and female students.

This uncertainly that female students seem to have about their mathematical abilities goes beyond anything that can be identified solely by their actual mathematics achievement (Ganley & Lubienski, 2016; Pampaka et al., 2011). Lent et al. (1993) found that this difference also extended to course interest and intentions. Though drastically outnumbered by studies stating the opposite, some studies did not find any significant difference in mathematics self-efficacy between male and female students (e.g., Lau et al., 2018; Lent, Lopez, & Bieschke, 1991; Pajares & Graham, 1999). The discrepancy between findings may be the result of the context in which female students are asked to evaluate their own mathematics self-efficacy. The difference in mathematics self-efficacy between male and female students in the context of a generalized level may be more dramatic than when the females are asked to judge their confidence in solving more specific problems (Ayotola & Adedeji, 2009; Pajares & Kranzler, 1995). Further research is needed to understand how context and instrumentation may affect how female students report their mathematics self-efficacy.

Numerous explanations have been posited to explain the differences between male and female students in identified factors relating to mathematics self-efficacy. As antecedents of mathematics self-efficacy, mastery experience has been recorded as higher in male students (Joët et al., 2011; Lau et al., 2018; Usher & Pajares, 2006), while social persuasion has been identified as the primary efficacy source for female students (Usher & Pajares, 2006). Other studies were not able to identify any significant difference between male and female students in their sources of self-efficacy (Lent et al., 1991; Pajares, Johnson, & Usher, 2007).

Another hypothesis to explain these gender differences is that female students tend to express less favorable attitudes about their intellectual and mathematical abilities than boys (Ferla et al., 2009). This difference is consistent across countries, as measured by both TIMSS and PISA (Ganley & Lubinski, 2016). Gender has also been shown to be significantly correlated with anxiety toward mathematics, with female students reporting higher levels than their male peers (Pajares & Kranzler, 1995).

Females have demonstrated a strong tendency to maintain entity beliefs toward their mathematical ability, which may contribute to their lower mathematics self-efficacy beliefs (Boaler, 2013; Dweck, 2006; Nix et al., 2015; van Aalderen-Smeets & Walma van der Molen, 2018). Lent et al. (1993) found that these internalized beliefs served as a mediator of differences between male and female students regarding their mathematics-related academic choices. When self-efficacy was controlled, any difference in the interest and intention between male and female students was either eliminated or drastically reduced. Since these factors affecting female students in their study of mathematics, but not in other academic areas such as writing, these differences between male and female students may be applicable to mathematics, but may not be generalized across academic subjects (Joët et al., 2011; Lent, Lopez, Brown, & Gore, 1996; Pajares et al., 2007).

Measuring mathematics self-efficacy. Assessments of student mathematics self-efficacy are not consistent. They have been created by different researchers with different goals and ideas. The result is a pastiche of instruments with different numbers of items, type of items, type of response and content. As a result, findings from the growing body of data on student mathematics self-efficacy cannot be easily blended and generalized to positively affect pedagogical practices. Many instruments use Likert-type response formats that range from 4 to 10 categories (Morony, Kleitman, Lee, & Stankov, 2013; Pajares & Graham, 1999; Parker et al., 2014; Pintrich & De Groot, 1990; Usher & Pajares, 2009). Some self-efficacy instruments have been written in accordance with Bandura's (2006) guidelines of utilizing a 101-point response format in which students indicate their level of confidence by writing in a number between 0 and 100. A variation of these two approaches was utilized by Bong and Hocevar (2002), in which students were asked to rate their confidence on a scale ranging from 0 to 100 in 10-unit intervals. Another obstacle to generalizing results is that there is not consistency between labels on self-efficacy scales (Toland & Usher, 2016).

Student self-efficacy reporting and skill testing should all measure the same specific capabilities (Bandura, 1986). This means that mathematics self-efficacy should be measured by instruments that are written specifically for mathematical skills.

Most recent studies that focused specifically on adolescent mathematics self-efficacy have utilized questions that are task-specific, according to Bandura's (1993, 1997) recommendations (e.g. Cheema & Kitsantas, 2014; Chen & Zimmerman, 2007). When evaluating mathematics achievement every three years, PISA also administers a task-specific approach to measure the mathematics self-efficacy of its 15-year old respondents around the world. Parker et al. (2014) utilized an eight-item scale from the PISA database with questions focused on real world, rather than curriculum-based, mathematical tasks. Pampaka et al. (2011) expressed a need to describe mathematics self-efficacy in two subscales, pure mathematics self-efficacy and applied mathematics self-efficacy, although that approach has not been commonly adapted. Other studies have prioritized the separation of mathematics self-efficacy into the four subscales of mastery experience, vicarious experience, social persuasion, and physiological states (e.g. Lau et al., 2018; Lent et al., 1996). As is the case with instruments that measure self-efficacy, there is significant variance between instruments designed specifically for measuring mathematics self-efficacy.

A commonly-used instrument for measuring mathematics self-efficacy in the context of math education is the Mathematics Self-Efficacy Scale (MSES) (Betz & Hackett, 1983). The questionnaire consists of three main domains involved in the study of mathematics, which are also factors of mathematics self-efficacy: solving mathematics problems, using mathematics in everyday tasks, and obtaining good grades in mathematics courses. Responses are recorded on a Likert-type scale and questionnaire items ask students about mathematics performance tasks, mathematics problems, and their ability to get at least a B in a variety of mathematics courses. Variations of the MSES include the Mathematics Self-Efficacy Scale – Revised (MSES-R) and the Middle School Mathematics Self-Efficacy Scale (MSMES) have been created by Pajares and Miller (1995) and Usher and Pajares (2009), respectively.

At least a half dozen instruments for measuring mathematics self-efficacy, all unrelated to MSES, have been created in recent years. Some examples:

Yavuz Mumcu and Cansiz Aktas (2015) analyzed the mathematics self-efficacy of high-school students in Turkey using the Self-Efficacy Toward Mathematics Scale (Umay, 2001), a 14-item, 5-point Likert-type scale.

Peklaj, Podlesek, and Pecjak (2015) utilized a self-efficacy scale based on the Patterns of Adaptive Learning Scale (PALS) (Midgley et al., 2000), another 5-point Likert-style scale but with only five items.

Skaalvik et al. (2015) utilized a larger, 6-point Likert-type scale, in administering an instrument of their own design.

In his Perceived Math Competence Scale, Jansen et al. (2013) presents generalizations about competency in mathematics on a Likert-style scale that extend beyond the student's perceptions of his or her own abilities.

Standing in the penumbra of these instruments it seems that the only consensus is that there is no consensus on the appropriateness or superiority of any mathematics self-efficacy scale, even in just the past few years.

The Mathematics Attitude Questionnaire (MAQ) has been utilized in some self-efficacy studies and is designed to measure four components of the theory of planned behavior: measured attitudes, subjective norms, perceived behavioral control, and measured intentions (Burrus & Moore, 2016; Lipnevich, Preckel, & Krumm, 2016). While there is some overlap between these measures and self-efficacy, there are, in fact, distinct. The foundation of the MAQ is the broader theory of planned behavior, as opposed to self-efficacy theory. As such, it is not ideal in the measurement of mathematics self-efficacy alone.

Toland and Usher (2016), in their recent study, concluded that adolescents judge their abilities in only four basic categories: I *cannot* do this, I'm *not sure that I can* do this, I am *pretty sure I can* do this, I *can definitely* do this. If students make use of only four response categories, even when offered more, there are significant implications as to the ideal instrument for the measurement of student mathematics self-efficacy.

Math Acceleration

Motives behind acceleration. Early, inclusive access to Algebra 1 has also been suggested as a proper response to scores from both the PISA and Trends in Mathematics and

Science Study (TIMSS), which placed the United States students in the bottom quartile when compared with other participating nations (Hemphill & Hill, 2013). A more aggressive math curriculum would put the U.S. more in line with countries like Taiwan, which lead international math achievement rankings and introduce formal symbolic algebra in elementary school (Askew, Hodgen, Hossain, & Bretscher, 2010).

Benefits of accelerating algebra instruction. Acceleration is one of the most common ways of supporting students who are identified as gifted or high achieving in mathematics. Unlike other methods, the option for acceleration allows students to learn material more efficiently and is also strongly supported by research (Robinson et al., 2007; Stanley & Benbow, 1983). Advocates of an accelerated algebra curriculum understand the importance of Algebra 1 and the applications that it has in future studies and employment opportunities. Beginning Algebra 1 at an earlier age allows a greater number of students to access Calculus in high school, and, perhaps, even Advanced Calculus or Advanced Statistics. Access to higher-level mathematics in high school is positively correlated with college graduation and employment income (Watson & McCarroll, 2010).

Negative outcomes associated with accelerated algebra. Recent research does not support the claim that widespread accelerated algebra instruction will be more beneficial to students and offer them more opportunities in their high school and college-level studies. Rickles (2013) determined that early algebra instruction, defined in the study as taking place during eighth grade, did not improve outcomes in twelfth-grade mathematics. Moreover, enrolling students in Algebra 1 before they are developmentally ready may lead to worse outcomes than if students were to wait and enroll when they are better prepared. Those bad outcomes could include higher failure rates and decreased achievement in post-Algebra 1 math classes, (Hemphill & Hill, 2013). Case in point: the acceleration initiative in North Carolina's Charlotte-Mecklenburg's schools, whose affected students experienced worsened Algebra 1 test scores and a reduced likelihood of progressing through a college-preparatory curriculum (Clotfelter, Ladd, & Vigdor, 2015).

Qualitative studies have uncovered that secondary students are often negatively and significantly affected psychologically by the process of tracking based on mathematical ability (Boaler, William, & Brown, 2000; Usher, 2009). One student and her mother expressed that the moment in Grade 4, when she was only one of two students not chosen for the school's accelerated track, was pivotal in negatively affecting her self-confidence. In contrast, two students who were chosen to skip a level of mathematics in Grade 1 expressed that their ongoing confidence in mathematics was based on that perceived validation of their abilities and their advanced standing in mathematics, relative to their peers. All students involved in the study were keenly aware of their mathematics abilities in comparison to their classmates and were significantly affected by their Grade 8 math placement. Students who were accelerated too quickly found relief and mastery by being moved to a lower level, while the student who chose to stay in a class too advanced for their ability experienced decreased self-efficacy (Usher, 2009). These findings are supported by Bandura's (1997) assertion that practices such as tracking based on ability lead children to make comparative appraisals, whether that is the intention of the school or organization. Acceleration programs also tend to disproportionately promote the mathematical education of white and Asian students, contributing to concerns of inequity in the context of STEM education (Sawchuk, 2018). Further research is required to quantitatively investigate the effects of mathematics tracking in schools using a larger sample.

Summary

Self-efficacy is a powerful component within the complex framework of human motivation. Its effects are well researched and consistent. Self-efficacy in the case of mathematics has consequences both profound and specific. Students' mathematics self-efficacy affects their attitude toward learning mathematics, their mathematics achievement, and their decision whether to pursue a STEM major or career.

Mathematics self-efficacy is consistently and positively correlated with many desirable outcomes. Students' perceptions of their mastery experiences in mathematics have significant influence on those students' mathematics self-efficacy (Bandura, 1997; Usher & Pajares, 2009). It is important for educators and administrators to promote positive self-efficacy in students to increase their short- and long-term motivation and achievement. As such, it continues to be a critical area for area for educational professionals to explore, especially since self-efficacy is fairly malleable in contrast to other predictors of achievement such as family background and socioeconomic status (Cheema & Kitsantas, 2014). Math acceleration programs have significant potential to benefit some students when administered appropriately. With the increasing prevalence and intensity of mathematics acceleration programs, schools are doing a more effective job of meeting the academic needs of gifted and high-achieving mathematics students (Robinson et al., 2007; Stanley & Benbow, 1983).

