THE IMPACT OF SELF-EFFICACY IN MATHEMATICS ON URBAN HIGH SCHOOL GRADUATES’ MATH PERFORMANCE

A thesis presented
by
Mustapha Benaoui

to
The School of Education

In partial fulfillment of the requirements for the degree of
Doctor of Education

in the field of
Education

College of Professional Studies
Northeastern University
Boston, Massachusetts
May 2016
Abstract

The purpose of this study, which used quantitative survey data, was to examine the extent to which the four sources of self-efficacy (i.e., performance experiences, vicarious experiences, verbal persuasion, and physiological and emotional reactions), in the subject of mathematics, correlate with student performance on the mathematics portion of community college placement tests taken by urban high school graduates entering community college. Using SurveyMonkey, a survey was administered to 191 urban high school graduates taking mathematics placement tests for Massachusetts community colleges. The findings showed that only two of the four sources of self-efficacy, performance experiences and physiological and emotional reactions, were found to be statistically significant factors that influence the performance of recent urban high school graduates on community college mathematics placement tests. The other two sources of self-efficacy, vicarious experiences and verbal persuasion, were found not to be statistically significant factors affecting students’ placement test performance. In addition, demographics (gender, ethnicity, and parent’s or guardian’s level of education) showed mixed findings. Specifically, gender was found to be significantly correlated with students’ placement test results, where females were found to be more likely to perform better on placement tests in mathematics than males; however, these findings only occurred after controlling for students’ levels of the four sources of self-efficacy. In addition, students’ parent’s or guardian’s level of education was found to be significantly correlated with placement test results; however, this relationship was no longer present after controlling for students’ levels of the four sources of self-efficacy. Furthermore, students’ ethnicity was found to not be a significant factor in placement test results. Future studies in the area of mathematics test performance should
investigate the impact of self-efficacy on other populations, such as a homogeneous group, students in nonurban schools, or students in a private school setting.

*Key words:* urban education, self-efficacy, four sources of self-efficacy, community college placement tests, remedial courses.
# Table of Contents

Abstract ........................................................................................................................................... 2  

Chapter 1: Introduction to the Study ............................................................................................ 7  
  Statement of the Problem ........................................................................................................... 7  
  Significance of the Research Problem ....................................................................................... 13  
  Research Question ................................................................................................................... 14  
  Hypothesis ............................................................................................................................... 15  
  Theoretical Framework ............................................................................................................ 16  
  Positionality Statement ........................................................................................................... 17  
  Summary ................................................................................................................................... 21  

Chapter 2: Review of the Literature .......................................................................................... 23  
  Self-Efficacy Theory and Student Math Performance ............................................................... 23  
  Demographic Factors .............................................................................................................. 40  
  Summary ................................................................................................................................... 43  

Chapter 3: Research Design ....................................................................................................... 45  
  Research Question ................................................................................................................... 45  
  Research Hypothesis .............................................................................................................. 46  
  Research Design ..................................................................................................................... 47  
  Research Site and Participants ............................................................................................... 48  
  Research Procedures ............................................................................................................. 49  
  Validity, Reliability, and Generalizability .............................................................................. 60  
  Protection of Human Subjects ................................................................................................. 63
Summary........................................................................................................64

Chapter 4: Research Findings............................................................................66
  Data Cleaning, Transformation, and Validation...............................................67
  Participant Demographics..............................................................................68
  Descriptive Statistics for Self-Efficacy Scores.................................................69
  Testing the Internal Consistency of Responses..............................................70
  Assumption Checking for Binary Logistic Regression.....................................71
  Assumption Checking for Chi-Square Test for Independence, Independent Samples
t-test and ANOVA..........................................................................................71
  Differences Among Demographic Groups in Placement Test Results..............73
  Difference Among Demographics Groups in Source of Self-Efficacy..............74
  Predictors of Placement Test Results.............................................................77
  Summary.......................................................................................................84

Chapter 5: Discussion of Research Findings....................................................86
  Results and Discussion of the Research Question..........................................86
  Demographic Variables Effects.....................................................................92
  Research Implications....................................................................................97
  Research Limitations.....................................................................................100
  Recommendations for Future Research.......................................................101
  Conclusion...................................................................................................104

References.....................................................................................................107

Appendix A.....................................................................................................130

Appendix B.....................................................................................................136
Appendix C ................................................................................................................. 138
Appendix D .................................................................................................................... 140
Appendix E ...................................................................................................................... 153
Appendix F ...................................................................................................................... 156
Appendix G ...................................................................................................................... 164
Chapter 1: Introduction

Statement of the Problem

In recent decades, higher education enrollment has risen dramatically with the increase in federal grants and loans intended to assist urban students from low-income households to meet the rising costs of attending college (Bowen & Bok, 1998). As a result of this government financial assistance, combined with support from the civil rights movement and affirmative action plans (Bowen & Bok, 1998), the road to college has become more accessible to many urban students (U.S. Department of Education, 2003a). The National Center for Public Policy and Higher Education (2011) announced that 44% of low-income students (those with family incomes less than $25,000 per year) choose community college as their first college after graduating from high school. Also, 38% of students whose parents did not graduate from college attend community colleges as their first educational institution. In recent years, community colleges have become a convenient and affordable road for many urban students to achieve their educational goals and improve their lives. Isaacs, Sawhill, and Haskins (2008) stated, “When children born into the bottom fifth of the income distribution get a college degree, their chances of making it to the top nearly quadruple, and their chances of making it out of the bottom increase by more than 50 percent” (p. 3). In addition, recent data obtained from Complete College America by Ngo, Kwon, Melguizo, Prather, and Bos (2013) stated that over half of today's first year college students find themselves in remedial college courses because their institution deemed them unprepared for the rigors of credit-level courses. These students entered college believing that they were prepared, only to find out that they must first pay for and pass
courses for which they will not earn college credit. Additionally, these would-be college graduates are shocked to learn that they will need to take remedial math courses before they are eligible to register for their credit bearing college courses (Bettinger & Long, 2009).

These statistics indicate that many urban students are not college-ready upon completion of their high school mathematics courses. A recent study of 57 community colleges across the country found that 59% of high school graduates who took the community college entrance exam were referred to developmental math or remedial math courses (Bailey, Jeong, & Cho, 2010). This proportion is even higher for urban high school students who are African American (67%), Latinos (58%), and low income (64%) (Jones, 2012). In some cases, students may have to take up to four remedial math courses in order to be college ready (Bailey et al., 2010). Ngo et al., (2013) showed that nearly 50% of students admitted to 2-year colleges were mandated to take remedial or developmental courses. Additionally, Bailey (2009) found that 21% of minority students placed in remedial mathematics courses did not enroll in any developmental programs within three years of their initial registration in community colleges. Unfortunately, these poor results leave many of these students discouraged, and as a result, many of these students choose to drop out of community college. Of these, 41% drop out after their first year and only 28% earn a two-year degree after three years (Liu, 2011). Since the majority of community college students mandated to take remedial courses are struggling in math, preparing students better for college mathematics would reduce the number of students needing to take remedial math classes and potentially diminish the community college dropout rate (Bailey, Jeong, & Cho, 2010).

When used in this study, the term urban education refers to schools and school systems in cities typically characterized by concentrated levels of poverty, racial, linguistic, and ethnic diversity, immigrant populations, and student mobility (Kincheloe, 2010). These urban systems
generally serve a larger population of students than their suburban and rural counterparts (Kinzeloe, 2010), and they often face operating issues such as inadequate or limited space and environments that are not conducive to learning due to location and financial restrictions (Ahram, Stembridge, Fergus & Noguera, 2013). The 2012 census data indicates that there are over 53 million Latinos and over 44.5 million Blacks in the United States (U.S. Bureau of the Census, 2012). The representation of school aged students (under 17 years old) was 22.5% Latino and 30.3% Black (Snyder & Dillow, 2012). Black and Latino students in urban schools consistently lag behind in performance compared to White students (National Assessment of Educational Progress, NAEP, 2013). Poor performance in school is especially acute in mathematics, which most minority students find inherently challenging (Rueda & Dembo, 2006). In fact, low performance in this subject is one of the factors contributing to a high drop-out rate at the high school level as students who are unable to pass their math tests drop out of school (Snyder & Dillow, 2010). Recent data shows that fewer Black and Latino students take Advanced Placement (AP) exams, which require students to have a firm grasp of mathematical concepts if they are to pass the exams (NAEP, 2013). The data shows that 60% of those who enrolled and took AP exams were White, compared to 15% Latino, 10% Asian, and 8% Black. As a result, the White population is overrepresented, the Latino population is slightly underrepresented, and the Black population at 8% is severely underrepresented considering that it forms 13% of the total high school population. The SAT and ACT mathematics results show that Black students score very poorly on these tests and lag behind nearly every ethnic minority in achievement scores (Snyder & Dillow, 2010). Data from the National Assessment of Educational Progress (NAEP) (2013) indicated that there has been a consistent achievement gap between White learners and Black and Latino students. Over the last twenty years, Blacks and
Latinos have considerably reduced the achievement gap that exists between them and White students, although the achievement gap between the two minorities and White students is still huge and is a serious cause for concern (NAEP, 2013). According to the National Assessment of Educational Progress (2013) report, the achievement gap between Latinos and White students stands at 19 points, while the gap between Black and White students is 26 points (NAEP scores range from 0 to 500).

**Understanding The Math “Problem.”** Programs such as Race To the Top and No Child Left Behind were designed to increase academic performance of students. Despite these efforts, high school students continue to fall behind and score poorly on exams, mathematics included, which is a very disconcerting problem, given how much money is being spent by federal and state governments to increase high school students’ math proficiency for standardized exams. Massachusetts alone increased the average per pupil expenditure nearly 34.7% from $9206 in 1994 to $12,398 in 2004 (U.S. Department of Education, 2008).

A number of factors might account for the low academic performance in mathematics of urban high school students entering community college. Some of these factors include: lack of preparation for middle school students in mathematics (Balfanz & Byrnes, 2006); lack of parental involvement (Campbell, Hombo, & Mezzano, 2000); and a shortage of skilled, trained, and knowledgeable mathematics teachers (National Commission on Mathematics and Science Teaching for the 21st Century, 2000).

While lacking tools such as books or technology might account for some of the obstacles urban high school graduates face when dealing with college math placement tests, modern research has started to turn the focus towards the “internal” factors – or psychosocial factors - which may have a far greater impact on a student’s math success or failure. Over the last 30
years, researchers, educators, and psychologists have taken a greater interest in studying the psychosocial problems that undermine urban student achievement (Ladson-Billings, 1997; Riconscente, 2014; Zimmerman, Moylan, Hudesman, White, & Flugman, 2011) and their achievement in mathematics in particular (Daresbourg & Blake, 2014; Hampton, 2014; Jeynes, 2014). Many innovative ideas have emerged to help improve urban students’ learning in mathematics. Ladson-Billings (2000) suggested that teachers should incorporate urban student’s cultural and social backgrounds into their instructions. Other researchers have asserted the need for teachers to change their pedagogical methods in order to accommodate urban students and achieve a preset goal while keeping the intended outcomes intact (Gilbert & Gay, 1985). Callahan (1994) added that urban educators should apply a variety of methods, such as cooperative learning groups, integration of technology, supervised practice, and good questioning techniques in order to help improve urban students math performance. Other researchers suggested that a student’s attitude toward mathematics (Hong, 1999; House, 1995) and lack of motivation (Ares, 2008; Balfanz & Byrnes, 2006; Radziwon, 2003) might play a key role in poor college math performance. Overall, what is becoming apparent is that a student’s performance is no longer a matter of what external “tools” they are given, such as books, technology, or better prepared math teachers, but also with what internal emotions and self-perceptions a student has learned to associate with a particular subject.

**Self-Efficacy.** One promising way to analyze students’ internal emotions and self-perceptions about a subject is to look at their self-efficacy relative to that subject (Hackett & Betz, 1989; Hannula, 2006; Pape & Smith 2003; Zimmerman & Cleary, 2006). Bandura (1997) defined self-efficacy as "the belief in one’s capabilities to organize and execute the courses of action required to manage prospective situations" (p. 3). Simply, self-efficacy is one’s
confidence in his or her ability to successfully complete a task or reach a goal. According to Bandura (1997), self-efficacy can be used to determine how individuals gain and retain certain behavioral patterns.

Bandura outlined four sources of information that individuals employ to judge their efficacy (see Figure 1): performance experiences, vicarious experiences, verbal persuasion, and physiological and emotional reactions. These sources can be defined through mathematics-based examples as: (1) performance experiences which are created when students have experienced success in their mathematics courses and as a result will most likely believe that they have the ability to achieve better performances in future mathematics courses; (2) vicarious experiences which are created when students have observed their peers doing well in certain tasks and as a result feel confident that they too can do well on those tasks; (3) verbal persuasion which occurs when students have been verbally encouraged by parents, teachers, and peers - either positively or negatively - to feel confident or unconfident in performing certain math tasks and as a result feel confident or unconfident performing those tasks; and lastly, (4) physiological and emotional reactions which occur when students have associated negative experiences with upsetting psychosomatic symptoms such as anxiety, pain or fatigue when attempting to complete certain mathematics tasks.
Purpose Statement

The purpose of this quantitative study is to examine whether there is a correlation between the four sources of self-efficacy in mathematics with recent urban high school graduates and their performances on community college mathematics placement tests.

Significance of the Research Problem

Practical significance. Examining the potential impact of the four sources of self-efficacy in mathematics on urban high school graduates’ mathematics performance has practical significance for mathematics teachers, parents or guardians, and school administrators. If the four sources are found to be significant factors affecting high school students’ mathematics performance in this study, such results would be useful to the whole education community and could be used to promote and reinforce the important role that self-efficacy is playing in the mathematics achievement of urban high school students. It is hoped that mathematics teacher education programs would consider and incorporate the training of teachers in promoting and enhancing their students’ self-efficacy in the mathematics subject.
Research and theoretical significance. Since its development, self-efficacy theory has been researched, developed, and expanded in many domains, including education. However, much research has focused on the elementary school and middle school levels in examining the issue of self-efficacy in mathematics education (Urdan, Pajares, & Lapin, 1997; Usher & Pajares, 2008; Schunk, 1981, 1995, 1996). While many studies of self-efficacy and mathematic achievement have suggested a positive correlation between the two (Hackett & Betz, 1989; Liu, Hsieh, Cho, & Schallert, 2006; Pajares, 1996), few studies have looked deeper to examine how each of the four sources of self-efficacy might impact students’ mathematics performances. Further, even fewer studies have focused on how students’ self-efficacy in mathematics affects their long-term math capabilities as they reach the collegiate level. This study will attempt to fill this gap in the literature by examining whether there is a correlation between the four sources of self-efficacy and how urban high school graduates entering community college perform on community college mathematics placement tests. In addition, the results of this study may allow researchers to spend more time focusing on improving research about the most effective source of self-efficacy.

Research Question

The research question for this study was framed around the intellectual goal of understanding if a student’s confidence, or self-efficacy, in their ability to do math problems affects their mathematical performance at successive stages in their academic careers, specifically on college placement exams. In turn, it is the hope of the researcher to explore how this confidence, based on students’ self-reported self-efficacy in mathematics, impacts their ability to perform at the college level.

To this end, the purpose of this study will examine: To what extent do the four sources of
self-efficacy (i.e., performance experiences, vicarious experiences, verbal persuasion, and physiological and emotional reactions), in the subject of mathematics, correlate with student performance on the mathematics portion of community college placement tests, as taken by urban high school graduates’ entering community college?

The independent variables in this study refer to students’ four sources of self-efficacy in mathematics, specifically, performance experiences, vicarious experiences, verbal persuasion, and physiological and emotional reactions. The dependent variable is the result of students’ college math placement test performances. In addition, since the study is focused on urban students, the demographic characteristics of the participants will be examined in relation to the above independent variables and dependent variable. Specifically, three demographic variables are included in this study: gender, ethnicity, and parent’s or guardian’s level of education.

**Hypothesis**

It was hypothesized that all of the four sources of self-efficacy (i.e., performance experiences, vicarious experiences, verbal persuasion, and physiological and emotional reactions) correlate significantly with student performance on the mathematics portion of community college placement tests, as taken by urban high school graduates’ entering community college.

The hypothesis will investigate a student’s ability and confidence to accomplish certain tasks. These tasks include good performance in mathematics courses, the ability to understand difficult concepts, the ability to complete challenging assignments with classmates, mastery of the skills being taught, and teachers’ and parents’ persuasion. The response variable will determine whether students are placed in a remedial course in mathematics or a college level course.
Theoretical Framework

To frame the investigation of the research question, this study employed Bandura’s four sources of self-efficacy (performance experiences, vicarious experiences, verbal persuasion, and physiological and emotional reactions) to provide the framework and the basis for detecting whether there is a correlation between urban high school graduates’ self-efficacy in mathematics and their performance in mathematics on placement tests at the community college level. Although numerous studies have examined the relationship between self-efficacy and mathematics achievement in general, few studies have looked deeper into self-efficacy and examined to what extent each of the four sources directly correlates to student performance on placement tests.

Self-efficacy constitutes a valid predictor of individuals’ behavior and was the focus of several major theoretical and empirical studies. For example, computer self-efficacy studies showed that self-efficacy was a significant predictor of an individual’s behavior (Looney, Valacich, & Akbulut, 2004). In other domains, such as child development, researchers included constructs from self-efficacy theory to investigate children’s physical, social, and academic development and found a degree of positive progress (Chattaraman & Lennon, 2010).

From a theoretical perspective, research shows learning mathematics requires a community that embraces collaboration, discussion, and tools for solving complex problems (Goos, Galbraith, Renshaw, & Geiger, 2003). In this learning environment, self-efficacy and all or some of its components (performance experiences, vicarious experiences, verbal persuasion, and physiological and emotional reactions) may facilitate the attainment, retention, and desire for knowledge among students (Schunk & Pajares, 2009).
According to Bandura (1986), performance experience is considered the most influential source of general self-efficacy. The research shows that this is especially true in such areas as mathematics, since learning mathematics relies heavily on tapping into prior knowledge. Students with positive experiences in mathematics tend to have better performance in math courses (Pajares, 1996). Vicarious experience is thought to be the second most influential source of general self-efficacy (Wise & Trunnell, 2001) since students use their prior knowledge to judge their capabilities in relation to others (Bandura, 1986, 1997). Verbal persuasion is assumed to be the third most influential source of general self-efficacy (Wise & Trunnell, 2001). Finally, physiological and emotional reaction is considered the least influential source of general self-efficacy (Chowdhury, Endres, & Lanis, 2002).

Researchers, including Bandura, have suggested that self-efficacy affects human motivation, persistence, efforts, action, behavior, and achievement (Bandura, 1977, 2000; Zimmerman, Bandura, & Martinez-Pons, 1992). In addition, scholars also have suggested that higher levels of self-efficacy are predictive of higher academic performance (Bong & Skaalvik, 2003). Likewise, students with high self-efficacy academically demonstrate greater success in mathematics (Pajares & Schunk, 2009). Very simply, this study attempts to determine whether there is a correlation between how urban students perceive their math capabilities and their resultant math performance on community college placement exams.

**Positionality Statement**

This statement will provide a short personal biography and an overview of my cultural background in order to inform the reader of the importance that urban education has for me. I will then explain my motivation to make a commitment to urban education. I will also touch
upon the issues surrounding this topic and what I believe to be my role as an educator and researcher in this challenging field.

Author background. As a child in the late 1970s in Morocco, I was fortunate enough to receive an education that included three different languages and several cultural settings. My family enjoyed close relations with many Arab, French, and Jewish neighbors. On any given day, I practiced French and Hebrew with neighborhood children, learned Arabic in school, and spoke Tamazight (a native dialect in North Africa) at home. I lived in a poor neighborhood that lacked positive role models. Drugs, prostitution, and violence were constants throughout my daily childhood experience. I had to ignore these negative realities and look to education as the surest way to better my future. Education became my focus at an early age and I was determined to succeed at every level. As a result of my early appreciation for education, I chose to become a math teacher.

I had been teaching mathematics to urban students in Boston for nearly a decade when I decided to focus on urban high school students and began to teach Sheltered English Immersion (SEI) students in Boston Public Schools at The English High School. There were times when I had to use my linguistic skills in my classroom in order to clarify and explain mathematical concepts. Throughout my practical experience in these multicultural classrooms, I believe my own background and physical appearance (male and brown) helped in my understanding of social justice and the importance of educational equality for poor urban students coming of age. Overall, I was well received by local students as well as by those from all over the world because I built personal bonds and connections with them. I never shied away from sharing my experiences with high school students in appropriate situations. I was able to overcome their perceptions of me as only an immigrant or a member of the middle class.
Although I was not aware of the four sources of self-efficacy in mathematics, I recall incorporating these sources often when I integrated various pedagogical methods to reach everyone in my classroom and often stayed after school (mastery experiences) to give students extra help. I encouraged students to work in groups (vicarious experiences). I persuaded and convinced students that they can excel in math and I also reassured students prior to their exams and allowed them more time to complete their assignments (physiological and emotional experiences).

As a mathematics teacher and adjunct instructor from a similar background as my students, I often felt I had an advantage over my White middle-class colleagues in understanding the dynamics and subsequent actions and reactions of impoverished students and their families. I speak five languages and, more importantly, I have lived through poverty. Because of this my colleagues considered me an asset and elected me to facilitate a mini-course for our school’s professional development. I created mini lectures and workshops entitled, “How to Enhance SEI (Sheltered English Immersion) Students Learning Mathematics in an Urban School.” This topic is connected to my current research and has allowed me to clarify many misconceptions, including the knowledge urban students bring into the classroom (mastery experiences), learning in groups in the classroom (vicarious experiences), the need to persuade and encourage students to complete classroom work and homework (verbal persuasion), and changing students’ perceptions and negative attitudes towards the subject of mathematics (physiological and emotional experiences).

**Biases.** It is clear from my mathematical background and interest in this research topic that I have a passion for teaching mathematics and therefore a bias concerning the teaching of mathematics and helping students to excel in math. I am convinced that students are not to blame
for their poor performance and that it is, in part, a lack of teachers properly trained in encouraging student self-efficacy that leads to the failure of urban students. My practical experience in urban settings has had a deep impact on these beliefs, but it has also helped me to understand that when a government builds schools, installs new computers, and hires a handful of novice teachers and administrators, these actions are not sufficient to solve the problems of inner city school students. Often the source of the problem may lie in how teachers are taught – or rather not taught - to emotionally reinforce their students.

The author as a researcher. It is critical to consider my biases when considering my objectivity as a researcher. My research interest stems from my everyday experience, which presents both opportunities and challenges (Machi & McEvoy, 2009). However, recognizing my biases allows me greater control of my research. Hence, I plan to maintain objectivity by balancing my preconceived notions with the literature review and research findings. In cases where my preconceptions are not supported by scholarly work, I will avoid including them in this research. Furthermore, when researching the impact of the four sources of self-efficacy on students’ performances on community college placement tests, I will examine the work and perceptions of other researchers on this topic and weigh their findings along with mine to keep me from presenting biased results. Finally, I will also seek advice from colleagues and advisors, who can provide both guidance and critical feedback regarding my research methods and designs. These steps will help to mitigate my biases and not obstruct my research.

In the event that my research finds no correlation between the four sources of self-efficacy and community college students’ performance on mathematics placement tests, I will thoroughly examine my study for any weaknesses in design. A rejected hypothesis will
encourage me to pursue other avenues to determine the effects of the four sources of self-efficacy on students learning mathematics at the high school and college levels.

**Summary**

Building upon the success of Bandura’s theory of self-efficacy, scholars in the field of psychology, education, science and other related fields, have begun to use Bandura’s social-efficacy theory to better understand mathematics thinking, teaching, and learning (Hannula, 2006; Higbee & Thomas, 1999; Silver, 1985). While a current and typical mathematics curriculum shows an increased emphasis on students solving problems, reasoning, collaborating, and using tools as a medium to develop and reflect their mathematics concepts (National Council of Teachers of Mathematics, 2000), college bound students are not achieving successful results on college placement exams. It is therefore important that the relationship between a student’s perceived ability to succeed in mathematics be examined to determine a possible correlation between how high school graduates perceive their ability with mathematical skills and their actual math performance on community college math entrance exams. The research findings could help educators find ways to better prepare students to perform and as a result, decrease the achievement gap and the college dropout rate among urban minority students.

**Definitions of Key Terms**

1. Urban education refers to schools in metropolitan communities that typically are characterized by higher concentrations of poverty, greater racial and ethnic diversity, larger concentrations of immigrant populations and linguistic diversity, and high rates of student mobility (Kincheloe, 2010).

2. Self-efficacy is defined as the belief “in one’s capabilities to organize and execute a course of action required to produce a given attainment” (Bandura, 1997, p. 3). In this
study, participants’ levels of self-efficacy in mathematics were measured by their responses to the Self-Efficacy in Mathematics Survey, which was modeled after the survey instrument, Sources of Middle School Mathematics Self-Efficacy, developed by Usher and Pajares (2009).

3. Community college placement tests are tools that measure and assess skills in mathematics, writing, and reading to candidates entering community colleges.

4. Remedial courses are courses that assist and prepare college candidates to be better prepared for more rigorous college level courses in mathematics, writing, and reading.

5. Bandura (1977) has defined the four sources of efficacy as: (a) performance experiences, (b) vicarious experiences, (c) verbal persuasion, and (d) physiological and emotional reactions.
   a. Performance experiences, the most important source of self-efficacy, are the experiences that influence a student’s ability to perform well in mathematics courses.
   b. Vicarious experiences are formed when students see other students succeed or fail and as a result their own self-efficacy is either increased or decreased thus affecting their mathematical performance.
   c. Verbal persuasion is the source of self-efficacy affected by positive or negative communication that ultimately results in students’ success or lack of success.
   d. Physiological and emotional reactions, the least influential of the sources of self-efficacy, are the body responses and associations that affect students’ performances.
Chapter 2: Review of the Literature

Over the past several decades, the federal government has increased financial assistance to low-income students who are accepted to college. Due to financial concerns, many of these students, often, urban high school graduates, opt to attend nearby community colleges. Sadly, larger and larger numbers of these recent urban graduates are forced to take remedial mathematics courses as a result of their low college placement scores. Given the option to take numerous remedial classes or simply give up, most students opt to drop out, even with the federal government footing much of the bill. This alarming dropout rate among community college students has initiated the need for a clear diagnosis as to why urban high school students begin to fall behind in mathematics, despite money being spent to increase their mathematics aptitude in Massachusetts as well as in every other state in the nation (U.S. Department of Education, 2008).

The purpose of this chapter is to review the literature regarding how the four sources of self-efficacy in the subject of mathematics affect student performance on the mathematics portion of college placement tests. First, the chapter will examine the current literature on the correlation between self-efficacy theory and student performance in mathematics. Second, this chapter will individually review each construct of self-efficacy. The chapter will next discuss an overview of how demographics impact student performance. Finally, this chapter will conclude by summarizing the findings in the review and pointing out important gaps in the literature.