Self-efficacy has been studied for decades by scores of researchers with results that consistently support Bandura's definition and causes. Organized mathematics acceleration programs, which are a relatively recent innovation in the history of formal education, have received less scrutiny. This hole in the research database is particularly deep when it comes to beginning Algebra 1 prior to Grade 8. Usher and Pajares (2009) found that one experience can increase the self-efficacy of one person and simultaneously decrease the self-efficacy of another. Since one factor of self-efficacy is the perception of one's mastery experiences, the selection of students for acceleration programs may influence both the students who are selected to accelerate as well as those who are not. If the selection of some students for acceleration programs gives other students the perception that they are not good at mathematics (because they were not chosen to be part of an acceleration program), this single experience might be increasing the self-efficacy of the students chosen for the acceleration program while decreasing the self-efficacy of the students who were not chosen. The research to date is silent on the relationship between math acceleration programs and mathematics self-efficacy.

This study aims to determine whether such acceleration programs have an impact on student mathematics self-efficacy. If a correlation exists between mathematics acceleration programs and student mathematics self-efficacy, future research will be necessary to determine how to maximize mathematics self-efficacy for all students, regardless of participation in a mathematics acceleration program. Further, educators and administrators should be aware of such a correlation that they may effectively create and administer mathematics acceleration programs that maintain or increase self-efficacy levels for all students.

CHAPTER THREE: METHODS

Overview

The purpose of this causal-comparative study was to compare gender and degree of mathematics acceleration to mathematics self-efficacy for math students at metropolitan private secondary schools in a northwestern state. The following sections describe the specific research design of the study, as well as the participants, setting, instrumentation, and procedures. The analysis used to answer the research questions is also described.

Design

A causal-comparative design was utilized to determine mathematics self-efficacy differences among math students in relation to gender and degree of mathematics acceleration. This research design type was chosen because the researcher identified differences in mathematics self-efficacy that already existed between math students and did not manipulate the independent variables, defined by the nominal categories of gender and degree of mathematics acceleration. While the causal-comparative design cannot confirm a cause-effect relationship, it is useful in situations where it is impossible or undesirable to manipulate the independent variable(s) (Gall, Gall, & Borg, 2007).

Student mathematics self-efficacy scores from the Mathematics Self-Efficacy Scale (MSES) constitute the dependent variable and were analyzed using a two-way analysis of variance (ANOVA) to compare means and possible interaction between the two independent variables of gender and degree of mathematics acceleration. The two-way ANOVA is the appropriate test to compare the means when more than one independent variable is involved (Warner, 2013). Degree of mathematics acceleration was defined as the year in which the student first enrolled in Algebra 1, relative to the traditional timing of ninth grade (Hemphill & Hill, 2013).

Research Questions

RQ1: Is there a statistically significant difference between the mathematics self-efficacy scores of math students who are 0, 1, or 2 years accelerated in mathematics?

RQ2: Is there a statistically significant difference between the mathematics self-efficacy scores of male and female math students?

RQ3: Is there a statistically significant interaction among the mathematics self-efficacy scores of male and female math students who are 0, 1, or 2 years accelerated in mathematics?

Hypotheses

$H_0$1: There is no statistically significant difference between the mathematics self-efficacy scores of math students who are 0, 1, or 2 years accelerated in mathematics.

$H_0$2: There is no statistically significant difference between the mathematics self-efficacy scores of male and female math students.

$H_0$3: There is no statistically significant interaction among the mathematics self-efficacy scores of male and female math students who are 0, 1, or 2 years accelerated in mathematics.

Participants and Setting

The participants for the study were in Grade 9 through Grade 12 Algebra 2 and Precalculus students, gathered via cluster sampling, who were enrolled in three different metropolitan private secondary schools in the same northwestern state during the 2018-2019 school year. Convenience sampling was used as all participating schools are in a 25-mile radius from the researcher (Warner, 2013). All identified private schools within the 25-mile radius that offer Algebra 2 and Precalculus after the completion of Algebra 1 and Geometry were invited to participate in the study. All schools are considered college-preparatory and are tuition based with tuition ranging between $16,000-$36,575 per secondary student. The schools primarily serve upper-middle- and upper-class families, although some financial aid is available. All schools utilize similar traditional Algebra 2 and Precalculus curriculum from major high school textbook publishers, which follow successful completion of Algebra 1 and Geometry. None of the schools utilize an integrated mathematics curriculum or any other alternative mathematics curriculum.

The total number of completed questionnaires received was 185. Only students who self-reported their initial Algebra 1 enrollment as 7th grade, 8th grade, or 9th grade were included in the results. Students who initially enrolled in Algebra 1 prior to 7th grade or after 9th grade were not included as those groups fall outside the boundaries of this study. Questionnaires that did not have the appropriate corresponding consent/assent or which were deemed invalid per the publisher's guidelines were not included. The number of participants sampled who fell within the scope of the study, had appropriate consent/assent documents, and turned in completed, valid surveys was 158, which exceeds the required minimum of 126 for a medium effect size with statistical power of 0.7 at the 0.05 alpha level when three groups are being used (Gall et al., 2007).

Instrumentation

The Mathematics Self-Efficacy Scale (MSES or MATH) was developed by Betz and Hackett (1983) and initially consisted of three subscales: math tasks, math problems, and college courses (See Appendix A for instrument permission and sample questions). The purpose of the MSES was originally designed to measure gender differences in college students' mathematics self-efficacy in specific mathematic areas. Reliability of the total scale ($\alpha = .96$) and each subscale ($\alpha = .92$ for math tasks, $\alpha = .96$ for math problems, $\alpha = .92$ for college courses) was reported by Betz and Hackett (1983) and later confirmed by Lent, Lopez, and Bieschke (1991). Lent, Lopez, and Bieschkle (1993) again confirmed reliability for the college courses subscale ($\alpha = .94$). Content and construct validity for the total scale and each subscale has been confirmed (Lagenfeld & Pajares, 1993).

The math problems subscale was later removed and the current version of the MSES now has only the two subscales, renamed "Everyday Math Tasks" and "Math Courses." Part 1, Everyday Math Tasks, measures an individual's confidence in their ability to successful complete a given task. An example is, "How much confidence do you have that you could successful add two large numbers (e.g. 5379 + 62543) in your head?" Part 2, Math Courses, measures an individual's confidence in his or her ability to complete a particular math course. An example is, "How much confidence do you have that you could complete the course with a final grade of "A" or "B" in Basic College Math?"

The MSES is a popular choice to measure mathematics self-efficacy. The MSES was recently used by Baxter, Bates, and Al-Bataineh (2017) to test college-level developmental mathematics students. The instrument was also used by Hall and Ponton (2005) to compare the mathematics self-efficacy of college freshmen enrolled in a developmental mathematics course to those college freshmen enrolled in a Calculus course. Waits (2016) used the MSES to measure mathematics self-efficacy of students considered gifted or talented based on their mathematics ability grouping. While the instrument was initially designed for college students, its content and readability was appropriate for this study's sample (Grade 9 through 12 students). The MSES has been successfully used in studies with students as young as Grade 8 (Waits, 2016).

The MSES, available in both paper and electronic formats, contains 34 items. The paper format was used for this study. The MSES takes approximately 15 minutes to administer. Each item has 10 possible response options on a Likert scale that ranges from 0 (*not confident at all*) to 9 (*complete confidence*). The total score is determined by dividing the total number of points by the number of items completed. This results in a value between 0 and 9, with 0 representing lowest self-efficacy and 9 representing highest self-efficacy. A comparison of total scores was the focus of this study, as was advised by the publisher of the instrument.

An MSES that contains more than three blank responses is invalid (Betz & Hackett, 1993). Such surveys were excluded from the data analysis. Two supplemental questions were asked at the start of the MSES: students were asked to identify their gender by circling M or F and; Students were asked the grade in which they were first enrolled in Algebra 1 by circling either 7, 8, 9, or OTHER.

Procedures

Full institutional review board (IRB) approval was obtained before any formal communication with schools or recruitment of participants took place (See Appendix B). Informal communications with heads of schools took place before final IRB approval to obtain site permissions required for full IRB approval. Informal communications were sent to all heads of schools, via email, whose schools were in the same metropolitan area and whose curriculum fell within the scope of this study. Formal participation emails were sent to designated school contacts after full IRB approval was obtained (See Appendix C).

After formal school approval was obtained, a combined parental consent and student assent form was sent home with each student via their math teachers along with a recruitment letter (See Appendixes D and E). A recruitment letter (See Appendix F) and consent form (See

Appendix G) were given to given to students who were at least 18 years of age. The forms indicated that students who first enrolled in Algebra 1 in either Grades 7, 8, or 9 could be included in the study.

The initial request for parental consent and student assent was sent in early January 2019, 2 weeks prior to the planned date of data collection. A follow-up email was sent from Algebra 2 and Precalculus teachers to all math students and parents approximately one week prior to the survey administration date in order to maximize the number of participants (See Appendix H). Consent via email was received from each Algebra 2 and Precalculus teacher who administered the questionnaire. The researcher met with each administering teacher approximately two weeks before the survey to discuss the purpose of the study, provide the recruitment and consent/assent materials, and provide instructions as to how administer the survey and collect data. Appendix I contains the teacher script for those meetings.

The MSES was administered during regular math classes to all students who had the appropriate consent or consent/assent forms completed. The questionnaire took approximately 15 minutes to administer. Students sat in quiet classrooms to complete the paper questionnaire and the math teachers supervised the students. The MSES was administered at all sites mid-week over 10 days that were not preceding a holiday, vacation day, school assembly, or any other distracting event.

Students who did not return a signed assent were not given a questionnaire at the time it was administered. Before the participants began the questionnaire, each supervising teacher followed the same script. The script reminded students of the importance of answering the questions honestly and also reassured students that their answers were anonymous and would not, in any way, affect their math grades or their relationship with their math teacher. Students were not permitted to talk during the questionnaire. In addition to a questionnaire, each participating student received a piece of colored paper to place over their questionnaire after they finished. After all students finished the questionnaire, the teacher used a random number generator to select three students who received a gift card for participating. Participating and non-participating students were eligible to win the gift cards. All participating students who did not receive a gift card received a small gift of candy and chocolates.

Each Algebra 2 and Precalculus teacher received a locking briefcase in which to place the completed questionnaires. The briefcase had a number lock and the code was known only to the researcher and administering teachers. All completed questionnaires were placed in the briefcase immediately upon completion and the briefcase was then locked. The locked briefcase remained in the secure possession of the administering teacher until it was transferred to the care of the researcher.

Neither student names nor school names were collected. All completed questionnaires were numbered by the researcher and tracked by school. Numbered stickers were used at the top of each page of the questionnaire, ensuring that any separated pages could be accurately matched for analysis. The numbering began with 1 and with increasing, sequential integers. The research entered each value of each questionnaire on a spreadsheet and the values were also entered on a separate spreadsheet by a third party not directly involved with the study. A computer program was written to identify any discrepancies between the two spreadsheets. Using the hard copies of the questionnaires, the researcher then reconciled any identified discrepancies. All data were then entered into SPSS. Gender was coded as 0 for male and 1 for female. Degree of mathematics acceleration was coded as 0 (ninth-grade Algebra 1), 1 (eighth-grade Algebra 1), or 2 (seventh-grade Algebra 1).

Data Analysis

An MSES that contains more than three blank responses is invalid (Betz & Hackett, 1983). Based on that criterion, MSES questionnaires that had fewer than 31 completed items were not included in the data analysis. Any completed MSES questionnaires that contained an initial Algebra 1 enrollment as anything other than Grade 7, 8, or 9 were likewise excluded from analysis as they did not fall within the scope of this study.

Data screening was conducted on each factor prior to analyzing the data using a two-way ANOVA (gender and degree of mathematics acceleration). Box and whisker plots were used to detect extreme outliers on the dependent variable. The total number of participants (n = 158) exceeded the required minimum of 126 for a medium effect size with statistical power of 0.7 at the 0.05 alpha level for three groups (Gall et al., 2007).