Self-Efficacy Theory and Student Math Performance

While there are many issues that impact the success of urban minority students, self-efficacy is one factor that many modern education researchers most often link to poor academic performance (Gushue, Clarke, Pantzer, & Scanlan, 2006; Witherspoon, Speight, & Thomas,
The four constructs of self-efficacy have indicated to researchers that self-efficacy is a strong predictor of students’ academic success, specifically in mathematics (Luzzo, Hasper, Albert, Bibby, & Martinelli, 1999). Self-efficacy and the associated outcome expectancies impact motivation and persistence in the face of challenge and hardship (Pajares, 1997). These beliefs determine how people feel, think, and motivate themselves, as well as behave (Pajares, 1997). People with low self-efficacy are inclined to shy away from challenging situations beyond their capabilities (Bandura, 1986). Equally, people with high self-efficacy readily engage in these challenges because they believe they can master them (Bandura, 1986). The self-efficacy of urban high school students plays a critical role in their choices (Chen & Zimmerman, 2007; Hackett, 1985; Pajares & Miller, 1997) in that students will gravitate toward and have a positive attitude toward activities and subjects in which they have the confidence to succeed.

**Performance experiences.** The first construct of self-efficacy, performance experiences, is the most influential source of self-efficacy (Bandura, 1986). Performance experiences are created when students have experienced success and as a result will most likely believe that they have the ability to achieve better performances in their courses (Bandura, 1977). In addition, the extent to which individuals change their self-efficacy through performance experience depends upon an array of factors: the difficulty of the task, the amount of effort expended, external help obtained, the conditions, and the progressive pattern of success and failure (Bandura, 1986). Strauser (1995) also asserted the importance of mastery experiences on performance by adding that when a person succeeds in certain tasks, efficacy expectations increase and when an individual fails to accomplish certain tasks, their efficacy expectations are lowered. Similarly, Smith (2002) stated that performance experiences are founded on direct and personal experiences and are accredited to one’s effort and skills. When students have an extensive repertoire of
experiences, they are able to effectively analyze and tackle tasks because learning math often depends on a student’s prior experiences. The building of relevant mastery experiences is a complex process, often involving the use of a variety of techniques and instructional approaches.

In addition, by employing Bandura’s Social Cognitive Theory as theoretical framework, Emmett, Hall, and McKenna (2014) conducted a multi-case study with four 7th grade math students at a low-performing urban middle school who demonstrated varying degrees of self-efficacy. Their purpose was to help students effectively improve their performances in math and English by discovering what attributed to their self-efficacy. Emmett et al. spent a year collecting data, which included one-on-one interviews and in-class observations, as well as information obtained from parent meetings. Through a cross-case analysis using a qualitative approach, the researchers investigated the cause of low self-efficacy. The researchers found that the absence of positive performance experiences impacted students’ performances in math since their learning of math relied mainly on foundations and skills acquired from previous courses. However, this study’s generalizability is limited and the study could be beneficial only to the group in a similar situation.

Further, a study by Andrade, Wang, Du, and Akawi (2009) found that performance experience had a significant impact on students’ achievement. In their study of a convenience sample of 268 students from 18 schools, the researchers divided students into two groups, a control group and a group that received training in the use of rubrics to self-assess. Although the results did not demonstrate an increase in self-efficacy with any significant statistical difference between the groups, the results did show the two groups improved their self-efficacy. Andrade et al. noted that when students wrote extensively, their self-efficacy for writing increased. Hence, performance experience improved their self-efficacy.
Likewise, a quantitative research study by Hailikari, Nevgi, and Komulainen (2008) used structural equation modeling to examine the relationship between previous knowledge, academic beliefs, and prior study success in predicting the achievement of 139 students in a university mathematics course. The research findings revealed that prior knowledge was the strongest predictor of student achievement over and above other variables included in the model. Moreover, academic self-beliefs strongly correlated with previous study success and had a strong direct influence on prior knowledge test performance. According to this research, performance experience is enhanced through prior knowledge and self-beliefs. The results suggested that both prior knowledge and self-beliefs were essential and had to be taken into consideration to support educators in teaching mathematics. However, the credibility of this study could be challenged because the self-belief assessment was determined using a pre-/post-test approach with students’ final grades as the achievement measure whereas this study used a survey measuring students’ perceptions of self-efficacy.

Notwithstanding, homework, which is defined as teacher assigned tasks that are done by students during non-instructional time (Bembenutty, 2011), has been used as a tool to supplement learning, practice concepts, and enhance the performance experiences of learners (Cooper, Robinson, & Patall, 2006). Homework is usually done with minimal direction from instructors and hence it is considered as an effective way of helping learners to develop performance experiences and self-efficacy beliefs (Kitsantas & Zimmerman, 2009), especially in high school populations (Cooper, 2009). Kitsantas, Cheema and Ware (2011) examined the correlation between self-efficacy beliefs, time spent on homework, homework resources, and mathematics achievement. They also explored how gender and race impacted the correlation between mathematics achievement and self-efficacy. Using data obtained from the 2003 Program
for International Student Assessment (PISA) as well as school and student questionnaires from the 2003 National Center for Educational Statistics (NCES), they randomly selected a sample of 5,200 students consisting of 2,603 boys and 2,597 girls with an ethnic composition of 59.56% Caucasian, 15.36% African American, 16.98% Latino, 3.25% Asian, and the rest of mixed or other ethnicity. The researchers’ analysis of the data showed that introduction of homework support materials significantly increased mathematics achievement while reducing the achievement gap between minority students and their White counterparts. Interestingly, the research indicated that increasing the amount of time spent in mathematics actually reduced math achievement, a probable consequence of inefficient and disproportionate effort. Similarly, Trautwein, Köller, Schmitz, and Baumert (2002) argued that although the frequency of mathematics homework improved achievement, the amount of homework and time taken to complete it had no discernible effect on achievement.

Although homework is generally beneficial to achievement, Keith, Diamond-Hallam, and Fine (2004) showed that work completed at school had a more significant impact on achievement compared to homework completed out of school. To examine the correlation between school location, student achievement, and homework management, Xu (2009) conducted a study to determine whether homework management strategies had any effect on student achievement and whether there was a difference in homework management strategies between urban and rural settings. He sampled 377 rural students who were 68.7% Caucasian, 23.9% African American, and the rest of different ethnicities, and 182 urban students who were 51.9% African American, 37.4% Caucasian, and the rest a mix of different ethnicities. The students were asked to report on their homework management strategies using a Homework Management Scale (HMS) after having indicated their level of academic achievement over a period of two years. The study
found that urban students were more self-motivated and took more initiative with their work compared to rural students. In addition, students who managed their homework well attained higher achievement than those who did not employ homework management strategies. This research showed that homework management indeed contributed to better achievement and enrichment in mathematics knowledge, and hence increased performance experiences.

In summary, studies have shown that performance experience positively correlates with math achievement. When students, through their efforts, skill, and homework in mathematics, attain success, they develop positive performance experiences that in turn lead to future success in mathematics. Therefore, it is important for educators to employ varied teaching styles and instructional approaches so that students have the opportunity to build performance experiences in the classroom leading to their success.

**Vicarious experiences.** The second way of creating and strengthening self-efficacy is through vicarious experiences. Vicarious experiences are created when students have observed their peers doing well in certain tasks and as a result feel confident that they, too, can do well on those tasks (Bandura, 1997). When observers (students) are weak in self-efficacy, observing others with similar capabilities can enhance their self-efficacy. Vicarious experiences can be an effective method to model when novice observers have less experience and are uncertain with accomplishing certain tasks, or have experienced several past failures (Bandura, 1986). In this context, during challenging activities, individuals compare their efforts to the success of others, which may strengthen their beliefs in their own abilities (Bandura, 1997; Schunk, 2000).

In conjunction, Schunk (1987) stated students are most likely to modify their beliefs following a model’s success or failure to the degree that what they sense is similar to the model in the area of question, particularly in mathematics. Wahl (1999) suggested that cooperative
learning is an efficient pedagogy because when small groups of students work together, they gain new knowledge and maximize learning. He also added that through cooperative learning, students showed higher achievement and greater productivity; form more caring, supportive, and committed relationships; and have greater psychological health, social competence, and self-esteem. These findings were consistent with Bandura’s (1977, 1986, 1997) results in relation to vicarious experiences or modeling effects of self-efficacy.

More than two decades ago, education leaders began mainstreaming all students, including minorities and special needs students, into the same classroom (Wahl, 1999) in order to maximize students’ performances and achievements. Researchers suggested that cooperative learning, as part of vicarious experiences where small groups of students are assigned certain tasks (Johnson & Johnson, 1987, 2000; Kagan, 1989) and contribute equally in solving a problem (Leikin & Zaslavsky, 1999), was an efficient pedagogy. Cooperative learning leads to higher achievement and greater productivity because it allows students with different levels of ability to understand complex concepts and to adopt their own way of learning (Leikin & Zaslavsky, 1999). Pajares and Urdan (2006) also underlined the importance of vicarious experiences because peer modeling can influence a student’s self-perception and competency. However, Johnson and Johnson (2009) cautioned against grouping students for the sole purpose of positive impact because when members of a group lack accountability, the practice becomes inefficient and the group does not reach its goals. Finlay and Faulkner (2005) stated that educators needed to ensure a balance during group task performance so that students with low self-efficacy are able to build their own positive internal expectations, too.

Furthermore, vicarious experiences can also be student-initiated where students observe peers who are achieving and therefore develop the confidence to attempt similar tasks. In a
biographical study, Noble (2011) sampled six African American males, aged between 18 and 23 majoring and excelling in math at two different colleges, to determine the impact of self-efficacy beliefs on their mathematics achievement at the post-secondary level. After collecting and analyzing data thematically, Noble found that vicarious experiences were one of the primary reasons why the subjects excelled in math.

As well, vicarious experiences can also be teacher-initiated where teachers modify their instructional approaches to provide more varied experiences to the learners. Siegle and McCoach (2007) conducted a study to determine whether students’ self-efficacy in mathematics could be increased through specific teacher training. Teachers were required to provide positive feedback to the students, help them in setting goals, and encourage modeling in class. The study used a cluster-randomized pre-test/post-test design where schools volunteering for the study were randomly assigned a treatment or a control condition. The study was divided into two phases. In the first phase, teachers were given approximately 2 hours of training on how to apply strategies that increased self-efficacy in the classroom. The second phase involved the delivering of mathematical lessons that were specially prepared for the study by the teachers. The researchers then used two instruments to measure the impact of the teacher training on student achievement. An analysis of the teacher training found that teachers who had been trained had a clear understanding of the self-efficacy strategies and expressed confidence in their ability to implement the strategies. After analyzing the data, Siegle and McCoach found that there was a significant statistical difference between the self-efficacy of the control and treatment groups, with the treatment group showing higher levels of improved performance. Ernest (2006) stated that teacher training is important in equipping teachers with the knowledge, beliefs, and attitudes necessary for developing a pedagogical approach that enhances vicarious experiences in the
learning environment. The integration of technology into the learning environment provides a powerful tool for delivering vicarious experiences to learners (Ertmer, Conklin, Lewandowski, Osika, Selo, & Wignall, 2003). When students are working in a multimedia environment, they can view successful models helping to increase their self-efficacy.

Although vicarious experiences have a positive impact on the development of self-efficacy, they are weak sources of self-efficacy compared to performance experiences (Britner & Pajares, 2006). Ertmer (2006) asserted that the impacts of vicarious experiences alone are insufficient. The researcher designed a 2 by 2 study, which included independent prompts for questions and group discussion, to determine whether question prompts or group discussion prompts had any effect on pre-service teachers’ judgments of competency as well as their self-efficacy in integrating technology. Using four experimental scenarios, the study investigated participants’ perceptions of their knowledge and skills, pre- and post-study competencies, and self-efficacy in integrating technology. These comprised: 1) the control group with no group discussion and no question prompts; 2) a group with no group discussion, but with question prompts; 3) a group with discussion, but no question prompts; and 4) a group with discussion coupled with prompts for questions. The study found that pairing extra variables (prompts for questions as well as group discussion) with vicarious experiences did not cause any significant differences in pre-service teachers’ perceptions across the groups.

In summary, vicarious experiences appear not to increase self-efficacy when used in isolation; instead, they need to be coupled with other conditions, such as prior knowledge, and peers, adults, and parents’ competencies in the subject matter, if they are to be effective in improving student math performance. Learners can initiate their own vicarious experiences through their own positive observations of their peers within the learning environment. In like
manner, teachers can also encourage the improvement of their students’ vicarious experiences by employing varied pedagogical approaches in the classroom, a distinction that was not apparent in these studies.

**Verbal persuasion.** Verbal persuasion, the third construct of self-efficacy, is widely used to persuade people to believe that they possess capabilities to complete certain tasks. It occurs when students have been verbally encouraged by parents, teachers, and peers, either positively or negatively, to feel confident or unconfident in performing certain math tasks, and as a result feel confident or unconfident performing those tasks (Bandura, 1997). Parents, teachers, peers, and administrators are vital to a student’s beliefs in self-efficacy (Bandura, 1977, 1986, 1997), since “[they] contribute to successful performance if the heightened appraisal is within realistic bounds” (Bandura, 1986, p. 400). Yet, verbal persuasion allows only a partial influence, particularly for individuals that seek feedback from others instead of relying on self-judgment. Verbal persuasion may be limited in creating a long-term increase in self-efficacy, but it could contribute to successful performance if the desired appraisal is within realistic bounds and happens continuously in subjects where constant encouragement is needed as problems get increasingly difficult to master. Additional factors that impact the effectiveness of verbal persuasion in promoting efficacy beliefs include the persuader’s reputation, credibility, and subject matter expertise (Bandura, 1986).

Since parents, teachers, and peers play a vital role in inspiring students to achieve academic success, their encouragements can boost a student’s confidence and interest in their academic capabilities (Walker, 2002). When parents share the notion of high expectations from children, mainly in mathematics, those children thrive in mastery of the subject. Starkey and Klein (2000) demonstrated that effective intervention of urban students’ parents in learning
mathematics has been confirmed to increase and improve their children’s mathematical skills. Mathematics teachers’ encouragement and persuasion have a great influence on their students’ performances, particularly when teachers give specific compliments for specific tasks (Siegle & McCoach, 2007). In fact, Ferguson (2002) found that urban students rely greatly on their teachers’ encouragement. Ferguson also noted that urban students, in particular African-American and Latino students, who share their mathematical ideas and encourage their peers produce higher achievement in mathematics for both the mentors and the mentees. It is apparent that parents, teachers, and peers are integral pillars of verbal persuasion.

Additionally, parents are a primary source of verbal persuasion for learners, since students spend a considerable amount of their time with them. Yet, parents have different educational achievements and they are unlikely to share a similar approach to engagement with their children. In their longitudinal quantitative study, Hill, Castellino, Lansford, Nowlin, Dodge, Bates, and Pettit (2004) followed students from grades 7 to 11. The participants were mostly European Americans (83%) with some African Americans (16%) and others. Through this research, Hill et al. (2004) established that highly educated parents who were academically involved not only increased student aspirations, but also improved behavior and increased achievement in their children. Moreover, they found that academic involvement by African-American parents was likely to increase student academic achievement more than any other ethnic group. Conversely, the researchers noted that academic involvement by less educated parents augmented aspiration, but it did not have an impact on school behavior or achievement.

Other than parents, verbal persuasion can also originate from peers who encourage each other to attempt solving mathematical problems. Verbal persuasion from mathematically successful peers is especially powerful in motivating low-achieving students and enabling them
to build the confidence required to master math (Noble, 2011). Verbal persuasion involves the opening of communication channels and the building of relationships between parties. Walker (2006) conducted a study in 2004 and 2005 at an urban high school in New York City, where minorities form 97% of the predominantly female (60%) student population, to determine the effect of verbal persuasion on students’ academic achievement. The researcher in this qualitative study used a purposeful sample of 21 students from this urban high school. He administered semi-structured interviews conducted by graduate students. The study found that when students collaborated in math outside the classroom without the intervention of adults, there was an increase in student achievement.

Along with parents and peers, teachers are another important source of verbal persuasion through the feedback they give during the learning process. Students spend a substantial amount of time in school and have extensive interaction with teachers. Their views of teacher feedback, teacher encouragement and availability, as well as their perceptions about the roles and purposes of school will influence the effectiveness of teacher persuasion on students (Honora, 2003). Teacher involvement, which is defined as the deliberate attempt by teachers to take an interest in the lives of their students and to engage them verbally and sincerely in all aspects of their lives, can help teachers to structure their feedback for maximum efficacy (Tucker, Zayco, Herman, Reinke, Trujillo, & Carraway, 2002). When a teacher talks to and listens to students about academic and personal issues, he or she makes the student feel that the teacher cares for them as individuals and they can develop a positive relationship, which allows the students to adjust positively in school (Honora, 2003).

Finally, research shows that among African-Americans with low socioeconomic status, academic achievement is strongly related to their perceived teacher feedback (Honora, 2003).
Teacher persuasion is especially efficacious for female African-American students of low socio-economic status, who are more likely to be higher achievers than their male counterparts, and who tend to relate good academic achievement to positive feedback from teachers (Honora, 2003). Conversely, male African American students were more likely to relate feedback from teachers, like “being a good student,” to their behavior rather than to their academic performance. Therefore, there is a need to determine the kind of teacher persuasion that can enhance academic achievement and not merely good behavior in students.

In summary, parental verbal persuasion is important in shaping the aspirations of urban students, although educated parents have a higher impact on achievement and the self-efficacy of their children. Peer persuasion, though effective, depends on the student’s willingness to associate with peers and the effort the student is willing to expend to improve self-efficacy beliefs. Teacher verbal persuasion has a mixed effect on the math achievement of students; therefore, there needs to be more research on the feedback that can foster self-efficacy beliefs in students. Although verbal persuasion plays a role in the development of self-efficacy, its efficacy, especially when used in isolation, is open to debate (Goddard, Hoy, & Hoy, 2000). Resultantly, verbal persuasion is more effective when used with other methods of enhancing self-efficacy since the positive feedback can help student achievement (Goddard et al., 2000; Hoy, Sweetland, & Smith, 2002). Used alone it is not wholly sufficient, though it can significantly contribute to student achievement. However, when students are consistently verbally discouraged and demoralized in their academic work, they will eschew a similar task in the future (Bandura, 1986). The aforementioned studies indicate the importance of verbal persuasion as a positive medium in improving students’ achievement in mathematics and other subjects in general.

**Physiological and emotional reactions.** The final source of self-efficacy, physiological
and emotional reactions, includes both negative and positive reactions. Students often associate negative experiences with upsetting psychosomatic symptoms such as anxiety, pain, or fatigue when attempting to complete certain tasks such as mathematics (Bandura, 1997). The resulting physiological responses can include increased heart rate and blood pressure, as well as sweating which can weaken self-efficacy. Conversely, when individuals physically and emotionally feel comfortable with certain tasks, positive moods and reactions ensue which elicit positive beliefs of self-efficacy (Bandura, 1986, 1997). Still, some research has suggested that physiological and emotional reactions are considered the least influential source of general self-efficacy (Chowdhury et al., 2002).

Researchers have argued that anxiety-based physiological and emotional states, such as increased heart rate, sweating, trembling, and nausea, are a common occurrence in many mathematical courses (Ashcraft & Krause, 2007; Beilock, 2008; Lent, Lopez, & Bieschke, 1991; Lent, Lopez, Brown, & Gore, 1996; Ramirez, Gunderson, Levine, & Beilock, 2013). Usher and Pajares (2009) found that one of the most salient forms of physiological and emotional arousal in mathematics courses is anxiety, which is due to students’ attitudes and past negative experiences toward mathematics (Humbree, 1990; Sousa, 2002). Other researchers have documented that when students feel stress, anxiety, and fatigue, it causes deficits in students’ (urban and non-urban students alike) capabilities for learning or performing mathematical tasks (Ashcraft, Krause, & Hopko, 2007; Humbree, 1990). Math anxiety, a problem that affects a substantial amount of learners in high school (Venkatesh & Karmi, 2010), can develop at any age, making it difficult to determine when intervention measures should be implemented (Geist, 2010). Plaisance (2009) posited that the causes of the negative emotional responses to math that eventually result in math anxiety are complex and may depend on personality and intellectual
and environmental factors. The problem of math anxiety in students is compounded when teachers with math anxiety teach students with math anxiety (Sparks, 2011). Teachers represent, therefore, both solutions and causes of math anxiety, further complicating attempts to find a general solution for math anxiety.

Furthermore, the complex relationship between working memory and long-term memory also affects the emotional and physiological responses that learners exhibit when tackling math problems (Ramirez et al., 2013). Ramirez et al. (2013) conducted a research study with young children to examine the effects of anxiety on students’ mathematical achievement. The study was comprised of 154 children from Grade 1 (88 participants) and Grade 2 (66 participants). There were 69 boys and 85 girls. These children hailed from five public schools in a large urban district. They were given a test of math achievement and working memory. The children’s math anxiety was assessed later using a different test. The purpose of the study was to investigate the affective factors that impact early learning. Ramirez et al. found that children with higher working memories showed a negative correlation between math anxiety and math achievement. The researchers argued that children depend on working memory while completing mathematical tasks. These tasks are likely interrupted by math anxiety for children with a high working memory. However, for children with low working memory, there was no impact on anxiety and math achievement. These findings conform to Beilock’s (2008) conclusions regarding adult anxiety and its impact on mathematics performance. Ramirez et al. established that it is crucial to intervene early through identification and treatment of math anxiety before it worsens.

Close and Solberg (2008) investigated whether social, cognitive, and self-determinism theories (Bandura, 1986) could predict high school students’ distress, motivation, self-efficacy beliefs, and academic achievement using structural equation modeling, a test that allows
researchers to measure these theories. Social cognitive theory is defined by an individual’s confidence in successfully completing or performing specific academic related activities with the subsequent positive academic results related to certain levels of self-efficacy (Bandura, 19986, 1989, 1997; Close & Solberg, 2008). Based on self-determination theory, autonomous motivation is related to self-efficacy when one voluntarily chooses to be involved and engaged in certain behaviors. Further, controlled motivation occurs when an individual is pressured (internally or externally) to act or to behave in certain ways (Close & Solberg, 2008). Close and Solberg chose 427 predominately Latino youths from an inner-city low-income high school as participants. They reported that students, who reported feeling connected to teachers and their school, showed higher levels of autonomous motivation for attending school. The same research also concluded that students with higher levels of autonomous motivation for attending school reported more confidence (i.e., self-efficacy) in their academic ability and therefore performed better academically. At the same time, students who reported higher self-efficacy beliefs described less physical and psychological distress and showed higher levels of academic achievement. They found that the combination of achievement and the absence of physical/psychological distress contributed to greater retention in school (Close & Solberg, 2008).

Mathematical anxiety is an area that has received much attention in recent years as scholars continue to investigate the relationship between math anxiety and math achievement (Beilock, 2008; Close & Solberg, 2008; Ramirez et al., 2013). Research has focused on how math anxiety can be reduced as a means of helping learners improve their self-efficacy beliefs. One of the ways of reducing anxiety is through parental involvement in the student’s academic life. For the purpose of studying children’s mathematics anxiety as it relates to parental
involvement and their children’s achievement in mathematics, Vukovic, Roberts, and Wright (2013) surveyed 78 second grade participants from low income, African American and Latino homes and assessed their mathematics anxiety as it related to whole number arithmetic, word problems, and algebraic reasoning. The authors found that parental home support and expectations are instrumental in reducing mathematics anxiety in children when dealing with higher levels of word problems and algebraic reasoning. Parental involvement for urban minorities is mainly limited to expectations and home support (Vukovic et al., 2013). However, the authors added that parental support does not reduce anxiety for all types of mathematical problems, as anxiety on whole number arithmetic for students receiving parental support remained unchanged (Vukovic et al., 2013). Managing math anxiety is instrumental in increasing math achievement in school, although there is no universally efficacious way of reducing math anxiety for urban high school students. These findings also echoed another study with young children. In that study, Ashcraft and Krause (2007) established a connection between math anxiety and math achievement. They found that poor mathematical knowledge and low course grades correlated directly with students’ anxiety levels.

In summary, physiological and emotional reactions, though deemed the least influential of the sources of self-efficacy, are yet real and viable to students who experience anxiety, fear and even pain in association with academics, specifically math. While lack of knowledge and poor performance can lead to anxiety, through the involvement of both parents and teachers who demonstrate interest in students’ success, those students can move past the negative associations that can then pave the way to successful math performance outcomes. In addition, scholars have found that positive physiological and emotional reactions may have a positive impact on students’ performance. Teachers and parents could play an important role in reducing anxiety
towards the mathematics by encouraging and pursuing students. Parents and teachers could also mention the usefulness of the subject matter in real life and its importance in their future academic endeavors.

**Demographic Factors**

As previously mentioned self-efficacy is not the only factor impacting student performance. Gender, socioeconomic status, and parents’ educational levels are a few of those factors that have been analyzed and studied extensively for the past several decades.

**Gender.** Historically, gender has been determined to be one of the predictors of student academic performance, particularly in science and mathematics. Males have been reported to outperform females in mathematics (NSF, 2009). However, researchers have shown both girls and boys have the same innate ability to learn mathematics and are born interested in a variety of objects and ideas (Spelke & Grace, 2007). Researchers have posited a number of potential explanations for gender differences in math performance such as intrinsic (biological) and extrinsic (social factors) factors (Ceci, Williams, & Barnett, 2009; Fennema & Peterson, 1985).

Intrinsic factors such as the developmental patterns of self-esteem, body image, and academic interests do not diminish as males and females grow older and mature. A nation-wide survey conducted in 1990 by the American Association of University Women (AAUW) revealed that 69% of boys in early education and 60% of girls in early education reported that they were “happy the way I am.” However, for high school students, the percentages changed to 46% for boys and only 29% for girls who reported that they were “happy the way I am.” Other studies also showed an obvious gender gap in the math scores where males scored higher than females (Campbell & Beaudry, 1998). This data shows that gender has an influence on students’ performance in mathematics and science depending on the stages of their schooling. Researchers
also found that gender differences existed for only some mathematics content areas and types of problems. Females were shown to outperform males in number and computation skills relying heavily on the recall of procedures and information (Gibbs, 2010; Hyde, Fennema, & Lamon, 1990). On the other hand, males perform better than females in problem solving, geometry, and measurement (Gibbs, 2010; Hyde et al., 1990).

Extrinsic factors include social factors such as gender-based stereotypes and family influence (Eccles, 1987; Eccles & Jacobs, 1986). Despite the conclusions drawn from ample literature, social factors, like gender socialization, may impact math performance due to girls’ increased anxiety about mathematics as well as the social phenomenon of stereotype threat (Steele, 1997). Eccles and Jacobs (1986) found that gender-based stereotypes might prompt females to have higher anxiety about mathematics. As they get older females become familiar with the stereotype that math is a male dominated field. This social phenomenon may affect girls during assessment in the subject of mathematics, consequently leading them to underperform (Steele, 1997). Other factors such as teachers and family members who are influenced by gender stereotype heavily influence a female’s ability and related performance in mathematics (Dweck, 2007). In addition, Usher (2009) conducted a study among 8th graders and found that teachers’ and parents’ attitudes and beliefs towards mathematics are factors that may contribute to the differences identified between boys and girls in their attitudes towards mathematics. However, other results from achievement tests given to elementary and high school students concluded that the gender gap is closing (Hyde et al., 2008) and researchers found strong evidence of gender similarities in mathematics performance (Lindberg et al., 2010).

**Parent or guardian educational level.** Notwithstanding, a large body of evidence suggests that a parent’s or a guardian’s educational level is a factor in their child’s academic
achievement (Campbell et al., 2000; Coleman, 1966; Pollard, 1989; Schwartz, 1999). Schwartz (1999) suggested that parents or guardians with little education may not be aware of the significance in excelling in school, pursuing higher education, or taking Advanced Placement courses. These parents may not even be familiar with whether their children’s public schools offer such support during and after school. Additional studies confirm that students who are successful in mathematics were more likely than students unsuccessful in mathematics to have hailed from educated parents who value and perceive education as a means to be successful in society (Pollard, 1989).