The two-way ANOVA is the appropriate test to compare the means when more than one independent variable is involved (Warner, 2013). The two factors considered for significance were gender (male or female) and degree of mathematics acceleration (0, 1, or 2 years). The two-way ANOVA requires that the assumptions of normality and homogeneity of variance are met (Gall et al., 2007). Normality was examined using two Kolmogorov-Smirnov tests. The Kolmogorov-Smirnov test is appropriate when $n > 50$ (Warner, 2013). Levene's test of equality of error variances was used to examine whether there were violations of the homogeneity of variance assumption among the factors of degree of mathematics acceleration and gender, between the factors, and with regard to the interaction of the two factors (Gall et al., 2007).

The assumption of random sampling was met as all math students had an equal probability of being included in the study, provided they were currently enrolled in either Algebra 2 or Precalculus and their enrollment in Algebra 1 fell within the range addressed in the study. The dependent variable, mathematics self-efficacy score as measured by the MSES, was measured on interval, which is acceptable because responses have order and equal intervals (Warner, 2013). The assumption of independence was met, as the observations between groups were independent as well as the observations within each group. Effect size was measured in terms of the eta-squared statistic and was interpreted in light of Cohen's *d* (Warner, 2013).

CHAPTER FOUR: FINDINGS

Overview

The purpose of causal-comparative study was to compare the effect of degree of mathematics acceleration and gender on mathematics self-efficacy for math students enrolled in private secondary schools in a northwestern state during the 2018–2019 school year. MSES data collected from 158 Algebra 2 and Precalculus students were used in the study.

Research Questions

RQ1: Is there a statistically significant difference between the mathematics self-efficacy scores of math students who are 0, 1, or 2 years accelerated in mathematics?

RQ2: Is there a statistically significant difference between the mathematics self-efficacy scores of male and female math students?

RQ3: Is there a statistically significant interaction among the mathematics self-efficacy scores of male and female math students who are 0, 1, or 2 years accelerated in mathematics?

Description of the Sample

Complete information was received from 158 students (See Table 1). The majority (105 or 66.5%) of the students who participated in the study were enrolled at School A, while 25.9% of the participants were enrolled at School B. More boys (83 or 52.5%) participated in the study than did girls (75 or 47.5%).

The reliability of the MSES instrument was tested using Cronbach's alpha. The total scale contained 34 items and produced an alpha value of .92. That value is similar to the reliability of the total score obtained by Betz and Hackett (1983).

Table 1

Breakdown of Participants by School, Gender, and Degree of Mathematics Acceleration

	Degree of mathematics acceleration						
	Grade 7 (2 years)		Grade 8 (1 year)		Grade 9 (0 years)		
School	Male	Female	Male	Female	Male	Female	Total
A	33	24	15	20	9	4	105
B	2	2	11	7	7	12	41
C	2	2	2	3	2	1	12
Total	37	28	28	30	18	17	158

Results

A two-way ANOVA was used to compare the total MSES score among and between two independent variables. The two factors used were gender (male or female) and degree of mathematics acceleration (0, 1, or 2 years of acceleration). This section contains a description of the tests used to assure that the data met the assumptions of the two-way ANOVA and a presentation of the results of the subsequent analysis of the research hypotheses.

Data Screening

Box and whisker plots were used to test the assumption of no extreme outliers for the dependent variable, total MSES score, and no extreme outliers were identified (See Figure 1). The Kolmogorov-Smirnov test was used to test the assumption of normality and the results were non-significant for all groups (See Table 2).

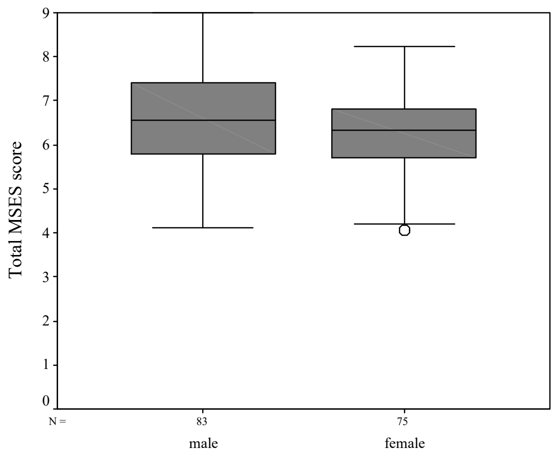

Figure 1. Box and whisker plots for gender.

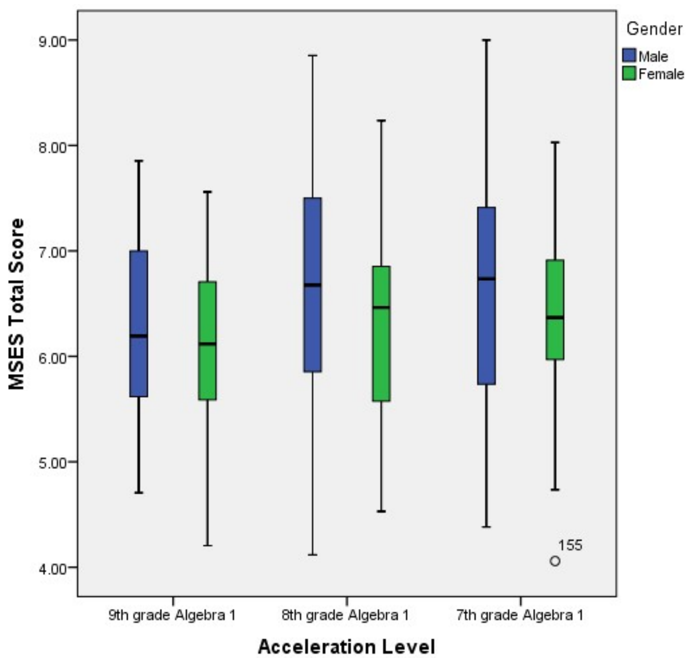

Figure 2. Box and whisker plots for degree of mathematics acceleration.

Table 2

Tests of Normality

Independent variable	*n*	Kolmogorov-Smirnov Statistic	*df*	*p*
Gender				
Male	83	.044	83	.20*
Female	75	.051	75	.20*
Degree of mathematics acceleration				
0 (Grade 9)	35	.094	35	.20*
1 (Grade 8)	58	.082	58	.20*
2 (Grade 7)	65	.073	65	.20*

* This is a lower bound of the true significance

Levene's test of equality of error variances, used to determine homogeneity of variance, was not significant, *F* (5, 152) = 1.37, *p* = .24 (See Table 3). Concerning the assumptions of random sampling and independence of scores, all math students who qualified to be in the study had an equal probability of being included in the study and the participants' total MSES scores were not dependent on other participants' scores.

Table 3

Test of Equality of Error Variances

F	df1	df2	Sig.
1.370	5	152	.239

Results of Data Analysis

The results of the two-way ANOVA were evaluated first by presence of main effects of the two independent variables, group and gender, and then by the interaction of those two independent variables. The results of the ANOVA are presented in Table 4.

Table 4

Results of Two-Way Analysis of Variance to Test Hypotheses

Source	Type III *SS*	*df*	*MS*	*F*	*p*	Partial η^2
Corrected model	5.88	5	1.18	1.18	.32	.037
Intercept	5987.97	10	5987.97	2996.70	<.01	.972
Gender	3.34	1	3.34	3.34	.07	.022
Degree of mathematics acceleration	1.95	2	0.97	0.97	.38	.013
Gender x degree of mathematics acceleration	0.13	2	0.07	0.07	.94	.001
Error	151.78	152	1.00			
Total	6700.54	158				
Corrected total	157.66	157				

Null Hypothesis 1

There is no statistically significant difference between the mathematics self-efficacy scores of math students who are 0, 1, or 2 years accelerated in mathematics.

The mean MSES score for math students 0 years accelerated was M = 6.23 (n = 35, SD = 0.86). The mean MSES score for math students 1 year accelerated was M = 6.47 (n = 58, SD = 1.02). The mean MSES score for students 2 years accelerated was M = 6.52 (n = 65, SD = 1.06). The main effect of degree of acceleration was not significant, F (2, 152) = 0.97, p = .38, η^2 =

.013. Therefore, Hypothesis 1 was not rejected. Degree of mathematics acceleration did not have an effect on mathematics self-efficacy.

Null Hypothesis 2

There is no statistically significant difference between the mathematics self-efficacy scores of male and female math students.

The mean MSES score for male participants was M = 6.58 (n = 83, SD = 1.10) and for female participants was M = 6.27 (n = 75, SD = 0.87). The main effect of gender was not significant, F (1,152) = 3.34, p = .07, η^2 = .022. Therefore, Hypothesis 2 was not rejected. Gender did not have an effect on mathematics self-efficacy.

Null Hypothesis 3

There is no statistically significant interaction among the mathematics self-efficacy scores of male and female math students who 0, 1, or 2 years accelerated in mathematics.

The mean MSES score for male participants 0 years accelerated was M = 6.35 (n = 18, SD = 0.85), the mean MSES score for male participants 1 year accelerated was M = 6.66 (n = 28, SD = 1.16), and the mean MSES score for male participants 2 years accelerated was M = 6.63 (n = 37, SD = 1.15). The mean MSES score for female participants 0 years accelerated was M = 6.09 (n = 17, SD = 0.86), the mean MSES score for female participants 1 year accelerated was M = 6.28 (n = 30, SD = 0.83), and the mean MSES score for female participants 2 years accelerated was M = 6.37 (n = 28, SD = 0.93). The interaction between degree of mathematics acceleration and gender was not significant, F (2, 152) = 0.07, p = .94, η^2 = .001. Therefore, Hypothesis 3 was not rejected. The effect of gender on mathematics self-efficacy was not dependent on the degree of mathematics acceleration.

CHAPTER FIVE: CONCLUSIONS

Overview

Chapter Five discusses the results of the study and the implications of the analysis within the context of related research and practical applications. The limitations of the study are also addressed, along with recommendations for further, related research.

Discussion

The purpose of this study was to compare the effect of degree of mathematics acceleration and gender on mathematics self-efficacy. Understanding this relationship is beneficial for determining acceleration strategy and implementation at the district and school levels. The results of the study should be considered in the context of its theoretical foundation and related research for the two independent variables of gender and degree of mathematics acceleration.

Gender and Mathematics Self-Efficacy

Decreasing the gap in mathematics self-efficacy scores may lead to many positive related outcomes such as mathematics achievement and participation of women in math and math-related fields of study and careers. Nix et al. (2015) and Wang (2013) identified mathematics self-efficacy as playing a role in whether female students choose math-related degree fields and professions. It follows that a decrease in the mathematics self-efficacy gap between genders may precede an increase of female involvement in mathematics after secondary school.

The results of this study showed no statistically significant difference in mathematics self-efficacy between male and female math students. These results align with prior studies that found no statistically significant difference in mathematics self-efficacy between genders (e.g., Lau et al., 2018; Lent, Lopez, & Bieschke, 1991; Pajares & Graham, 1999). However, these studies are in contrast to the numerous studies which identified a statistically significant difference in mathematics self-efficacy between genders (e.g., Ferla et al., 2009; Goetz et al., 2013; Joët et al., 2011; Lent et al., 1993; Pajares & Miller, 1994; Skaalvik et al., 2015; Usher et al., in press; Williams & Williams, 2010).

One possible explanation for the lack of a statistically significant difference in mathematics self-efficacy scores between males and females is the recent attention given in the media and academic settings to research supporting the importance of having a growth mindset. Previous studies have identified that females are more likely than males to believe their abilities and intelligence in math are fixed traits which cannot be improved through effort. This mindset may contribute to lower mathematics self-efficacy (Boaler, 2013; Dweck, 2006; Nix et al., 2015; van Aalderen-Smeets & Walma van der Molen, 2018). Efforts toward educating female students about the importance of holding a growth mathematical mindset, and focusing on effort, rather than natural ability, may then prevent a decrease in mathematics self-efficacy.