Colman (1966) found that a parent’s or a guardian’s educational level and student’s academic performance are highly correlated. In their research, Campbell et al. (2000) confirmed this as well. In another study with 182 sixth-graders, Perry et al. (2012) found that parents and guardians should serve as important role models and guides in encouraging their children to pursue higher educational goals by making educational resources available at home and also by establishing and modeling positive attitudes and values about educational achievement for their children.

**Socioeconomics factors.** A number of studies show socioeconomic status to be a factor influencing students’ academic performance, particularly in the field of mathematics. In a research study using the 1988-1992 National Educational Longitudinal Study data set, Jeynes (2002) found mathematics achievement to be directly proportionate with the annual income of parents and guardians. Research suggests that this direct correlation is because parents with higher socioeconomic status are more likely to be involved in their children’s daily activities, to foster the value of education, to instill a positive attitude towards learning, to help their children with homework, and to enhance school attendance (Stevenson & Baker, 1987). In contrast, low
socioeconomic status has been shown to have an adverse effect on student academic performance, in part because children from low SES homes lack access to educational materials and resources in the home. This lack of resources, in addition to other family problems including mobility, has been shown to disrupt students’ learning (Jeynes, 2002). Consequently these elements have an impact on students in mathematics performance.

Summary

Literature demonstrates that multiple factors affect students’ academic success, specifically in regard to mathematics performance, and have a significant impact on how well students do (or do not) perform. A student’s self-efficacy beliefs (i.e., performance experiences, vicarious experiences, verbal persuasion, physiological and emotion reactions) constitute the strongest factor in determining their achievement (Bandura (1997). Educators, parents, and peers are key players that impact these beliefs and shape students’ self-efficacy. Research reveals that when parents and educators are made aware of the impact of self-efficacy, the possibility of students achieving higher academic scores, especially in mathematics, improves. Effective pedagogy, verbal encouragement, and parent and peer care all contribute to students’ higher levels of self-efficacy leading to completed work, positive attitudes, and significant improvement in mathematics (Balfanz & Byrnes, 2006).

Furthermore, society is witnessing a demographic explosion particularly in urban cities. It is predicted that in two decades minority students will become the majority in this country (Villegas & Lucas, 2004). Data concerning urban high school students shows mediocre academic performance, particularly in the subject of mathematics. This vulnerable population is in desperate need to escape the cycle of poverty that plagues their communities and to improve their lives. There are abundant resources available to help this underserved population. Along
with resources, effective education is one way to accomplish the so-called “American Dream.” Using the right pedagogical methods and understanding urban students’ mathematical performance might be one way to improve the experiences of urban students and help them to succeed in higher education.

The literature review presented here demonstrates the need to support students through the understanding of the four sources of self-efficacy as tools for equity, equality, and success for all students, particularly urban students. Yet, the gap in empirical research still remains. This study aims to fill this gap while looking at the correlation between the four sources of self-efficacy individually and urban students’ performance in mathematics on community college placement tests.
Chapter 3: Research Design

The purpose of this quantitative study was to determine the relationship between each of the four sources of self-efficacy and performance on community college placement tests in mathematics. This chapter will present and discuss the research question, research design, data collection, and analysis that were used to carry out this study, as well as the validity, reliability, and generalizability of the study. In addition, this chapter will present the measures that were taken in order to protect human subjects, in accordance with the Northeastern University Institutional Review Board (IRB) requirements.

Research Question

The purpose of this quantitative study was to examine to what extent the four sources of self-efficacy (i.e., performance experiences, vicarious experiences, verbal persuasion, and physiological and emotional reactions), in the subject of mathematics, correlate with performance on the mathematics portion of community college placement tests taken by recent urban high school graduates entering community college.

Defining independent and dependent variables. This study utilized participants’ responses to survey statements regarding their self-efficacy in mathematics, along with their course placement results to assess the extent of the correlation between participants’ self-efficacy and their performance on community college placement tests in mathematics. The independent variables, also known as explanatory variables, were the participants’ four sources of self-efficacy in mathematics, specifically including: (a) mastery experiences, (b) vicarious experiences, (c) verbal persuasion, and (d) physiological and emotional reactions. These explanatory variables were chosen because self-efficacy is a major component of social cognitive theory (Pajares & Kranzler, 1995; Usher, 2009) and the four constructs of self-efficacy constitute
the main sources of influence by which a person’s self-efficacy is developed and maintained (Bandura, 1977). This theory has also been widely used and accepted in the literature (Hackett & Betz, 1992; Lent, Lopez, Brown, & Gore, 1997; Usher, 2009). In addition to these explanatory variables, participants’ demographic variables (i.e., gender, ethnicity, and their parent’s or guardian’s level of education) were considered as additional explanatory variables that were used primarily as control variables because participants’ demographic factors could have had an impact on the way participants responded to the survey statements or how participants performed on their placement tests in mathematics (Creswell, 2012).

The dependent variable, also known as the response variable, was participants’ community college placement test scores in mathematics, indicated by whether the participants were: (a) placed in a remedial course in mathematics or (b) placed in a college-level course in mathematics. These two options were chosen for the response variable because being placed in remedial mathematics courses generally indicates unsatisfactory performance in high school (Adelman, 1999; Kowski, 2013; Medhanie, Dupuis, LeBeau, Harwell, & Post, 2012).

**Research Hypothesis**

This study intended to resolve confusion in the literature about whether each of the four sources of self-efficacy, individually rather than aggregately, significantly correlates with urban high school graduates’ performance on community college mathematics placement tests. To resolve this discrepancy, this study’s hypothesis was based on the findings of several studies that demonstrated a strong correlation between self-efficacy and students’ performance in mathematics courses (Betz & Hackett, 1989; Pajares & Miller, 1994). As such, the articulated hypothesis for this study was as follows:
Hypothesis: Each of the four sources of self-efficacy correlates significantly with recent urban high school graduates’ performance on community college placement tests in mathematics.

Research Design

To test this hypothesis, this study utilized a correlational design. In general, a correlational design is appropriate for studies seeking to determine the significance of the relationship between explanatory and response variables (Creswell, 2012). Additionally, Fraenkel, Wallen, and Hyun (2009) noted that correlational research is appropriate for studies seeking to determine the relationships among variables. Since this study aimed to find the relationship between the four sources of self-efficacy (i.e., the explanatory variables) and college mathematics placement test (i.e., the response variable), correlational design was appropriate for this study. Creswell (2012) stated that this common research design has resulted in well-refined methods of analysis and precise procedures for identifying correlations. Correlational design is appropriate when measuring how two or more values co-vary with each other, as measured at one point in time; researchers who use this type of correlational design are not interested in past or future performance of individuals in the study (Creswell, 2012). Furthermore, correlational research is appropriate when looking for the degree of association between two variables rather than any causal inference (Creswell, 2012). Since this study did not aim to explain the cause-and-effect relationship between the explanatory and response variables, but rather the degree of association that the four sources of self-efficacy had with recent urban high school graduates’ performance on community college placement tests in mathematics, correlational design was the best option for this study’s design. Additionally, the design of this study used a cross-sectional survey, which allowed the researcher to collect data at one point in time to examine recent urban
high school graduates’ current attitudes, beliefs, opinions, or practices in regards to mathematics (Creswell, 2012).

**Research Site and Participants**

**Research site.** This study was conducted in Massachusetts using SurveyMonkey, a private company that specializes in gathering data for research and marketing purposes (Waclawski, 2012). SurveyMonkey was chosen due to its reputation and its reliability (Alessi & Martin, 2010), its ease of use for sending and receiving data and updates (Waclawski, 2012), and its popularity among teachers and college students (Gordon, 2002). Massachusetts was chosen because it is the host of many community colleges and it is known for its quality of education provided to a diverse population nationally and internationally. In fact, the U.S. Department of education reported in 2011 that there were 192,381 public community college students in Massachusetts. These students attended one of 15 institutions within the state, with 118,281 enrolled full time and 74,163 enrolled part time. Massachusetts community college students accounted for more than 55% of undergraduate credit enrollments and a total of 47% of the overall student population in the public higher education system. Community colleges also served the highest percentage of low-income students, with 36% of the students receiving Pell Grants, which is financial aid that, for eligible undergraduates and some post-baccalaureates, does not need to be repaid (U.S. Census Bureau, 2012).

**Participants.** The participants for this study were drawn from recent graduates of urban high schools who were admitted to urban community colleges in Massachusetts and who took community college placement tests in mathematics. These requirements helped to generate a sample of participants that fairly represented the desired population characteristics for this study in that they were urban high school graduates from diverse social, ethnic, and cultural
backgrounds. The study concentrated on first-year community college students who recently completed their high school educations in an urban setting because these students were exposed to the four sources of self-efficacy in mathematics during their recent high school experience.

To find participants who met the above qualifications, the researcher instructed SurveyMonkey to include a paragraph at the beginning of the survey informing respondents about the criteria needed to be eligible for the incentive. From the aforementioned population, a sample of 395 participants responded. The researcher was then able to obtain a sample size of 191 participants who met all the criteria needed for this research. All participants were newly enrolled at community colleges in Massachusetts, from a variety of ethnic backgrounds, and between the ages of 18-24.

Research Procedures

Instrumentation. The Self-Efficacy in Mathematics Survey used in this study was modeled after the survey instrument, Sources of Middle School Mathematics Self-Efficacy, developed by Usher and Pajares (2009). It was both closely aligned with this study’s hypothesis and was validated by other research (Usher & Pajares, 2006; Usher, 2009; Zimmerman & Schunk, 2008). To protect against error and to reduce the extent to which individual survey items were at risk to systematic and unsystematic measurement error (Muijs, 2011), Usher and Pajares tested the survey for validity and reliability. They developed the Sources of Middle School Mathematics Self-efficacy survey instrument through three stages in different research studies, and through many revisions, finalized a survey that held up in terms of validity. After consultations and feedback from experts in the social cognitive theory field, including advice from fellow psychologists Bandura, Schunk, and Zimmerman, items from the instrument were reduced to a total of 73 items that more accurately reflected the influence of student
characteristics on the four theorized sources of mathematical self-efficacy (Usher & Pajares, 2009), thus making this survey a valid instrument to measure participants’ relative levels of the four sources of self-efficacy. Usher and Pajares exercised other revisions to finalize the instrument to 24 items consisting of four sections, each of which contained six questions regarding each of the four sources of self-efficacy, respectively (see Appendix A for the Self-Efficacy in Mathematics Survey used in this study).

In terms of reliability of the survey instrument, Usher and Pajares (2009) stated that the six items contained within each of the four sections had an average Cronbach’s alpha coefficient of approximately .87, well above the .70 coefficient required for reliability and internal consistency of survey items. Specifically, the Cronbach’s alpha coefficients for each source of self-efficacy were .88 for performance experiences, .84 for vicarious experiences, .88 for verbal persuasion, and .87 for physiological and emotional reactions (Usher & Pajares, 2009).

In the Self-Efficacy in Mathematics Survey used in this study, participants were first asked to confirm that they were of legal age (over 18 years of age) and were volunteering to participate in the survey. Potential participants were then asked whether or not they met a preliminary set of minimum criteria, such as whether they were applying to community college and whether they had taken placement tests in mathematics. The survey also asked participants about their community college placement test results in order to determine whether the participants were placed in remedial or college-level courses in mathematics. Once all of these preliminary questions were completed, participants were then asked to complete the web-based Self-Efficacy in Mathematics Survey based on their best recollection of their past experiences.

The explanatory variables were obtained through participants’ selections of their responses. Participants were posed 24 statements about their experiences in mathematics,
soliciting participants to select the appropriate answers according to a six-point Likert-type scale from 1 to 6 (representing choices ranging from strongly disagree to strongly agree).

The first section, statements 1 through 6, pertained to participants’ performance experiences. The statements sought to determine participants’ perceptions towards their skills and capacities in handling mathematical tasks. Example statements included, “I do well on even the most difficult math assignments” and “I do well on math assignments.” The second section, statements 7 through 12, was designed to determine participants’ vicarious experiences. The participants were asked to select the level of influence of their peers and teachers in their mathematics study. Example statements included, “Seeing adults do well in math pushes me to do better” and “When I see how another student solves a math problem, I can see myself solving the problem in the same way.” The third section, statements 13 through 18, was intended to establish participants’ perceptions towards verbal persuasion from family members, peers, and mathematics teachers. Example statements included, “Adults in my family have told me what a good math student I am” and “My math teachers have told me that I am good at learning math.” The final section, statements 19 through 24, examined participants’ physiological and emotional reactions to delving into mathematics assignments. Example statements included, “Just being in math class makes me feel stressed and nervous” and “Doing math work takes all of my energy.”

Additional explanatory variables were measured through a demographic questionnaire, items 25 through 31, embedded at the end of the survey. Precision in this study required that the nominal survey was kept short and limited to simple demographic questions. Application of a demographic questionnaire helped the researcher obtain important information about each participant to filter the sample to better represent the urban socioeconomic status, and to determine differences in gender, ethnicity, and each participant’s parent’s or guardian’s level of
education. These questions about demographic information were posed at the end of the survey because some participants prefer not to answer these kinds of personal questions; these questions are often assigned at the end of instruments in order to encourage participants to complete the survey (Muijs, 2011).