Degree of Mathematics Acceleration and Mathematics Self-Efficacy

The fact that this study found no statistically significant difference in mathematics self-efficacy based on degree of mathematics acceleration cannot be easily compared to other studies, as there is a shortage of quantitative studies comparing these specific variables. There are indirect relationships to other studies that should be considered in light of these results, most significantly in the areas of self-efficacy theory and student perception of acceleration programs.

Bandura's (1997) theory of self-efficacy bases overall self-efficacy on four distinct sources – mastery experiences, vicarious experiences, social persuasion, and emotional and physiological states. These four sources have been confirmed by later studies (e.g. Usher & Pajares, 2009). With appropriate acceleration in mathematics, each of these factors may be either increased or not affected. The specific correlation between ability groupings and decreased self-efficacy of individuals relegated to lower ability groups has been identified (Schunk & Pajares, 2002). It follows that mathematics self-efficacy levels should be higher for students who have accelerated as a result of a combination of higher levels of subject mastery and being positively singled-out over their peers. The results of this study do not support this assumption, however.

One theory for the finding is an interaction between learning theory, self-efficacy factors and reciprocal determinism. Piaget's (1973) initial age range of 11-15 for the development of algebraic reasoning was later pushed back on account of breakthroughs in the field of neuroscience and Piaget's own research (Susac et al., 2014). An inference of the ages of participants in this study, based on typical enrolment ages in Grade 7, 8, and 9, does not fit within the identified formal operational stage. This stage is when students are able to reason abstractly, which is necessary to fully understand the material of Algebra 1. If students are not cognitively ready for the acceleration they experience, they may experience decreased achievement as a result of the gaps in their understanding (Clotfelter et al., 2015; Hodgen et al., 2010; Spielhagen, 2010). The theory of reciprocal determinism, which explains the relationship between self-efficacy and achievement as bi-directional, has been confirmed with high school students generally, and in mathematics specifically (Hwang et al., 2016; Parker et al., 2014; Retelsdorf et al., 2014; Schöber et al., 2018). Increased self-efficacy resulting from acceleration may be mitigated by later achievement struggles if a student was accelerated to Algebra 1 prior to secure development in the formal operational stage. Such a combination of factors could explain why there was no statistically significant difference in mathematics self-efficacy based on degree of acceleration in this study.

Implications

This study contributes to the current research base of math acceleration and contributes to the literature that considers the specific variables of gender, degree of mathematics acceleration, and mathematics self-efficacy score.

The results of this study are that there is no statistically significant difference between mathematics self-efficacy scores of male and female students who are 0, 1, or 2 years accelerated in mathematics. The results of this study should also be considered in the context of the percentile equivalents for MSES scores, as determined by the publisher of the MSES. The mean mathematics self-efficacy scores for male participants in this study were 6.58, 6.66, and 6.35 for students who are 2, 1, and 0 years accelerated in mathematics, respectively. These scores fall between the 40^{th} and 60^{th} percentiles for all male students taking the MSES. While this range would certainly be considered average, it is surprising to see the mean of male students who are accelerated by 1 and 2 years fall in this range. It is well supported by research that mathematics self-efficacy is largely shaped by mastery experiences (Bandura, 1997; Skaalvik, 1997; Usher & Pajares, 2009). Students who are 1 and 2 years accelerated in mathematics have been singled out among their peers as being, in some ways, more capable in mathematics and ready for the faster pace and increased challenge that comes with acceleration (Robinson et al., 2007; Stanley & Benbow, 1983). It seems, then, that these students should naturally have higher levels of mathematics self-efficacy than their peers who have remained at grade level.

The mean mathematics self-efficacy scores for female participants in this study were 6.36, 6.28, and 6.09 for students who are 2, 1, and 0 years accelerated, respectively. These scores fall between the 60^{th} and 70^{th} percentiles for all females who have completed the MSES. It is worth noting that while there is no statistically significant difference between the mean

MSES scores of male and female students in this study, the percentiles in which their mean scores fall are noticeably higher for female students than for male students. This may indicate that the math programs included in the study are exceptionally successful in promoting the mathematics self-efficacy of their female students.

Overall, the results of this study neither support nor discourage appropriate acceleration at the school level, as there is no indication that appropriate acceleration decreases or increases mathematics self-efficacy. It is important for districts to create and implement acceleration policies that support the mathematics self-efficacy students who demonstrate algebra readiness, regardless of what grade the student is in. Math teachers should be aware of the causes of mathematics self-efficacy in order to make curricular, instructional, and acceleration decisions that promote mathematics self-efficacy and consider its importance alongside achievement. Ideally, mathematics self-efficacy should be monitored at the school level pre- and post-acceleration in order to make timely changes, as needed. Students and parents would also benefit from a greater understanding of mathematics self-efficacy and the role it plays when making acceleration decisions. Promotion of a growth mindset, for example, should be consistent between school and home environments.

Limitations

Several limitations related to the sampling method and site differences pose threats to the validity of the current study. While the sample size was large enough for the requirements of the performed analysis, it is too small to generalize to a large population. The sample size is linked to the number of participating schools. The same participation email was sent to 12 private schools in the same metropolitan area whose math progression fell within the scope of this study. Of those 12 schools, only three agreed to participate. The specific metropolitan area was chosen to fit the logistical and resource limitations of the researcher, preventing the selection of a random sample over a larger geographic area. Public schools were also not included in the study due to the difficulty of obtaining site permissions, limiting the results to be interpreted in the context of private school education.

The three schools included in the study have differences that may have introduced confounding variables to the study. Two of the participating schools are suburban faith-based schools, while the third school is an urban secular school. It is unknown whether this difference in school culture and climate affects academic self-efficacy and mathematics self-efficacy, in particular. While data were collected at each site during the same two weeks, the academic calendars at each school are different. School A was starting their second semester at the time of data collection, while School B was studying for final exams for their first semester. The academic calendar for School C was unavailable to the researcher. It is possible that mathematics self-efficacy may fluctuate during the academic year and may be affected by the added stress of preparing for final exams. Finally, Precalculus is taught by only one teacher at both School A and School B, while four different teachers teach Precalculus at School C, only two of whom agreed to participate. Algebra 2 teachers from Schools B and C declined to participate. Individual factors, such as teaching styles, personalities, and understanding of mathematics self-efficacy, may affect classroom strategies that subsequently affect student mathematics self-efficacy. The differences between sites, including location, school type, academic calendar, and number of Precalculus teachers may have affected students' reporting of their mathematics self-efficacy.

The distribution of students by acceleration level differed from school to school and may have affected the outcome of the study. For School A, 54% of participants were 2 years accelerated, 33% of participants were 1 year accelerated, and 12% of participants were 0 years accelerated in mathematics. For School B 10% of participants were 2 years accelerated, while the remaining students were nearly evenly divided between 1 and 0 years accelerated at 44% and 46%, respectively. School C had the most even distribution of acceleration at 25% of students reporting 2 years of acceleration, 42% of students reporting 1 year of acceleration, and 33% of students reporting 0 years of acceleration. Again, due to the limited participation of Schools B and C, it is unknown whether those numbers represent the acceleration distribution of the entire school. Since not all Algebra 2 and Precalculus teachers at School B and School C agreed to participate, this distribution may not be reflective of those school populations, which may have affected the overall findings.

Recommendations for Future Research

No quantitative study was found examining the relationship between math acceleration and mathematics self-efficacy and few qualitative studies have addressed the causes of low or high mathematics self-efficacy during the secondary school years. These qualitative studies have focused on general causes and not the specific situation of mathematics acceleration at an early age. In light of the results and limitations of the current study, the researcher recommends the following areas for future research:

1. Replicate the current study to involve a larger number of participants and greater diversity of geography, school type, and curricular structure.
2. Conduct a longitudinal study which would measure students' mathematics self-efficacy prior to acceleration and for several years after acceleration.
3. Conduct a mixed-method study using the MSES that also includes interviewing students to understand the events relating to mathematics acceleration that have contributed to

their current mathematics self-efficacy. Mixed-method research has been used previously to simultaneously quantify student mathematics self-efficacy and understand the factors and events affecting it (Usher et al., in press).

4. Conduct a causal-comparative study focusing on the independent variables of mathematics achievement and degree of mathematics acceleration and the dependent variable of mathematics self-efficacy.
5. Conduct a causal-comparative study focusing on the independent variables of mathematics achievement and degree of mathematics acceleration and the dependent variable of mathematics self-efficacy.
6. Replicate the current study in schools who do not have, or have eliminated, mathematics acceleration prior to ninth grade to identify the mean MSES score for such student populations.

REFERENCES

Ahlfors, L. V., Bacon, H. M., Bell, C., Bellman, R. E., Bers, L., Birkhoff, G…Wittenberg, A. (1962). On the mathematics curriculum of the high school. *The American Mathematical Monthly, 69*(3), 189-193. doi:10.2307/2311046

Amitay, G., & Gumpel, T. (2015). Academic self-efficacy as a resilience factor among adjudicated girls. *International Journal of Adolescence and Youth, 20*(2), 202-227. doi:10.1080/02673843.2013.785437

Askew, M., Hodgen, J., Hossain, S., & Bretscher, N. (2010). Values and variables: Mathematics education in high-performing countries. Retrieved from http://www.nuffieldfoundation.org/sites/default/files/Values_and_Variables_Nuffield_Foundation_v__web_FINAL.pdf

Atik, G., & Atik, Z. E. (2017). Predicting hope levels of high school students: The role of academic self-efficacy and problem solving. *Education and Science, 42*(190), 157-169. doi:10.15390/EB.2017.5348

Ayotola, A., & Adedeji, T. (2009). The relationship between mathematics self-efficacy and achievement in mathematics. *Procedia Social and Behavioral Sciences, 1*, 953-957. doi:10.1016/j.sbspro.2009.01.169

Bandura, A. (1982). Self-Efficacy mechanism in human agency. *American Psychologist, 37*(2), 122-147. doi:10.1037/0003-066X.37.2.122

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

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist, 28*(2), 117-148. Retrieved from https://www.tandfonline.com/loi/hedp20

Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York, NY: W. H. Freeman.

Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual Review of Psychology, 52*, 1-26. Retrieved from https://www.annualreviews.org/journal/psych

Bandura, A. (2006). Guide for constructing self-efficacy scales. In F. Pajares & T. Urdan (Eds.), *Adolescence and education, Vol. 5: Self-efficacy and adolescence* (pp. 307–337). Greenwich, CT: Information Age Publishing.

Bandura, A., Adams, N. E., & Beyer, J. (1977). Cognitive processes mediating behavioral change. *Journal of Personality and Social Psychology, 35*, 125-139. doi: 10.1037/0022-3514.35.3.125

Bandura, A., Barbaranelli, C., Caprara, G. V., & Pastorelli, C. (1996). Multifaceted impact of self-efficacy beliefs on academic functioning. *Child Development, 67*(3), 1206-1222. doi:10.1111/j.1467-8624.1996.tb01791.x

Bandura, A., Caprara, G. V., Barbaranelli, C., Gerbino, M., & Pastorelli, C. (2003). Role of affective self-regulatory efficacy in diverse spheres of psychosocial functioning. *Child Development, 74*(3), 769-782. doi:10.1111/1467-8624.00567

Batool, S. S., Khursheed, S., & Jahangir, H. (2017). Academic procrastination as a product of low self-esteem: A mediational role of academic self-efficacy. *Pakistan Journal of Psychological Research, 32*(1), 195-211. Retrieved from http://www.pjprnip.edu.pk/pjpr/index.php/pjpr

Baxter, R., Bates, A., & Al-Bataineh, A. T. (2017). Developmental mathematics students: Who are they and what is their mathematics self-efficacy? *International Journal of Assessment Tools in Education, 4*(1), 37-53. doi:10.21449/ijate.264026

Betz, N., & Hackett, G. (1983). The relationship of mathematics self-efficacy expectations to the selection of science-based college majors. *Journal of Vocational Behavior, 23*, 329-345. Retrieved from https://www.journals.elsevier.com/journal-of-vocational-behavior

Betz, N. E., & Hackett, G. (1993). *Mathematics self-efficacy scale sample set: Manual, instrument and scoring guide.* Retrieved from www.mindgarden.com

Boaler, J. (2013). Ability and mathematics: the mindset revolution that is reshaping education. *Forum, 55*(1), 143-152. Retrieved from https://bhi61nm2cr3mkdgk1dtaov18-wpengine.netdna-ssl.com/wp-content/uploads/jogenderMTLpaper.pdf

Boaler, J., Dieckmann, J. A., Pérez-Núñez, G., Sun, K. L., & Williams, C. (2018). Changing students minds and achievement in mathematics: The impact of a free online student course. *Frontiers in Education, 3*, 1-7. doi:10.3389/feduc.2018.00026

Boaler, J., & Sengupta-Irving, T. (2006). Nature, neglect and nuance: Changing accounts of sex, gender and mathematics. In C. Skelton & L. Smulyan (eds.) *Handbook of gender and education* (pp 207-220). Thousand Oaks, CA: Sage Publications. Retrieved from https://bhi61nm2cr3mkdgk1dtaov18-wpengine.netdna-ssl.com/wp-content/uploads/jogenderMTLpaper.pdf

Boaler, J., William, D., & Brown, M. (2000). Students' experiences of ability grouping – disaffection, polarization and the construction of failure. *British Educational Research Journal, 26*(5), 631-648. Retrieved from https://bhi61nm2cr3mkdgk1dtaov18-wpengine.netdna-ssl.com/wp-content/uploads/BoalerWiliamBrownBERJ.pdf

Boe, M. V., Henriksen, E. K., Lyons, T., & Schreiner, C. (2011). Participation in science and technology: young people's achievement-related choices in late-modern societies. *Studies in Science Education, 47*(1), 37-72. doi:10.1080/03057267.2011.549621

Bong, M., & Hocevar, D. (2002). Measuring self-efficacy: Multitrait-multimethod comparison of scaling procedures. *Applied Measurement in Education, 15*, 143-171. Retrieved from https://www.tandfonline.com/loi/hame20

Bong, M., & Skaalvik, E. M. (2003). Academic self-concept and self-efficacy: How different are they really? *Educational Psychology Review, 15*, 1-40. doi:10.1023/A:1021302408382

Bonne, L., & Johnston, M. (2016). Students' beliefs about themselves as mathematics learners. *Thinking Skills and Creativity, 20*, 17-28. doi:10.1016/j.tsc.2016.02.001

Brisson, B. M., Dicke, A-L., Gaspard, H., Häfner, I., Flunger, B., Nagengast, B., & Trautwein, U. (2017). Short intervention, sustained effects: Promoting students' math competence beliefs, effort, and achievement. *American Educational Research Journal, 54*(6), 1048-1078. doi:10.3102/0002831217716084

Brummelman, E., Thomaes, S., Orobio de Castro, B., Overbeek, G., & Bushman, B. J. (2014). "That's not just beautiful – that's incredibly beautiful!": The adverse impact of inflated praise on children with low self-esteem. *Psychological Science, 25*(3), 728-735. doi:10.1177/0956797613514251

Burrus, J., & Moore, R. (2016). The incremental validity of beliefs and attitudes for predicting mathematics achievement. *Learning and Individual Differences, 50*, 246-251. doi:10.1016/j.lindif.2016.08.019

Cassidy, S. (2015). Resilience building in students: The role of academic self-efficacy. *Frontiers in Psychology, 8*, 1-13. doi:10.3389/fpsyg.2015.01781

Cheema, J. R. (2018). Effect of math-specific self-efficacy on math literacy: Evidence from a Greek survey. *Research in Education, 102*(1), 13-36. doi:10.1177/0034523717741914

Cheema, J. R., & Kitsantas, A. (2014). Influences of disciplinary classroom climate on high school student self-efficacy and mathematics achievement: A look at gender and racial-ethnic differences. *International Journal of Science and Mathematics Education, 12*, 1261-1279. Retrieved from http://www.springer.com/education+%26+language/mathematics+education/journal/10763

Chen, P., & Zimmerman, B. (2007). A cross-national comparison study on the accuracy of self-efficacy beliefs of middle-school mathematics students. *The Journal of Experimental Education, 75*(3), 221-244. doi:10.3200/JEXE.75.3.221-244

Chen, X., & Soldner, M. (2013). *STEM attrition: College students' paths into and out of STEM fields* (NCES Publication No. 2014-001). Washington DC: U.S. Department of Education and National Center for Education Statistics. Retrieved from https://nces.ed.gov/pubs2014/2014001rev.pdf

Clotfelter, C. T., Ladd, H. F., & Vigdor, J. L. (2015). The aftermath of accelerating algebra: Evidence from district policy initiatives. *Journal of Human Resources, 50*(1), 159-188. Retrieved from http://jhr.uwpress.org/

Drago, A., Rheinheimer, D. C., & Detweiler, T. N. (2018). Effects of locus of control, academic self-efficacy, and tutoring on academic performance. *Journal of College Student Retention, 19*(4), 433-451. doi:10.1177/152102511664602

Dweck, C. S. (2000). *Self-theories: Their role in motivation, personality, and development.* Philadelphia, PA: Psychology Press.

Dweck, C. S. (2006). Is math a gift? Beliefs that put females at risk. In S. J. Ceci & W. Williams (Eds.) *Why aren't more women in science? Top researchers debate the evidence.* Washington, DC: American Psychological Association. Retrieved from http://www.ms.uky.edu/~ma113/s.17/cdweckmathgift.pdf

Dweck, C. S. (2016). *Mindset: The new psychology of success*. New York, NY:Ballantine Books.

Eddy, C. M., Fuentes, S. Q., Ward, E. K., Parker, Y. A., Cooper, S., Jasper, W. A., . . . Wilkerson, T. L. (2015). Unifying the algebra for all movement. *Journal of Advanced Academics, 26*(1), 59-92. doi:10.1177/1932202X14562393

Erturan, S., & Jansen, B. (2015). An investigation of boys' and girls' emotional experience of math, their math performance, and the relation between these variable. *European Journal of Psychology of Education, 30*, 421-435. Retrieved from https://link.springer.com/journal/10212

Ferla, J., Valcke, M., & Cai, Y. (2009). Academic self-efficacy and academic self-concept: Reconsidering structural relationships. *Learning and Individual Differences, 19*, 499-505. doi:10.1016/j.lindif.2009.05.004

Ford, C. (2015). *Understanding Q-Q plots*. Retrieved from https://data.library.virginia.edu/ understanding-q-q-plots/

Forrest-Bank, S. S., & Jenson, J. M. (2015). The relationship among childhood risk and protective factors, racial microaggression and ethnic identity, and academic self-efficacy and antisocial behavior in young adulthood. *Children and Youth Services Review, 50*, 64-74. doi:10.1016/j.childyouth.2015.01.005

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

Galla, B. M., Wood, J. J., Tsukayama, E., Har, K., Chiu, A. W., & Langer, D. A. (2014). A longitudinal multilevel model analysis of the within-person and between-person effect of effortful engagement and academic self-efficacy on academic performance. *Journal of School Psychology, 52*, 295-308. doi:10.1016/j.jsp.2014.04.001

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

Ghazi, S. R., Khan, U. A., Shahzada, G., & Ullah, K. (2014). Formal operational stage of Piaget's cognitive development theory: An implication in learning mathematics. *Journal of Educational Research, 17*(2), 71-84. Retrieved from https://www.tandfonline.com/loi/vjer20

Goetz, T., Bieg, M., Lüdtke, O., Pekrun, R., & Hall, N. C. (2013). Do girls really experience more anxiety in mathematics? *Psychological Science, 24*(10), 2079-2087. doi:10.1177/0956797613486989

Hackett, G., & Betz, N. E. (1989). An exploration of the mathematics self-efficacy/mathematics performance correspondence. *Journal for Research in Mathematics Education, 20*, 261-273. Retrieved from http://www.nctm.org/publications/journal-for-research-in-mathematics-education/

Hall, M. J., & Ponton, M. K. (2005). Mathematics self-efficacy of college freshmen. *Journal of Developmental Education, 28*(3), 26-28, 30, 32. Retrieved from https://ncde.appstate.edu/publications/journal-developmental-education-jde

Hemphill, D. C., & Hill, J. W. (2013). Tested and placed in: Are sixth-grade boys and girls completing early challenge math coursework before they are ready? *Creative Education, 4*(8), 521-527. doi:10.4236/ce.2013.48076

Higbee, J. L., & Thomas, P. V. (1999). Affective and cognitive factors related to mathematics achievement. *Journal of Developmental Education, 23*, 8-24. Retrieved from https://ncde.appstate.edu/publications/journal-developmental-education-jde

Hodgen, J., Kuchemann, D., Brown, M., & Coe, R. (2010). Lower secondary school students' attitudes to mathematics: Evidence from a large-scale survey in England. *Research in Mathematics Education, 12*(2), 155-156. doi:10.1080/14794802.2010.496983

Hoigaard, R., Kovač, V. B., Øverby, N. C., & Haugen, T. (2015). Academic self-efficacy mediates the effects of school psychological climate on academic achievement. *School Psychology Quarterly, 30*(1), 64-74. doi:10.1037/spq0000056

Honicke, T., & Broadbent, J. (2016). The influence of academic self-efficacy on academic performance: A systematic review. *Educational Research Review, 17*, 63-84. doi:10.1016/j.edurev.2015.11.002

Huang, C. (2013). Gender differences in academic self-efficacy: A meta-analysis. *European Journal of Psychology of Education, 28*(1), 1-35. doi:10.1007/s10212-011-0097-y

Hwang, M. H., Choi, H. C., Lee, A., Culver, J. D., & Hutchison, B. (2016). The relationship between self-efficacy and academic achievement: A 5-year panel analysis. *Asia-Pacific Education Researcher, 25*(1), 89-98. doi:10.1007/s40299-015-0236-3

Inhelder, B., & Piaget, J. (1958). *The growth of logical thinking from childhood to adolescence: An essay on the construction of formal operational structures.* Abingdon, England: Basic Books.

Jansen, B. R., Louwerse, J., Straatemeier, M., Van der Ven, S. H., Klinkenberg, S., & Van der Maas, H. L. (2013). The influence of experiencing success in math on math anxiety, perceived math confidence, and math performance. *Learning and Individual Differences, 24*, 190-197. doi:10.1016/j.lindif.2012.12.014

Jansen, M., Lüdtke, O., Schroeders, U. (2016). Evidence for a positive relation between interest and achievement: Examining between-person and within-person variation in five domains. *Contemporary Educational Psychology, 46*, 116-127. doi:10.1016/j.cedpsych.2016.05.004

Joët, G., Usher, E. L., & Bressoux, P. (2011). Sources of self-efficacy: An investigation of elementary school students in France. *Journal of Educational Psychology, 103*(3), 649-663. doi:10.1037/a0024048

Jung, K-R., Zhou, A. Q., Lee, R. M. (2017). Self-efficacy, self-discipline and academic performance: Testing a context-specific mediation model. *Learning and Individual Differences, 60*, 33-39. doi:10.1016/j.lindif.2017.10.004

Kalaycioğlu, D. B. (2015). The influence of socioeconomic status, self-efficacy, and anxiety on mathematics achievement in England, Greece, Hong Kong, the Netherlands, Turkey, and the USA. *Educational Sciences: Theory & Practice, 15*(5), 1391-1401.