**Data Collection.** First, the researcher sought and obtained approval from the Institutional Review Board (IRB) at Northeastern University to administer the Self-efficacy in Mathematics Survey to participants (see Appendix B). Next, the researcher uploaded the complete survey to SurveyMonkey and sent a link via email to the participants. The Self-Efficacy in Mathematics Survey was administered to the participants online through SurveyMonkey, which enabled the researcher to more easily gather data and monitor participants’ responses. If a participant failed to complete the survey after a week of administration, SurveyMonkey sent an email reminder asking participants to consider completing the survey within the time allocated (10 days) so as to avoid delays in data collection. After 10 days, the researcher received an email with an attached file containing the completed surveys. The researcher then uploaded the data into IBM’s Statistical Package for the Social Sciences (SPSS), software version 19.0. The data was immediately stored in the researcher’s personal computer and external drive, both accessible only after entering a password that was set up by the researcher. This procedure kept the data safe from deletion or unauthorized tampering. Next, the data was verified and reviewed for accuracy through data cleaning procedures. There was no need for any additional secondary collection of data.

**Data Analysis**

Analysis was conducted based on the following hypothesis: Each of the four sources of self-efficacy correlated significantly with urban high school graduates’ performance on
community college placement tests in mathematics. In this study, the researcher calculated several binary logistic regression models to test the hypothesis and to find a relationship between the four explanatory variables and the one response variable. The four explanatory variables were composite scores of responses to statements across the four different sources of self-efficacy: (a) performance experiences, (b) vicarious experiences, (c) verbal persuasion, and (d) physiological and emotional reactions. The binary response variable measured participants’ responses to a statement about whether they were placed in a remedial course in mathematics or a college-level course in mathematics. This variable was coded as 1 = the participant was placed into a remedial course in mathematics and 2 = the participant was placed into a college-level course in mathematics.

**Filtering participants and data transformation.** In the preparation phase of this study, the researcher addressed some essential steps that had to be completed before data analysis could commence, such as cleaning and coding data. The collected data were cleaned and participants who did not fit the desired population were removed from the sample. One of the survey statement’s responses was reverse-coded to better match other survey statement responses, and data was further transformed through the generation of the four composite score variables, one for each of the four sources of self-efficacy. The processes of data cleaning, filtering of participants, transformation of statement responses, and the generation of composite variables, which form the primary independent variables of this study, are discussed in further detail in Chapter 4.

**Descriptive statistics.** Descriptive statistical analyses were conducted to determine general quantitative descriptions of participants’ responses. The descriptive statistics included information on the mean and standard deviation to illustrate measures of central tendency and
dispersion. All individual statement responses could take on values ranging between one and six, corresponding to a six-point Likert-type scale. In general, greater numbers on the six-point scale indicated that participants believed that the statements applied more accurately to themselves. Descriptive statistics regarding the statements within each of the four sources of self-efficacy are described in more detail in Chapter 4.

**Differences among demographic groups.** Demographic variables (i.e., gender, ethnicity, and participants’ parent’s or guardian’s levels of education) were included as control variables in the binary logistic regression models that the researcher used to answer the research question and test the hypothesis. Prior to including these control variables, the researcher performed Chi-square tests of independence to determine the correlations, if any, between each of the demographic variables and placement test results. By performing these tests, the researcher would be able to better interpret how demographic variables might correlate with the placement test results variable that was used as the primary response variable in the binary logistic regression models that answered this study’s research question. In addition, the researcher performed different tests (i.e., independent samples t-tests and analyses of variance [ANOVAs]) to determine the correlations, if any, between each of the demographic variables and each of the four sources of self-efficacy. By performing these tests, the researcher would be able to better interpret how demographics might correlate with the four sources of self-efficacy that were used as the primary explanatory variables in the binary logistic regression models that answered this study’s research question. The results of these different tests are discussed in further detail in Chapter 4 and the relevant tables are presented in Appendix E and Appendix F.

When performing a Chi-square test of independence, five essential assumptions must be met (McHugh, 2013):
1. There must be two variables compared in each test, and each variable must be measured on a nominal or on an ordinal scale with two or more factor levels. This assumption must be met because this test compared data across factor levels, each of which must be defined as a distinct category, different from the other factor levels. Although interval or ratio scale variables that have been collapsed into ordinal categories may be used, a large number of factor levels can potentially generate a large number of cells, thus making it difficult to meet assumption #5 below.

2. The data in the cells must be frequencies or counts of cases rather than percentages of the whole sample.

3. Each participant must be able to belong to only one factor level within each nominal variable. This assumption must be met because if any participants belonged to more than one factor level, the data from these respondents would be incorrectly accounted for.

4. The observations must be random and independent samples from the population. This assumption must be met in order for the sample to be representative of the population. One participant’s responses should not affect any other participant’s responses.

5. The expected frequency for each cell must be greater than 5.0 for at least 80% of the cells and no cell may have an expected frequency of less than 1.0.

When performing an independent samples t-test or a one-way ANOVA test, six essential assumptions must be met (Muijs, 2011):

1. The response variable must be measured on an interval or ratio scale. This assumption of continuous data scales must be met to allow for inferences to be made and valid analysis to be performed with a measuring scale that can distinguish between changes in response variable values.
2. The variables must be measured on a nominal scale and must include two or more factor levels. This assumption must be met because these tests compared data across factor levels, each of which must be defined as a distinct category, different from the other factor levels.

3. Each participant must be able to belong to only one factor level within each nominal variable. This assumption must be met because if any participants belonged to more than one factor level, the data from these respondents would be incorrectly accounted for.

4. The observations must be random and independent samples from the population. This assumption must be met in order for the sample to be representative of the population. One participant’s responses should not affect any other participant’s responses.

5. Each variable that is measured on an interval or ratio scale must be approximately normally distributed for each factor level of the nominal variables. This assumption of normality ensures that the sample has normally distributed data, which is necessary to be able to infer probabilities from the distribution of the sample.

6. Each variable measured on an interval or ratio scale must have approximately equal variances. This assumption ensured that the test results were robust and had adequate statistical power.

These assumptions were checked in order to perform the tests to determine differences among demographic groups. Descriptions of whether these assumptions were met and the methods in which any violations were managed are summarized and described in Chapter 4.

**Binary logistic regression.** The researcher conducted a series of binary logistic regression tests to identify the significant predictors of participants’ placement test results. These binary logistic regression tests were the most important tests performed in this study.
because they directly addressed this study’s research question and hypothesis. For these binary logistic regression models, the researcher used four explanatory variables (i.e., independent variables) that were defined as the participants’ composite scores in each of the four sources of self-efficacy and one response variable (i.e., dependent variable) that was defined as the placement test results of whether participants were placed in remedial or college-level courses in mathematics. In addition, in some instances within the regression models, the researcher included demographic variables of participants’ gender, ethnicity, and parent’s or guardian’s levels of education as additional explanatory variables that were used primarily as control variables.

In general, logistic regression is a type of predictive correlational analysis in which the response variable is measured on a nominal scale with a number of possible categories. By using a logistic or logit transform of variables, logistic regression is able to generate predictive relationships between explanatory variables and response variables by making significant distinctions between each of the nominal options available in the response variable. In the case of binary logistic regression specifically, the response variable that is measured on a nominal scale must be dichotomous and include exactly two different categories, thus giving the test the name *binary*. In addition, binary logistic regression models allow researchers to inspect the influence of the explanatory variables on the response variable by estimating the probability of the response variable taking on one of its two possible options. The relationship between the explanatory variables and the response variable are presented in terms of the outcomes of log odds presented in a binary format as opposed to using the dependent variable as its whole. This method of presenting the regression results means that the relationship between the explanatory
variables and the response variable will be considered based on the probability that the response variable takes on one of its two possible options (Muijs, 2011).

Binary logistic regression was an appropriate test to use for data analysis in this study because the research question was based on the relationship between four explanatory variables (i.e., the four composite scores that measured participants’ sources of self-efficacy in mathematics) that were measured on a continuous scale and one response variable (i.e., whether the participant was placed in a remedial course in mathematics or a college-level course in mathematics) that was measured on a nominal scale with exactly two possible categories.

When calculating a binary logistic regression model, five essential assumptions must be met (Burns & Burns, 2008):

1. The sample size must include at least ten cases per explanatory variable. This assumption must be met to eliminate instances of bias while maintaining confidence in making inferences about the chosen population.

2. The observations must be random and independent samples from the population. This assumption must be met in order for the sample to be representative of the population. One participant’s responses should not affect any other participant’s responses.

3. The response variable must be measured on a dichotomous scale, including exactly two response options, which are mutually exclusive and together are collectively exhaustive. This assumption must be met because if any participants belonged to more than one factor level, the data from these participants would be incorrectly accounted for. In addition, every participant must be represented by one factor level to be included in the sample data and the regression analysis.
4. For every explanatory variable measured on an ordinal or an interval scale, no more than 20% of outcomes are allowed to have expected values of less than 5.0. This assumption must be met to ensure that the binary logistic regression models are robust and have adequate statistical power.

5. Each explanatory variable must have a linear relationship with the logistic transformation of itself. This assumption must be met to ensure that the binary logistic regression models are robust and have adequate statistical power. If this assumption is violated, the regression model would underestimate the strength of the relationship between the explanatory variables and the binary response variable, and would reject the relationship too easily.

These assumptions were checked in order to calculate the binary logistic regression models to determine predictors of placement test results. Descriptions of whether these assumptions were met and the methods in which any violations were managed are summarized and described in Chapter 4.

In this study, the Likert-type statement responses to the survey instrument were measured on an ordinal scale; the responses to multiple survey items were combined into composite variables for each of the four sources of self-efficacy, each of which was measured on a continuous scale. Although some researchers (MacCallum, Zhang, Preacher, & Rucker, 2002; Royston, Altman, & Sauerbrei, 2006) warned against treating ordinal variables as continuous variables, Norman (2010) argued these warnings were “unfounded.” In his 2010 study, Norman found that Likert-type scales could be used in parametric methods without resulting in any significant weaknesses in the results of the findings.
Binary logistic regression data analysis resulted in coefficients corresponding to each explanatory variable in order to predict the response variable. After data analysis, the values of coefficients were converted to odds ratios, making relative probability of success measurements regarding one group comparable to a baseline group. In this way, throughout the analysis, the researcher was able to respond to the question, “What is the probability of being placed in a remedial or college-level course given different levels of explanatory variables?” In addition, logistic regression analysis enabled the researcher to see the contribution that each individual amount of change within the four predictors had on the dependent variable. This method of analysis helped to test whether the independent variables could potentially be used to predict the relationship between student self-efficacy and the results of community college placement tests in mathematics. In addition, logistic regression, through goodness of fit, permitted the researcher to evaluate how well the overall model fit, which was how the independent variables combined together to predict the dependent variable (Muijs, 2011). The results of binary logistic regression models are quantified in Chapter 4 and the implications of these results are discussed in Chapter 5.

**Validity, Reliability, and Generalizability**

Threats to validity, reliability, and generalizability are inherent to any research study using quantitative survey methods (Creswell, 2012). This section will outline those threats and speak to the actions that the researcher took to minimize those threats throughout various stages of the research process.

Since it is a complex and difficult process to create a reliable and valid survey instrument, this study employed a previously developed and tested instrument as recommended by Creswell (2012). The Self-Efficacy in Mathematics Survey used in this study was modeled after the
Sources of Middle School Mathematics Self-Efficacy survey instrument developed by Usher and Pajares (2009). The Sources of Middle School Mathematics Self-Efficacy survey instrument had previously been tested for validity and reliability (Usher & Pajares, 2009). As previously discussed, Usher and Pajares developed the Sources of Middle School Mathematics Self-Efficacy survey instrument through three stages in different research studies, and through many revisions, finalized a survey that held up in terms of validity. Despite this reassurance of validity and reliability, there were still potential threats to the validity and reliability of the survey instrument that was used in this study and to the generalizability of the results measured on such a survey instrument. These concerns and the steps taken to mitigate potential problems are discussed here.

In general, one threat to the reliability of survey research is the extent to which individual survey items are at risk of systematic and unsystematic measurement error (Muijs, 2011). In this study, repeated measurement was not applicable since the participants were allowed to answer the online survey only once. In addition, internal consistency was analyzed to confirm whether there were any other potential reliability problems with the survey instrument. The researcher performed Cronbach’s alpha analyses on the internal consistency of statement responses within each of the four sources of self-efficacy. The value of Cronbach’s alpha was greater than the acceptable level of .7 in order to confirm that the test was internally consistent (Nix, 2006). These results indicated that the internal consistency of statements were reliable for this survey instrument and this study. Cronbach’s alpha results are discussed in more detail in Chapter 4.

Another threat to the validity and reliability of this study was potentially unwanted sample selection. Selection (i.e., people factors) refers to intentionally selecting participants who might have had an impact on the outcome of the study beyond the scope of the generalizable
trends among the overall population. In this study, the randomness in sample selection and control of participants helped to eliminate instances of having a predetermined outcome. Apart from this threat, it is also generally important to understand the effect of validity as a threat in any study (Fraenkel et al., 2012). For example, particular locations in which data are gathered, or in which a survey is carried out, may create alternative explanations for results. In this study, participants were allowed to complete the survey at a location and time of their own convenience, such as a school library, a classroom, or at home, thus making responses more valid and reliable since the participants were in their comfort zone (Creswell, 2012). Another possible set of threats to survey research pertained to instrumentation and its application within the study. The SurveyMonkey web service was used in order to nullify the effects of instrument decay, data collector characteristics, and data collector bias because there was no contact with the researcher during any part of the study.

Finally, testing and mortality threats had to be taken into consideration in order to ensure accurate information presentation. Testing threats can occur when students have certain recollections of previous surveys or pretests which enable them to change their performance in the current test or post-test; in those instances, researchers would be required to consider the results of the post-test as an improvement on the pre-test. In this study, the researcher employed a single survey, which the students completed at the beginning of their first school year at community college, thus mitigating any threats to validity as caused by testing threats. Mortality of subjects, another threat to validity, results from the unexpected incompletion when taking a survey. In general, survey participants may sometimes decide to stop taking a survey before completely providing all statement responses, which can have a significant influence on the sample size of the survey (Fraenkel et al., 2012; Prescott, 2006). To avoid these threats and
achieve a high response rate, the SurveyMonkey web service sent reminder emails to complete the survey, along with emails informing survey participants that incentives would be provided only to those who completed the entire survey.