Kitsantas, A., Cheema, J., & Ware, H. (2011). Mathematics achievement: the role of homework and self-efficacy beliefs. *Journal of Advanced Academics, 22*(2), 310-339. Retrieved from http://journals.sagepub.com/home/joa

Klassen, R., Ang, R. P., Chong, W. H., Krawchuk, L. L., Huan, V. S., … Yeo, L. S. (2010). Academic procrastination in two settings: Motivation correlates, behavioral patterns, and negative impact of procrastination in Canada and Singapore. *Applied Psychology: An International Review, 59*(3), 361-379. doi:10.1111/j.1464-0597.2009.00394.x

Klassen, R. M., Krawchuck, L. L., & Rajani, S. (2008). Academic procrastination of undergraduates: Low self-efficacy to self-regulate predicts higher levels of procrastination. *Contemporary Educational Psychology, 33*(4), 915-931. doi:10.1016/j.cedpsych.2007.07.001

Klassen, R. M., & Usher, E. L. (2010). Self-efficacy in educational settings. Recent research and emerging directions. In T. C. Urdan & S. A. Karabenick (Eds.), *Advances in Motivation and Achievement: Vol. 16A. The decade ahead: Theoretical perspectives on motivation and achievement* (pp. 1-33). Bingley, UK: Emerald.

Lagenfeld, T. E. & Pajares, F. (1993). *The mathematics self-efficacy scale: A validation study.* Presented to the annual conference of the American Education Research Association. Atlanta, GA. Retrieved from https://eric.ed.gov/?id=ED364413

Larson, M. (2016). *A brief history of mathematics education: Lessons for today*. Retrieved from http://www.nctm.org/uploadedFiles/About/President,_Board_and_Committees/Board_Materials/MLarson-SF-NCTM-4-16.pdf

Larson, M. R., & Kanold, T. D. (2016). *Balancing the equation: A guide to school mathematics for educators and parents.* Bloomington, IN: Solution Tree.

Lau, C., Kitsantas, A., Miller, A. D., Drogin Rodgers, E. B. (2018). Perceived responsibility for learning, self-efficacy, and sources of self-efficacy in mathematics: A study of international baccalaureate primary years program students. *Social Psychology of Education.* doi:10.1007/s11218-018-9431-4

Lent, R. W., Lopez, F. G., Brown, S. D., & Gore, P. A. (1996). Latent structure of the sources of mathematics self-efficacy. *Journal of Vocational Behavior, 49*, 292-308. Retrieved from https://www.journals.elsevier.com/journal-of-vocational-behavior

Lent, R. W., Lopez, F. G., & Bieschkle, K. J. (1991). Mathematics self-efficacy: Sources and relation to science-based career choice. *Journal of Counseling Psychology, 38*, 424-430. Retrieved from http://www.apa.org/pubs/journals/cou/

Lent, R. W., Lopez, F. G., & Bieschkle, K. J. (1993). Predicting mathematics-related choice and success behaviors: Test of an expanded social cognitive model. *Journal of Vocational Behavior, 42*, 223-236. doi:10.1006/jvbe.1993.1016

Lipnevich, A. A., Preckel, F., & Krumm, S. (2016). Mathematics attitudes and their unique contribution to achievement: Going over and above cognitive ability and personality. *Learning and Individual Differences, 47*, 70-79. doi:10.1016.j.lindif.2015.12.027

Liu, R., Zhen, R., Ding, Y., Liu, Y., Wang, J., Jiang, R., & Xu, L. (2018). Teacher support and math engagement: Roles of academic self-efficacy and positive emotions. *Educational Psychology, 38*(1), 3-16. doi:10.1080/01443410.2017.1359238

Maltese, A. V., Tai, R. H., & Fan, X. (2012). When is homework worth the time? Evaluating the association between homework and achievement in high school science and math. *High School Journal, 96*(1), 52-72. doi:10.1353/hsj.2012.0015

Mangels, J. A., Butterfield, B., Lamb, J., Good, C., & Dweck, C. S. (2006). Why do beliefs about intelligence influence learning success? A social cognitive neuroscience model. *Social Cognitive and Affective Neuroscience, 1*, 75-86. doi:10.1093/scan/nsl013

Mann, M. J., Smith, M. L., & Kristjansson, A. L. (2015). Improving academic self-efficacy, school connectedness, and identity in struggling middle school girls: A preliminary study of the REAL Girls program. *Health Education & Behavior, 42*(1), 117-126. doi:10.1177/1090198114543005

March H. W. (1990). Causal ordering of academic self-concept and academic achievement: A multiwave, longitudinal panel analysis. *Journal of Educational Psychology, 82*(4), 646-656. doi:10.1037/0022-0663.82.4.646

Marsh, H. W., & Yeung, A. S. (1998). Top-down, bottom-up, and horizontal models: The direction of causality in multidimensional, hierarchical self-concept models. *Personality and Social Psychology, 75,* 509-527. doi:10.1037/0022-3514.75.2.509

May, D. K. (2009). *Mathematics self-efficacy and anxiety questionnaire* (Doctoral dissertation). Retrieved from https://getd.libs.uga.edu/pdfs/may_diana_k_200908_phd.pdf

McLeod, D. B. (2003). From consensus to controversy. In G. M. A. Stanic & J. Kilpatrick (Eds.), *A history of school mathematics* (vol. 1, pp. 753-818). Reston, VA: National Council of Teachers of Mathematics.

Mega, C., Ronconi, L., & De Beni, R. (2013). What makes a good student? How emotions, self-regulated learning, and motivation contribute to academic achievement. *Journal of Educational Psychology, 106*(1), 121-131. doi:10.1037/a0033546

Midgley, C., Maehr, M., Hruda, L., Anderman, E., Anderman, L., Freeman, K., … Urdan, T. (2000). *Manual for the patterns of adaptive learning scales.* Retrieved from http://www.umich.edu/~pals/manuals.html

Miller, D. I., Eagly, A. H., Linn, M. C. (2015). Women's representation in science predicts national gender-science stereotypes: Evidence from 66 nations. *Journal of Educational Psychology, 107*(3), 631-644. doi:10.1037/edu0000005

Morony, S., Kleitman, S., Lee, Y. P., & Stankov, L. (2013). Predicting achievement: Confidence vs self-efficacy, anxiety, and self-concept in Confucian and European countries. *International Journal of Educational Research, 58*, 79-96. doi:10.1016/j.ijer.2012.11.002

Motlagh, S. E., Amrai, K., Yazdani, M. J., Abderahim, H. A., & Souri, H. (2011). The relationship between self-efficacy and academic achievement in high school students. *Procedia Social and Behavioral Sciences, 15*, 765-768. Retrieved from https://www.journals.elsevier.com/procedia-social-and-behavioral-sciences/

Muris, P. (2002). Relationships between self-efficacy and symptoms of anxiety disorders and depression in a normal adolescent sample. *Personality and Individual Differences, 32*, 337-348. doi:10.1016.S0191-8869(01)00027-7

National Science Board (NSB). (2018). *Science and engineering indicators 2018* (NSB Publication No. NSB-2018-1). Alexandria, VA: National Science Foundation. Retrieved from https://www.nsf.gov/statistics/2018/nsb20181/report/sections/higher-education-in-science-and-engineering/highlights

National Science Foundation (NSF). (2017). *Women, minorities, and persons with disabilities in science and engineering 2017* (NSF Publication No. NSF-17-310). Arlington, VA: National Science Foundation National Center for Science and Engineering Statistics. Retrieved from https://www.nsf.gov/statistics/2017/nsf17310/digest/about-this-report/

Nix, S., Perez-Felkner, L., & Thomas, K. (2015). Perceived mathematical ability under challenge: a longitudinal perspective on sex segregation among STEM degree fields. *Frontiers in Psychology, 6*, 1-19. doi:10.3389/fpsyg.2015.00530

Ojose, B. (2008). Applying Piaget's theory of cognitive development to mathematics instruction. *The Mathematics Educator, 18*(1), 26-30. Retrieved from http://tme.journals.libs.uga.edu/index.php/tme/index

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

Pajares, F., & Graham, L. (1999). Self-efficacy, motivation constructs, and mathematics performance of entering middle school students. *Contemporary Educational Psychology, 24*, 124-139. Retrieved from https://www.journals.elsevier.com/contemporary-educational-psychology/

Pajares, F., Johnson, M. J., & Usher, E. L. (2007). Sources of writing self-efficacy beliefs of elementary, middle, and high school students. *Research in the Teaching of English, 42*(1), 104-120. Retrieved from http://www2.ncte.org/resources/journals/research-in-the-teaching-of-english/

Pajares, F., & Kranzler, J. (1995). Self-efficacy beliefs and general mental ability in mathematical problem-solving. *Contemporary Educational Psychology, 20*, 426-443. Retrieved from https://www.journals.elsevier.com/contemporary-educational-psychology/

Pajares, F., & Miller, M. D. (1994). The role of self-efficacy and self-concept beliefs in mathematical problem-solving: A path analysis. *Journal of Educational Psychology, 86*, 193-203. Retrieved from http://www.apa.org/pubs/journals/edu/index.aspx

Pajares, F., & Miller, M. D. (1995). Mathematics self-efficacy and mathematics performances: The need for specificity of assessment. *Journal of Counseling Psychology,* 42, 190-198. doi:10.1037/0022-0167.42.2.190

Pajares, F., & Schunk, D. H. (2001). Self-beliefs and school success: Self-efficacy, self-concept, and school achievement. In R. Riding & S. Rayner (Eds.), *Perception* (pp. 239-266). London: Ablex Publishing.

Pajares, F., & Usher, E. L. (2008). Self-efficacy, motivation, and achievement in school from the perspective of reciprocal determinism. *Advances in Motivation and Achievement, 15*, 391-423. doi:10.1016/S0749-7423(08)15012-9

Pajares, F., & Valiante, G. (2002). Students' self-efficacy in their self-regulated learning strategies: A developmental perspective. *Psychologia, 45*, 211-221. doi:10.2117.psysoc.2002.211

Pampaka, M., Kleanthous, I., Hutcheson, G. D., & Wake, G. (2011). Measuring mathematics self-efficacy as a learning outcome. *Research in Mathematics Education, 13*(2), 169-190. doi:10.1080/14794802.2011.585828

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), S385-S411. Retrieved from http://www.springer.com/education+%26+language/mathematics+education/journal/10763

Parker, P. D., Lüdtke, O., Trautwein, U., & Roberts, B. W. (2012). Personality and relationship quality during the transition from high school to early adulthood. *Journal of Personality, 80*(4), 1061-1089. doi: 10.1111/j.1467-6494.2012.00766.x

Parker, P. D., Marsh, H. W., Ciarrochi, J., Marshall, S., & Abduljabbar, A. S. (2014). Juxtaposing math self-efficacy and self-concept as predictors of long-term achievement outcomes. *Educational Psychology, 34*(1), 29-48. doi:10.1080/01443410.2013.797339

Peguero, A. A., & Shaffer, K. A. (2015). Academic self-efficacy, dropping out, and the significance of inequality. *Sociological Spectrum, 35*, 46-64. doi:10.1080/02732173.2014.978428

Peklaj, C., Podlesek, A., & Pecjak, S. (2015). Gender, previous knowledge, personality traits and subject-specific motivation as predictors of students' math grade in upper-secondary school. *European Journal of Psychology of Education, 30*, 313-330. Retrieved from https://link.springer.com/journal/10212

Pekrun, R. (2006). The control-value theory of achievement emotions: assumptions, corollaries, and implications for educational research and practice. *Educational Psychology Review, 18*, 315-341. doi:10.1007/s10648-006-9029-9

Pekrun, R. (2017). Emotion and achievement during adolescence. *Child Development Perspectives, 11*(3), 215-221. doi:10.1111/cdep.12237

Pekrun, R., Goetz, T., Titz, W., & Perry, R. P. (2002). Academic emotions in students' self-regulated learning and achievement: A program of qualitative and quantitative research. *Educational Psychologist, 37*, 91-105. doi:10.1207/S15326985EP3702_4

Piaget, J. (1970). *Science of education and the psychology of the child.* New York: Grossman Publishers.

Piaget, J. (1973). Comments on mathematical education. In A. G. Howson (Ed.), *Developments in mathematical education: Proceedings of the second international congress on mathematical education.* Cambridge, England: Cambridge University Press.

Piaget, J. (1977). *Epistemology and psychology of functions.* Dordrecht, Netherlands: D. Reidel Publishing Company.

Pintrich, P. R., & De Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology, 82*, 33-40. doi:10.1037/0022-0663.82.1.33

Putwain, D., Sander, P., & Larkin, D. (2013). Academic self-efficacy in study-related skills and behaviours: Relations with learning-related emotions and academic success. *British Journal of Educational Psychology, 83*, 633-650. doi:10.1111/j.2044-8279.2012.02084.x

Retelsdorf, J., Köller, O., & Möller, J. (2014). Reading achievement and reading self-concept – testing the reciprocal effects model. *Learning and Instruction, 29*, 21-30. doi:10.1016/j.learninstruc.2013.07.004

Richardson, M., Bond, R., & Abraham, C. (2012). Psychological correlates of university students' academic performance: a systematic review and meta-analysis. *Psychological Bulletin, 138*, 353-387. doi:10.1037/a0026838

Rice, L., Barth, J. M., Guadagno, R. E., Smith, G. P. A., & McCallum, D. M. (2013). The role of social support in students' perceived abilities and attitudes toward math and science. *Journal of Youth and Adolescence, 42*, 1028-1040. doi:10.1007/s10964-012-9801-8

Rickles, J. H. (2013). Examining heterogeneity in the effect of taking algebra in eighth grade. *The Journal of Educational Research, 106*, 251-268. doi:10.1080/00220671.2012.692731

Robinson, A., Shore, B. M., & Enersen, D. L. (2007). *Best practices in gifted education: An evidence-based guide.* Waco, TX: Prufrock Press.

Rocchino, G. H., Dever, B. V., Telesford, A., & Fletcher, K. (2017). Internalizing and externalizing in adolescence: the roles of academic self-efficacy and gender. *Psychology in the Schools, 54*, 905-917. doi:10.1002/pits.2045

Roick, J. & Ringeisen, T. (2018). Students' math performance in higher education: Examining the role of self-regulated learning and self-efficacy. *Learning and Individual Differences, 65*, 148-158.

Rosario, P., Nunez, J. C., Vallejo, G., Cunha, J., Nunes, T., Mourao, R., & Pinto, R. (2015). Does homework design matter? The role of homework's purpose in student mathematics achievement. *Contemporary Educational Psychology, 43*, 10-24. doi:10.1016/j.cedpsych.2015.08.001

Sahin, A., Ekmekci, A., & Waxman, H. C. (2017). The relationship among high school STEM learning experiences, expectations, and mathematics and science efficacy and the likelihood of majoring in STEM in college. *International Journal of Science Education, 39*(11), 1549-1572. doi:10.1080/09500693.2017.1341067

Sass, T. R. (2015). *Understanding the STEM pipeline.* Washington, DC: American Institutes for Research. Retrieved from https://caldercenter.org/sites/default/files/WP%20125.pdf

Sawchuk, S. (2018, June 12). A bold effort to end algebra tracking shows promise. *Education Week.* Retrieved from https://www.edweek.org/ew/articles/2018/06/13/a-bold-effort-to-de-track-algebra-shows.html

Schöber, C., Schütte, K., Köller, O., McElvany, N., & Gebauer, M. M. (2018). Reciprocal effects between self-efficacy and achievement in mathematics and reading. *Learning and Individual Differences, 63*, 1-11.

Schunk, D. H. (1991). Self-efficacy and academic motivation. *Educational Psychologist, 26*, 207-231. Retrieved from https://www.tandfonline.com/loi/hedp20

Schunk, D. H., & Pajares, F. (2002). The development of academic self-efficacy. In A. Wigfield & J. Eccles (Eds.), *Development of achievement motivation* (pp. 15-31). San Diego, CA: Academic Press.

Schunk, D. H., & Pajares, F. (2009). Self-efficacy theory. In K. R. Wentzel, & A. Wigfield (Eds.). *Handbook of motivation at school.* (pp. 35-54). New York, NY: Routledge.

Schunk, D. H., & Zimmerman, B. J. (2007). Influencing children's self-efficacy and self-regulation of reading and writing through modeling. *Reading & Writing Quarterly, 23*(1), 7-25. doi:10.1080/10573560600837578

Siegle, D., & McCoach, D. B. (2007). Increasing student mathematics self-efficacy through teacher training. *Journal of Advanced Academics, 18*(2), 278-312. Retrieved from http://journals.sagepub.com/home/joa

Skaalvik, E. M. (1997). Issues in research on self-concept. In M. Meahr, & P. R. Pintrich (Eds.), *Advances in motivation and achievement* (vol. 10, pp. 51-97). Greenwich, CT: JAI Press, Inc.

Skaalvik, E. M., Federici, R. A., & Klassen, R. M. (2015). Mathematics achievement and self-efficacy: Relations with motivation for mathematics. *International Journal of Educational Research, 72*, 129-136. doi:10.1016/j.ijer.2015.06.008

Spielhagen, F. R. (2010). Algebra for everyone? Student perceptions of tracking in mathematics. *Middle Grades Research Journal, 5*(4), 213-223. Retrieved from http://www.infoagepub.com/middle-grades-research-journal

Stanley, J. C., & Benbow, C. P. (1983). SMPY's first decade: Ten years of posing problems and solving them. *Journal of Special Education, 17*, 11-25. Retrieved from https://us.sagepub.com/en-us/nam/journal/journal-special-education

Stein, M. K., Kaufman, J. H., Sherman, M., & Hillen, A. F. (2011). Algebra: A challenge at the crossroads of policy and practice. *Review of Educational Research, 81*(4), 453-492. doi:10.3102/0034654311423025

Susac, A., Bubic, A., Vrbanc, A., & Planinic, M. (2014). Development of abstract mathematical reasoning: The case of algebra. *Frontiers in Human Neuroscience, 8,* 679. doi:10.3389/fnhum.2014.00679

Tai, R. H., Liu, C. Q., Maltese, A. V., & Fan, X. (2006). Planning early for careers in science. *Science, 312*(5777), 1143-1144. Retrieved from http://science.sciencemag.org/

Talsma, K., Schuz, B., Schwarzer, R., & Norris, K. (2018). I believe, therefore I achieve (and vice versa): A meta-analytic cross-lagged panel analysis of self-efficacy and academic performance. *Learning and Individual Differences, 61*, 136-150. doi:10.1016/j.lindif.2017.11.015

Toland, M. D., & Usher, E. L. (2016). Assessing mathematics self-efficacy: How many categories do we really need? *Journal of Early Adolescence, 36*(7), 932-960. doi: 10.1177/0272431615588952

U.S. Congress Joint Economic Committee. (2018). The 2018 Joint Economic Report. Retrieved from https://www.jec.senate.gov/public/_cache/files/7faf912a-0fd2-4a92-bba4-e41c2c1f8e93/2018-joint-economic-committee-response.pdf

Usher, E. L. (2009). Sources of middle school students' self-efficacy in mathematics: A qualitative investigation. *American Educational Research Journal, 46*(1), 275-314. doi:10.3102/0002831208324517

Usher, E. L., Ford, C. J., Li, C. R., & Weldner, B. (in press). Sources of math and science self-efficacy in rural Appalachia: A convergent mixed methods study. *Contemporary Educational Psychology.* doi:10.1016/j.cedpsych.2018.10.003

Usher, E. L., & Pajares, F. (2009). Sources of self-efficacy in mathematics: A validation study. *Contemporary Educational Psychology, 34*, 89-101. doi:10.1016/j.cedpsych.2008.09.002

van Aalderen-Smeets, S. I., & Walma van der Molen, J. H. (2018). Modeling the relationship between students' implicit beliefs about their abilities and their educational STEM choices. *International Journal of Technology and Design Education, 28*, 1-27. doi:10.1007/s10798-016-9387-7

Villafañe, S. M., Xu, X., & Raker, J. R. (2016). Self-efficacy and academic performance in first-semester organic chemistry: testing a model of reciprocal causation. *Chemistry Education Research and Practice, 17*(4), 973-984. doi:10.1039/c6rp00119j

Waits, A. (2016). *Interpreting differences of self-efficacy of gifted or talented students with grouping practices in middle school mathematics* (Doctoral dissertation). Retrieved from ProQuest. (10291321).

Wang, X. (2013). Why students choose STEM majors: Motivation, high school learning, and postsecondary context of support. *American Educational Research Journal, 50*(5), 1081-1121. doi:10.3102/0002831213488622

Warner, R. (2013). *Applied statistics. From bivariate through multivariate techniques.* Thousand Oaks, CA: SAGE Publications, Inc.

Watson, J., & McCarroll, J. C. (2010). *Eighth grade algebra: Findings from the eighth-grade round of the early childhood longitudinal study, Kindergarten class of 1998-1999*. (NCES Publication No. 2010-016). Washington DC: U.S. Department of Education and National Center for Education Statistics. Retrieved from https://nces.ed.gov/pubs2010/2010016.pdf

Wilkins, J. L. M., & Ma, X. (2003). Modeling change in student attitude toward and beliefs about mathematics. *The Journal of Educational Research, 97*(1), 52-63. Retrieved from https://www.tandfonline.com/toc/vjer20/current

Williams, T., & Williams, K. (2010). Self-efficacy and performance in mathematics: Reciprocal determinism in 33 nations. *Journal of Educational Psychology, 102*(2), 453-466. doi:10.1037/a0017271

APPENDIX A

mind garden

www.mindgarden.com

To Whom It May Concern,

The above-named person has made a license purchase from Mind Garden, Inc. and has permission to administer the following copyrighted instrument up to that quantity purchased:

Mathematics Self-Efficacy Scale

The two sample items only from this instrument as specified below may be included in your thesis or dissertation. Any other use must receive prior written permission from Mind Garden. The entire instrument may not be included or reproduced at any time in any other published material. Please understand that disclosing more than we have authorized will compromise the integrity and value of the test.

Citation of the instrument must include the applicable copyright statement listed below.
Sample Items:

How much confidence do you have that you could successfully:

Add two large numbers (e.g., 5379 + 62543) in your head.

How much confidence you have that you could complete the course with a final grade of "A" or "B" in:

Basic College Math

Sincerely,

Robert Most
Mind Garden, Inc.
www.mindgarden.com

APPENDIX B

LIBERTY UNIVERSITY
INSTITUTIONAL REVIEW BOARD

December 17, 2018

Jacqueline R. Probst

IRB Approval 3541.121718: A Causal-Comparative Analysis of Mathematics Self-Efficacy Based on Gender and Math Acceleration

Dear Jacqueline R. Probst,

We are pleased to inform you that your study has been approved by the Liberty University IRB. This approval is extended to you for one year from the date provided above with your protocol number. If data collection proceeds past one year or if you make changes in the methodology as it pertains to human subjects, you must submit an appropriate update form to the IRB. The forms for these cases were attached to your approval email.

Your study falls under the expedited review category (45 CFR 46.110), which is applicable to specific, minimal risk studies and minor changes to approved studies for the following reason(s):

> Your study involves surveying or interviewing minors, or it involves observing the public behavior of minors, and you will participate in the activities being observed.

Thank you for your cooperation with the IRB, and we wish you well with your research

project. Sincerely,

G. Michele Baker, MA, CIP

Administrative Chair of Institutional Research **The Graduate School**

LIBERTY
UNIVERSITY

Liberty University | Training Champions for Christ since 1971

APPENDIX C

December 18, 2018

Dear Head of School:

As a graduate student in the School of Education at Liberty University, I am conducting research to better understand the relationship between acceleration in secondary mathematics courses and student mathematics self-efficacy. In order to have an appropriately sized research sample, I am asking for numerous local private schools to participate.

If you choose for your school to participate, I will ask for all of your Algebra 2 and Precalculus teachers to administer a questionnaire to their Algebra 2/Precalculus students in order to measure their confidence in several areas relating to mathematics. It should take approximately 15 minutes for your students to complete the questionnaire. Student participation will be completely anonymous, and no personal, identifying information will be required. The identities of participating schools will also not be disclosed, nor will the state or region in which the study was performed.