The generalizability, or the threat to external validity, refers to the ability to apply the findings of research outside the acquired sample. The sample used in this study included only recent graduates from urban high schools who were entering urban community colleges in Massachusetts. This meant that the generalizability of the findings would be most accurate when limited to recent graduates from urban high schools who were entering urban community colleges in Massachusetts. This sample was meant to be generalizable enough to represent the population of all recent graduates from urban high schools who were entering urban community colleges in any US state, not limited to only the state of Massachusetts. However, generalizations to this population should be considered with caution. In addition, generalizations to make conclusions about recent high school graduates who are entering non-community college institutions, or who are of non-urban high socioeconomic status, should only be considered with extreme caution. This limitation is discussed further in Chapter 5.

In addition, this study focused on community college placement tests in the subject of mathematics only. Generalizability regarding how the four sources of self-efficacy are correlated to performance in other fields of study, such as reading comprehension, writing, or science, should be considered with extreme caution. This limitation is discussed further in Chapter 5.

Protection of Human Subjects

The request to conduct this study was approved by the Institutional Review Board after it agreed that the study was within the guidelines presented as the core reason for pursuing the research (see Appendix B). Meanwhile, the researcher established all the processes that would be
needed to protect participants’ rights to privacy (Ellen, 1987) (for a full list of privacy concerns of participants, see Appendix C). In addition to making the intentions of the researcher unknown to the respondents, the identity of the participants and the specific community colleges surveyed remained undisclosed. The college was identified by its general geographic location and the students were identified based on their anonymously assigned identification numbers. The online survey was set up to be taken anonymously, and since the need to hide respondents’ real identities became important, the participants were specifically asked not to provide their names or their identification numbers to anyone (Butin, 2010). Furthermore, students were advised to log out and close their browsers upon completion of their survey responses. The survey was administered online and the answers were encrypted to specifically assigned identification numbers representing each participant. A consent form was available for the participants stating that any participant was allowed to voluntarily withdraw from the study at any time and that their data would immediately be removed from the research database. In addition, the researcher set up a password on the researcher’s personal computer to keep the data safe from alteration.

Participants were informed during the survey that their answers would be kept confidential, and each respondent was informed that no information would be revealed to the public without the consent of the respondent. In addition, the researcher had no direct access to the participants and did not discuss the survey with his own students at the college.

Summary

The purpose of this quantitative study was to determine the relationship between each of the four sources of self-efficacy and student performance on community college placement tests in mathematics. This study used a correlational design in order to determine if participants’ levels of the four sources of self-efficacy (i.e., the explanatory variables) were significantly
correlated with whether participants were placed in a remedial or college-level course in mathematics (i.e., the response variable). An investigation of statement responses regarding the four sources of self-efficacy was conducted based on a sample of urban high school graduates who were entering community colleges in Massachusetts and had taken placement tests in mathematics. Data was collected via SurveyMonkey using the Self-Efficacy in Mathematics Survey. This survey instrument was modeled after Usher and Pajares’ (2009) Sources of Middle School Mathematics Self-Efficacy survey instrument, which had been found to be both reliable (i.e., for each of the four sources of self-efficacy, the Cronbach’s alpha value was greater than the acceptable level of .7 in order to confirm that the test was internally consistent) and valid in a previous study (Usher & Pajares, 2009).

The data was analyzed via Chi-square tests of independence, independent samples t-tests, and analyses of variance (ANOVAs). Binary logistic regression was used to determine the extent to which recent urban high school graduates’ inherent and learned levels of each of the four sources of self-efficacy were related to their performance on community college placement tests in mathematics. To ensure minimal risk and confidentiality to study participants, responses were and will remain confidential and were reported in aggregate to preserve the privacy of participants.
Chapter 4: Research Findings

The purpose of this quantitative study was to determine the relationship between each of the four sources of self-efficacy and student performance on community college placement tests in mathematics, as stated in the research question. To answer the research question, binary logistic regression analysis tests were carried out. In addition, Chi-square tests of independence, independent samples t-tests, and analyses of variance (ANOVAs) were used to identify the differences, if any, in the placement test results and the four sources of self-efficacy among the different demographic groups (i.e., gender, ethnicity, and parent’s or guardian’s level of education). This chapter will discuss the data analysis associated with the research question and any subsequent findings resulting from the study.

Chapter 4 contains six main sections. The first section provides details about the cleaning, transformation, and validation of the data. This section discusses the researcher's efforts to check whether the final data utilized for the study is complete and accurate and whether the final data conforms to acceptable values for each variable. The second section describes the demographic profile of the participants being studied. The frequencies of the participants’ demographics, such as gender, ethnicity, and parent’s or guardian’s level of education, are all presented in this section. The third section provides descriptive statistics, such as the central tendency and spread of each survey instrument item and the central tendency and spread of the composite scores of related survey instrument items. The fourth section presents how the researcher tested the internal consistency of survey statement responses to check the validity of the survey instrument. The fifth section discusses whether the assumptions were met for binary logistic regression, Chi-square test of independence, independent samples t-test, and ANOVA. The sixth and final section reports the findings from the demographic group difference tests (i.e.,
Chi-square tests of independence, independent samples t-tests, and ANOVAs) and the tests that determine the predictors of placement test results (i.e., binary logistic regression tests). These findings are organized and discussed relative to the research question and its hypothesis.

**Data Cleaning, Transformation, and Validation**

The researcher took the following steps to review and clean the data received from SurveyMonkey after it was uploaded in the SPSS software:

- The participants who had not taken community college placement tests in mathematics were removed from the study reducing the sample size from 395 to 335.
- To ensure that participants fit the definition of “urban” based on their socioeconomic status (SES) as defined by Kincheloe (2010), only participants receiving free lunches or reduced-price lunches through government assistance were included in the sample data. Of the 335 participants, 141 (42%) received free lunches, and 56 (17%) received reduced-price lunches. This filtering resulted in a further reduction of the sample size to 197 participants.
- After the survey responses were quantified, the researcher utilized the outlier-labeling rule developed by John Tukey (1962) to remove outlier participants.\(^1\) Six participants who had scored significantly lower than the outliers’ lower fence on some of the survey responses were excluded from the sample. Thus, the final filtered sample used in this study consisted of 191 participants (\(N = 191\)).
- After grouping each of the survey statements into one of the four sources of self-efficacy, a composite score was then generated for each of the four sources of self-efficacy by summing the statement response values within each source.

\(^1\) The outlier-labeling rule developed by John Tukey (1962) is widely used in many popular software packages because of its simplicity and ability to detect multiple outliers (Frigge et al., 1989; Hoaglin et al., 1986).
• To keep the Likert-type scale responses consistent across all statements, one statement was reverse-coded.

**Participant Demographics**

The sample for this study was comprised of recent urban high school graduates ($N = 191$) who had taken the mathematics portion of a Massachusetts community college placement test in 2014 and 2015. All demographic data of the participants are outlined in Table 1. This researcher studied a group of participants (51% males; 49% females) from 15 different community colleges in Massachusetts. Participants were composed of 35% White participants, 32% Black participants, 19% Latino participants, 6% Asian participants, 4% American Indian or Alaskan Native participants, and 4% participants from other races. Lastly, participants’ parents and guardians had attained different levels of education (11% elementary school; 16% middle school; 31% high school; 28% college; and 14% graduate school).

<table>
<thead>
<tr>
<th>Table 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research Participants’ Demographic Data (Gender, Ethnicity, Parent’s or Guardian’s Level of Education)</td>
</tr>
<tr>
<td>Gender</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Female</td>
</tr>
<tr>
<td>Ethnicity</td>
</tr>
<tr>
<td>White</td>
</tr>
<tr>
<td>Black</td>
</tr>
<tr>
<td>Latino</td>
</tr>
<tr>
<td>Asian</td>
</tr>
<tr>
<td>American Indian or Alaskan Native</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td>Parent’s or Guardian’s Level of Education</td>
</tr>
<tr>
<td>Elementary School</td>
</tr>
<tr>
<td>Middle School</td>
</tr>
<tr>
<td>High School</td>
</tr>
<tr>
<td>College</td>
</tr>
<tr>
<td>Graduate</td>
</tr>
</tbody>
</table>
Descriptive Statistics for Self-efficacy Scores

Descriptive statistical analyses were conducted on each of the 24 Likert-type statements and then on each of the four composite scores that represented the sources of self-efficacy (see Table 2). Of all four composite scores, vicarious experiences resulted in the highest mean composite score \((M = 25.77, SD = 4.90)\) and physiological and emotional reactions resulted in the lowest mean composite score \((M = 19.30, SD = 8.02)\). The performance experiences statement, “I do well on math assignments,” resulted in the highest mean and the lowest standard deviation of all 24 statement responses \((M = 4.71, SD = 0.98)\). The standard deviation of each of the six statements presented within the physiological and emotional reactions source of self-efficacy was higher than the standard deviation of any individual statement presented within any of the other three sources of self-efficacy. These wide dispersions were due to large differences among participants’ opinions on their physiological and emotional reactions source of self-efficacy (see Table 2).
Table 2

*Descriptive Statistics for Responses to Statements Regarding the Four Sources of Self-efficacy (N = 191)*

<table>
<thead>
<tr>
<th>Statements</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Performance Experiences Statements</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have always been successful with math</td>
<td>3.95</td>
<td>1.44</td>
</tr>
<tr>
<td>I make excellent grades on math tests</td>
<td>3.96</td>
<td>1.44</td>
</tr>
<tr>
<td>I got good grades in math on my last report card</td>
<td>4.17</td>
<td>1.46</td>
</tr>
<tr>
<td>Even when I study very hard, I do poorly in math</td>
<td>4.24</td>
<td>1.38</td>
</tr>
<tr>
<td>I do well on even the most difficult math assignments</td>
<td>3.69</td>
<td>1.35</td>
</tr>
<tr>
<td>I do well on math assignments</td>
<td>4.72</td>
<td>0.98</td>
</tr>
<tr>
<td><strong>Vicarious Experiences Statements</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seeing adults do well in math pushes me to do better</td>
<td>4.31</td>
<td>1.03</td>
</tr>
<tr>
<td>When I see how my math teacher solves a problem, I can picture myself solving the problem</td>
<td>4.24</td>
<td>1.17</td>
</tr>
<tr>
<td>Seeing kids do better than me in math pushes me to do better</td>
<td>4.36</td>
<td>1.12</td>
</tr>
<tr>
<td>I imagine myself working through challenging math problems successfully</td>
<td>4.35</td>
<td>1.16</td>
</tr>
<tr>
<td>When I see how another student solves a math problem, I can see myself solving the problem in the same way</td>
<td>4.21</td>
<td>1.07</td>
</tr>
<tr>
<td>I compete with myself in math</td>
<td>4.30</td>
<td>1.16</td>
</tr>
<tr>
<td><strong>Verbal Persuasion Statements</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>My math teachers have told me that I am good at learning math</td>
<td>4.35</td>
<td>1.26</td>
</tr>
<tr>
<td>People have told me that I have a talent for math</td>
<td>4.06</td>
<td>1.40</td>
</tr>
<tr>
<td>Adults in my family have told me what a good math student I am</td>
<td>4.15</td>
<td>1.39</td>
</tr>
<tr>
<td>I have been praised for my ability in math</td>
<td>3.97</td>
<td>1.40</td>
</tr>
<tr>
<td>Other students have told me that I’m good at learning math</td>
<td>4.12</td>
<td>1.32</td>
</tr>
<tr>
<td>My classmates like to work with me in math because they think I’m good at it</td>
<td>4.03</td>
<td>1.36</td>
</tr>
<tr>
<td><strong>Physiological and Emotional Reactions Statements</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Just being in math class makes feel stressed and nervous</td>
<td>3.41</td>
<td>1.60</td>
</tr>
<tr>
<td>Doing math work takes all of my energy</td>
<td>3.41</td>
<td>1.49</td>
</tr>
<tr>
<td>I start to feel stressed-out as soon as I begin my math work</td>
<td>3.34</td>
<td>1.55</td>
</tr>
<tr>
<td>My mind goes blank and I am unable to think clearly when doing math work</td>
<td>3.10</td>
<td>1.53</td>
</tr>
<tr>
<td>I get depressed when I think about learning math</td>
<td>3.08</td>
<td>1.55</td>
</tr>
<tr>
<td>My whole body becomes tense when I have to do math</td>
<td>2.96</td>
<td>1.51</td>
</tr>
<tr>
<td><strong>Composite Scores</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance Experiences Composite Score</td>
<td>24.72</td>
<td>6.37</td>
</tr>
<tr>
<td>Vicarious Experiences Composite Score</td>
<td>25.77</td>
<td>4.90</td>
</tr>
<tr>
<td>Verbal Persuasion Composite Score</td>
<td>24.68</td>
<td>7.28</td>
</tr>
<tr>
<td>Physiological and Emotional Reactions Composite Score</td>
<td>19.30</td>
<td>8.02</td>
</tr>
</tbody>
</table>

*a This statement response was reverse-coded.

**Testing the Internal Consistency of Responses**

Each of the four sources of self-efficacy achieved a Cronbach’s alpha score greater than .70, indicating that the survey instrument served as a reliable measurement tool (see Table 3).