A consent document and an IRB approval letter are attached to this email. The informed consent document contains additional information about my research and should be sent home with each Algebra 2/Precalculus student sometime during the first two weeks of January. I will communicate with each of your Algebra 2 and Precalculus teachers before that time and will follow up again in January. The study will take place during the third week of January, on a specific date that is mutually agreeable.

If you choose for your school to participate, I will provide your Algebra 2 and Precalculus teachers with an Amazon gift card worth $3 for every participating student. It is my hope that this incentive will offset the inconvenience of collecting consent forms and administering the survey. Student incentives will also be provided in the form of Amazon gift cards and small treats.

Please email me at JProbst1@Liberty.edu to make arrangements for participation or with any questions you may have regarding participation in the study.

Sincerely,

Jacqueline R. Probst
Liberty University - Ed.D. candidate

APPENDIX D

January 7, 2019

Dear Parent/Guardian of an Algebra 2/Precalculus student:

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for a Doctor of Education degree. The purpose of my research is to better understand the relationship between acceleration in secondary mathematics courses and student mathematics self-efficacy. I am writing to invite your student to participate in my study.

If your child is currently enrolled in either Algebra 2 or Precalculus, first enrolled in Algebra 1 in Grade 7, 8, or 9, and you are willing to allow your student to participate, he or she will be asked to complete a questionnaire related to his or her confidence in several areas relating to mathematics. It should take approximately 15 minutes for your student to complete the questionnaire. Your student's participation will be completely anonymous, and no personal, identifying information will be required.

A combined consent and assent document accompanies this letter and contains additional information about my research. In order for your student to participate, please sign the combined consent and assent document and return it to your student's Algebra 2/Precalculus teacher by January 22, 2019.

If you choose for your student to participate, he or she will be entered in a raffle to win one of three $25 Amazon gift cards. Students who do not receive a gift card will receive a small gift of candy and/or chocolates.

Sincerely,

Jacqueline R. Probst
Ed.D. candidate

APPENDIX E

The Liberty University Institutional
Review Board has approved
this document for use from
12/17/2018 to 12/16/2019
Protocol # 3541.121718

PARENT/GUARDIAN CONSENT FORM

A Causal-Comparative Analysis of Mathematics Self-Efficacy
Based on Gender and Math Acceleration

Jacqueline R. Probst
Liberty University
School of Education

Your student is invited to be in a research study on mathematics acceleration and mathematics self-efficacy. He or she was selected as a possible participant because of his or her enrollment in Algebra 2 or precalculus for the 2018-2019 school year and because of his or her initial enrollment in Algebra 1 in either Grade 7, 8, or 9. Please read this form and ask any questions you may have before agreeing to allow him or her to be in the study.

Jacqueline R. Probst, a doctoral candidate in the School of Education at Liberty University, is conducting this study.

Background Information: The purpose of this study is to determine if there is a statistically significant difference between the mathematics self-efficacy scores of Algebra 2 and precalculus students based on their degree of mathematics acceleration. Independent variables of interest in this study are gender and the year in which the student first enrolled in Algebra 1.

Procedures: If you agree to allow your student to be in this study, I would ask him or her to do the following things:

1. Your student will complete the Mathematics Self-Efficacy Scale, a validated instrument that measures a student's perception of his or her abilities in mathematics. The questionnaire will be completed during his or her regularly scheduled Algebra 2 or precalculus class and will take 15 minutes or less to administer in full.

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

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

Compensation: Your student will be compensated for participating in this study. Students who return this completed consent/assent form and also submit a completed questionnaire will be entered to win one of three gift cards for Amazon.com worth $25 each (per school). Students who do not participate will be given an alternate assignment during this time and will also be entered in the drawing for the gift cards. All other participating students (defined as having submitted a completed consent/assent form and completed questionnaire) will received candy and/or chocolate and school supplies, worth approximately $2. A random number generator will be used to determine the winners immediately after each school concludes administration of the questionnaire.

The Liberty University Institutional
Review Board has approved
this document for use from
12/17/2018 to 12/16/2019
Protocol # 3541.121718

Confidentiality: The records of this study will be kept private. In any sort of report I might publish, I will not include any information that will make it possible to identify a subject. Research records will be stored securely immediately after the completion of the questionnaires and will remain secured at all times when not being used by, and in the immediate possession of, the researcher. Only the researcher will have access to the records. When the records are no longer needed, they will be shredded by a document shredding company.

Voluntary Nature of the Study: Participation in this study is voluntary. Your decision whether or not to allow your student to participate will not affect his or her current or future relations with Liberty University, The Bear Creek School, or their school of enrollment. If you decide to allow your student to participate, he or she is free to not answer any question or withdraw at any time prior to submitting the survey without affecting those relationships.

How to Withdraw from the Study: If your student chooses to withdraw from the study, your student should inform the researcher that he or she wishes to discontinue participation prior to submitting the study materials. Your student's responses will not be recorded or included in the study.

Contacts and Questions: The researcher conducting this study is Jacqueline Probst. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact her at JProbst1@Liberty.edu. You may also contact the researcher's faculty advisor, Dr. Vivian O. Jones, at VOJones2@Liberty.edu.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the Institutional Review Board, 1971 University Blvd, Green Hall 2845, Lynchburg, VA 24515 or email at irb@liberty.edu.

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

Statement of Consent: I have read and understood the above information. I have asked questions and have received answers. I consent to allow my student to participate in the study.

Signature of Minor Date

____

Signature of Parent Date

____

Signature of Investigator Date

____

APPENDIX F

January 7, 2019

Dear Algebra 2/Precalculus student:

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for a Doctor of Education degree. The purpose of my research is to better understand the relationship between acceleration in secondary mathematics courses and student mathematics self-efficacy. I am writing to invite you to participate in my study.

If you are currently enrolled in Algebra 2 or Precalculus, first enrolled in Algebra 1 in Grade 7, 8, or 9, and if you are willing to participate, you will be asked to complete a questionnaire related to your confidence in several areas relating to mathematics. It should take approximately 15 minutes for you to complete the questionnaire. Your participation will be completely anonymous, and no personal, identifying information will be required.

A consent document accompanies this letter and contains additional information about my research. In order for you to participate, please sign the consent document and return it to your Algebra 2/Precalculus teacher by January 22, 2019.

Participating and non-participating students will be entered in a raffle to win one of three $25 Amazon gift cards. Participating students who do not receive a gift card will receive a small gift of candy and/or chocolates.

Sincerely,

Jacqueline R. Probst
Ed.D. candidate

APPENDIX G

The Liberty University Institutional
Review Board has approved
this document for use from
12/17/2018 to 12/16/2019
Protocol # 3541.121718

CONSENT FORM

A Causal-Comparative Analysis of Mathematics Self-Efficacy
Based on Gender and Math Acceleration
Jacqueline R. Probst
Liberty University
School of Education

You are invited to be in a research study on mathematics acceleration and mathematics self-efficacy. You were selected as a possible participant because of your enrollment in Algebra 2 or precalculus for the 2018-2019 school year and because of your initial enrollment in Algebra 1 in either Grade 7, 8, or 9. Please read this form and ask any questions you may have before agreeing to be in the study.

Jacqueline R. Probst, a doctoral candidate in the School of Education at Liberty University, is conducting this study.

Background Information: The purpose of this study is to determine if there is a statistically significant difference between the mathematics self-efficacy scores of Algebra 2 and precalculus students based on their degree of mathematics acceleration. Independent variables of interest in this study are gender and the year in which the student first enrolled in Algebra 1.

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

1. You will complete the Mathematics Self-Efficacy Scale, a validated instrument which measures a student's perception of his or her abilities in mathematics. The questionnaire will be completed during your regularly scheduled Algebra 2 or precalculus class and will take 15 minutes or less to administer in full.

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

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

Compensation: You will be compensated for participating in this study. Students who return this completed consent/assent form and also submit a completed questionnaire will be entered to win one of three gift cards for Amazon.com worth $25 each (per school). Students who do not participate will be given an alternate assignment during this time and will also be entered in the drawing for the gift cards. All other participating students (defined as having submitted a completed consent/assent form and completed questionnaire) will received candy and/or chocolate, worth approximately $2 each. A random number generator will be used to determine the winners immediately after each school concludes administration of the questionnaire.

Confidentiality: The records of this study will be kept private. In any sort of report I might publish, I will not include any information that will make it possible to identify a subject. Research records will be stored securely immediately after the completion of the questionnaires and will remain secured at all times when not being used by, and in the immediate possession of,

The Liberty University Institutional
Review Board has approved
this document for use from
12/17/2018 to 12/16/2019
Protocol # 3541.121718

the researcher. Only the researcher will have access to the records. When the records are no longer needed, they will be shredded by a document shredding company.

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

How to Withdraw from the Study: If you choose to withdraw from the study, you should inform the teacher that you wish to discontinue participation prior to submitting the study materials. Your responses will not be recorded or included in the study.

Contacts and Questions: The researcher conducting this study is Jacqueline Probst. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact her at JProbst1@Liberty.edu. You may also contact the researcher's faculty advisor, Dr. Vivian O. Jones, at VOJones2@Liberty.edu.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the Institutional Review Board, 1971 University Blvd, Green Hall 2845, Lynchburg, VA 24515 or email at irb@liberty.edu.

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

Statement of Consent: I have read and understood the above information. I have asked questions and have received answers. I consent to participate in the study.

Signature of Participant Date

Signature of Investigator Date

APPENDIX H

January 14, 2019

Dear Parent/Guardian of an Algebra 2 or Precalculus student:

As a graduate student in the School of Education at Liberty University, I am conducting research to better understand the relationship between acceleration in secondary mathematics courses and student mathematics self-efficacy. Mathematics self-efficacy refers to an individual's self-perception of his or her abilities to be successful in reaching goals in their study of mathematics. Three weeks ago, a parental consent form was sent home with your student inviting him or her to participate in a research study and also requesting your permission. This follow-up email is being sent to remind you to complete the parental consent form if you would like for your student to participate and have not already done so. The deadline for participation is January 22, 2019.

If you choose for your student to participate, he or she will be asked to complete a questionnaire related to his or her confidence in several areas relating to mathematics. It should take approximately 15 minutes for your student to complete the questionnaire. Your student's participation will be completely anonymous, and no personal, identifying information will be required.

A consent document is attached to this email. The informed consent document contains additional information about my research. For your child to participate, please print and complete the consent form attached to this email. Your student should return the completed form to his or her Algebra 2 or Precalculus teacher.

Participating and non-participating students will be entered in a raffle to win one of three $25 Amazon gift cards. Participating students who do not receive a gift card will receive a small gift of candy and/or chocolates.

Sincerely,

Jacqueline R. Probst
Ed.D. candidate

APPENDIX I

Teacher: Good morning/afternoon. Thank you for your willingness to participate in this study. Including these instructions, the survey should only take about 15 minutes of our class time. Before I hand out the questionnaires, I would like to communicate some important information:

1. Please answer each question honestly.
2. Your answers will be kept both anonymous. I will not look at your responses and the researcher will not have the ability to know which student completed which questionnaire.
3. You will notice that each questionnaire is numbered. Please do not write your name anywhere on the questionnaire.
4. Your participation in this study and the answers that you select will, in no way, affect your experience or grade in this Algebra 2/Precalculus class or your relationship with me as your Algebra 2/Precalculus teacher.
5. There are two parts to the questionnaire for a total of four pages. Please read the directions for each section carefully. Questionnaires containing unanswered questions or questions with more than one answer selected may be considered invalid.
6. Once you have finished the questionnaire, please place your test underneath the colored paper provided to you. When everyone is finished, I will select three numbers randomly that correspond to our class roster. These students will receive $25 Amazon gift cards. The numbers I call out will correspond to the numbers on your questionnaires.
7. I am going to hand out the questionnaires now. Please feel free to begin after you have read the instructions.

Please hand out questionnaires and colored paper to all students at this time.