Scholars recommend that acceptable values of Cronbach’s alpha should range between .70 and .95 (Tavakol & Dennik, 2011).
Table 3

<table>
<thead>
<tr>
<th>Source of Self-efficacy</th>
<th>Cronbach’s Alpha Based on Standardized Items</th>
<th>Number of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Experiences</td>
<td>.77</td>
<td>6</td>
</tr>
<tr>
<td>Vicarious Experiences</td>
<td>.87</td>
<td>6</td>
</tr>
<tr>
<td>Verbal Persuasion</td>
<td>.96</td>
<td>6</td>
</tr>
<tr>
<td>Physiological and Emotional Reactions</td>
<td>.94</td>
<td>6</td>
</tr>
</tbody>
</table>

**Assumption Checking for Binary Logistic Regression**

Using the steps discussed in Chapter 3, the following binary logistic regression assumptions were met (Peng, Lee, & Ingersoll, 2002): 1) minimum sample size of 40 participants was met ($N = 191$); 2) the survey was administered online and participants’ responses were adequately independent of each other; 3) participants could not be placed in multiple levels of mathematics courses at the same time (the available options for the response variable were mutually exclusive) and thus available options were collectively exhaustive; 4) Chi-square test revealed that 0% of the expected values for each of the four composite scores were less than 5.0 (see Table D1 in Appendix D); and 5) a Box-Tidwell test revealed that the interaction term between each composite score and its logistic transformation was statistically not significant ($p > .05$). Thus all four composite score explanatory variables were linearly related to their respective logistic transformations (see Table D2 in Appendix D).

**Assumption Checking for Chi-square Test of Independence, Independent Samples t-test, and ANOVA**

Using the steps discussed in Chapter 3, the following Chi-square test of independence assumptions were met (McHugh, 2013): 1) there were two variables compared in each test, and each variable was measured on a nominal scale (i.e., gender, ethnicity, parent’s or guardian’s
level of education, and placement test results); 2) the data in the cells were frequencies or counts of cases rather than percentages of the whole; 3) each participant was able to belong to only one factor level within each independent factor; 4) participants’ responses were made online and therefore adequately independent of each other; and 5) for the Chi-square test of independence between gender and placement test results as well as for the Chi-square test of independence between parent’s or guardian’s level of education and placement test results, the expected frequency for each cell was greater than 5.0 for at least 80% of the cells and no cell had an expected frequency of less than 1.0 (see Table E1, Table E2, and Table E3 in Appendix E). For the Chi-square test of independence between ethnicity and placement test results, only 58.3% of cells had expected frequencies of greater than 5.0, which violated an assumption of the Chi-square test of independence; in order to correct this violation, the researcher used the maximum-likelihood ratio Chi-square test of independence for determining independence between ethnicity and placement test results, as recommended by McHugh (2013). In addition, the following independent samples t-test and ANOVA assumptions were met (Muijs, 2011): 1) the response variable that measured the composite score for each of the four sources of self-efficacy was measured on an interval scale; 2) each of the independent factors (i.e., gender, ethnicity, and parent’s or guardian’s level of education) was measured on a nominal scale that consisted of two or more independent factor levels; 3) each participant was able to belong to only one factor level within each independent factor; 4) participants’ responses were made online and therefore adequately independent of each other; 5) a Levene’s test for homogeneity of variances for each of the composite scores for the four sources of self-efficacy revealed that performance experiences, vicarious experiences, verbal persuasion, and physiological and emotional reactions resulted in p-values of .803, .424, .865, and .854, respectively (p > .05); thus the variances of the
composite scores were not significantly different from each other (see Table D3 in Appendix D); and 6) a Shapiro-Wilk test for normality of the composite scores and the demographic variables revealed that some of the composite scores were found to be normally distributed while others were found to not be normally distributed, thus partially violating this assumption (see Table D4 in Appendix D). However, these violations of the normality assumption were considered acceptable because the one-way ANOVA is considered to be a robust test against the normality assumption, meaning that it tolerates violations to this assumption rather well (Laerd Statistics, n.d.).

**Differences Among Demographic Groups in Placement Test Results**

A Chi-square test of independence revealed that gender was not significantly correlated with placement test results, \( \chi^2 (1) = 2.68, p = .102 \) (see Table E1 in Appendix E), indicating that male participants were not significantly more or significantly less likely than female participants to be placed in college-level courses in mathematics instead of remedial courses in mathematics. Regarding ethnicity, a maximum-likelihood ratio Chi-square test of independence revealed that ethnicity was not significantly correlated with placement test results, \( \chi^2 (5) = 8.80, p = .117 \) (see Table E2 in Appendix E), indicating that participants of each ethnicity were not significantly more or significantly less likely than participants of other ethnicities to be placed in college-level courses in mathematics instead of remedial courses in mathematics. Finally, as to participants’ parents’ or guardians’ level of education, a Chi-square test of independence revealed that parents’ or guardians’ level of education was significantly correlated with placement test results, \( \chi^2 (4) = 22.33, p < .001 \) (see Table E3 in Appendix E), indicating that participants whose parents or guardians had attained certain levels of education were significantly more or significantly less likely than participants whose parents or guardians had attained different levels of education to
be placed in college-level courses in mathematics or remedial courses in mathematics. Specifically, the average likelihood of being placed in a college-level course in mathematics as opposed to a remedial course in mathematics was significantly lower for participants whose parents or guardians had attained only an elementary school level or a middle school level of education, as compared to those participants whose parents or guardians had attained an education of high school level, college level, or graduate school level of education (see Table E3 in Appendix E).

**Differences Among Demographic Groups in Sources of Self-efficacy**

**Performance experiences.** An ANOVA revealed that ethnicity was a statistically significant predictor of performance experiences composite scores, \( F(5, 185) = 3.13, p = .010 \) (see Table F2 in Appendix F). Post hoc analyses using Tukey’s post hoc criterion for significance indicated that the average composite score in the performance experiences source of self-efficacy was significantly higher for Asian participants \( (M = 28.64, SD = 6.07) \) as compared to American Indian or Alaskan Native participants \( (M = 21.88, SD = 7.92) \). No other ethnicity had a statistically significant effect on performance experiences composite scores. Another ANOVA revealed that a participant’s parents’ or guardians’ level of education was a statistically significant predictor of the participant’s performance experiences composite score, \( F(4, 186) = 6.27, p < .001 \) (see Table F5 in Appendix F). Post hoc analyses using the Scheffé post hoc criterion for significance indicated that the average performance experiences composite score was significantly lower for participants whose parents or guardians had only attained an elementary school level of education \( (M = 20.1, SD = 4.22) \) as compared to those whose parents or guardians had attained an education of college level \( (M = 26.56, SD = 6.80) \) or graduate school level \( (M = 27.46, SD = 6.20) \). No other level of a participant’s parent’s or guardian’s level
of education had a statistically significant effect on the participant’s performance experiences
composite score. An independent samples t-test revealed that the difference between males ($M = 24.59, SD = 6.32$) and females ($M = 24.86, SD = 6.45$) performance experiences composite scores was not statistically significant, $t (189) = -0.29$, $p = .772$ (see Table F1 in Appendix F).

**Vicarious Experiences.** An ANOVA revealed that a participant’s parent’s or guardian’s level of education was significantly correlated with the participant’s vicarious experiences composite score, $F (4, 186) = 2.94$, $p = .022$ (see Table F5 in Appendix F). Post hoc analyses using the Scheffè post hoc criterion for significance indicated that the average vicarious experiences composite score was significantly lower for participants whose parents or guardians had only attained an elementary school level of education ($M = 23.75, SD = 3.08$) as compared to those whose parents or guardians had attained an education of graduate school level ($M = 28.15, SD = 5.87$). No other level of the participants’ parents’ or guardians’ level of education had a statistically significant effect on the participant’s vicarious experiences composite score. In addition, an ANOVA revealed that ethnicity was significantly correlated with vicarious experiences composite scores, $F (5, 185) = 2.58$, $p = .028$ (see Table F2 in Appendix F). Post hoc analyses using the Duncan post hoc criterion for significance indicated that the average vicarious experiences composite score was significantly higher for White participants ($M = 26.42, SD = 5.34$), Black participants ($M = 26.41, SD = 4.45$), and Latino participants ($M = 25.51, SD = 3.72$), as compared to American Indian or Alaskan Native participants ($M = 21.38, SD = 4.78$). In addition, an independent samples t-test revealed that the difference between males ($M = 25.69, SD = 5.04$) and females ($M = 25.85, SD = 4.76$) vicarious experiences composite scores was not statistically significant, $t (189) = -0.22$, $p = .827$ (see Table F1 in Appendix F).
**Verbal Persuasion.** An ANOVA revealed that a participant’s parent’s or guardian’s level of education was significantly correlated with the participant’s verbal persuasion composite score, $F(4, 186) = 3.547, p = .008$ (see Table F5 in Appendix F). Post hoc analyses using the Scheffé post hoc criterion for significance indicated that the average verbal persuasion composite score was significantly lower for participants whose parents or guardians had only attained an elementary school level of education ($M = 19.60, SD = 6.48$) as compared to those whose parents or guardians had attained an education of college level ($M = 26.02, SD = 7.22$) or graduate school level ($M = 26.46, SD = 9.45$). No other level of the participants’ parents’ or guardians’ level of education had a statistically significant effect on the participants’ verbal persuasion composite score. In addition, an ANOVA revealed that ethnicity was not significantly correlated with verbal persuasion composite scores, $F(5, 185) = 2.001, p = .080$ (see Table F2 in Appendix F). Furthermore, an independent samples t-test revealed that the difference between males ($M = 24.41, SD = 7.41$) and females ($M = 24.96, SD = 7.17$) verbal persuasion composite scores was not statistically significant, $t(189) = –0.51, p = .610$ (see Table F1 in Appendix F).

**Physiological and emotional reactions.** An ANOVA revealed that a participant’s parent’s or guardian’s level of education was not significantly correlated with the participant’s physiological and emotional reactions composite score, $F(4, 186) = 0.93, p = .450$ (see Table F5 in Appendix F); another ANOVA demonstrated that ethnicity was not significantly correlated with physiological and emotional reactions composite scores, $F(5, 185) = 1.42, p = .220$ (see Table F2 in Appendix F); and an independent samples t-test uncovered that the difference between males ($M = 19.32, SD = 8.06$) and females ($M = 19.29, SD = 8.03$) physiological and emotional reactions composite scores was not statistically significant, $t(189) = 0.02, p = .982$ (see Table F1 in Appendix F).
Predictors of Placement Test Results

The researcher conducted a series of binary logistic regression tests to identify the significant predictors of college mathematics placement tests. These binary logistic regression tests addressed the research question and hypothesis (as restated below).

Research question: To what extent do the four sources of self-efficacy (i.e., performance experiences, vicarious experiences, verbal persuasion, and physiological and emotional reactions), in the subject of mathematics, correlate with performance on the mathematics portion of community college placement tests, as taken by recent urban high school graduates entering community college?

Hypothesis: Each of the four sources of self-efficacy correlates significantly with recent urban high school graduates' performance on community college placement tests in mathematics.

Performance experiences. The performance experiences source of self-efficacy was found to be a statistically significant predictor of whether participants were placed in remedial courses in mathematics or college-level courses in mathematics in all of the binary logistic regression models where the performance experiences explanatory variable was considered ($p < .05$). This coefficient consistently was positively correlated with the binary response variable implying that on average, holding all other variables constant, participants who had higher performance experiences composite scores were more likely to be placed in a college-level course in mathematics instead of a remedial course in mathematics.

A binary logistic regression model (see Table 4, Model 1) revealed that the explanatory variable for performance experiences was a statistically significant predictor of whether participants were placed in remedial or college-level courses in mathematics (Cox & Snell $R^2 =$
.32, Nagelkerke $R^2 = .44, p < .05$). The Cox and Snell $R^2$ and the Nagelkerke $R^2$ values indicated that between 32% and 44% of the variations in participants’ placement test results could be explained by variations in participants’ performance experiences composite scores.

Table 4

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Model 1</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$B$</td>
<td>$SE(B)$</td>
<td>$e^B$</td>
</tr>
<tr>
<td>Performance Experiences</td>
<td>0.27***</td>
<td>0.04</td>
<td>1.31</td>
</tr>
<tr>
<td>Cox &amp; Snell $R^2$</td>
<td>.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nagelkerke $R^2$</td>
<td>.44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$N$</td>
<td>191</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* $e^B =$ exponentiated $B$.
* $p < .05$. ** $p < .01$. *** $p < .001$

Vicarious experiences. The vicarious experiences source of self-efficacy was not found to be a statistically significant predictor of whether participants were placed in remedial courses in mathematics or college-level courses in mathematics in all of the binary logistic regression models where the vicarious experiences explanatory variable was considered ($p > .05$, see Appendix G for a complete list of all of the regression models). Generally, this coefficient was positively correlated with the binary response variable, implying that on average, holding all other variables constant, participants who had higher composite scores within the vicarious experiences source of self-efficacy were more likely to be placed in a college-level course instead of a remedial course in mathematics. However, since the coefficient for vicarious experiences was not statistically significant, the magnitude of this positive effect was found to be marginal.

Verbal persuasion. The verbal persuasion source of self-efficacy was not found to be a statistically significant predictor of whether participants were placed in remedial courses in
mathematics or college-level courses in mathematics in all of the binary logistic regression models where the verbal persuasion explanatory variable was considered \((p > .05, \text{see Appendix G for a complete list of all of the regression models})\). The results show that this coefficient generally was positively correlated with the binary response variable, implying that on average, holding all other variables constant, participants who had higher composite scores within the verbal persuasion source of self-efficacy were more likely to be placed in a college-level course instead of a remedial course in mathematics. However, since the coefficient for verbal persuasion was not statistically significant, the magnitude of this positive effect was found to be marginal.

**Physiological and emotional reactions.** The physiological and emotional reactions source of self-efficacy was found to be a statistically significant predictor of whether participants were placed in remedial courses in mathematics or college-level courses in mathematics in all of the binary logistic regression models where the physiological and emotional reactions explanatory variable was considered \((p < .05)\). The findings show that this coefficient was generally negatively correlated with the binary response variable, implying that on average, holding all other variables constant, participants who had higher physiological and emotional reactions composite scores were less likely to be placed in a college-level course in mathematics instead of a remedial course in mathematics.

A binary logistic regression model (see Table 5, Model 4) revealed that the explanatory variable for physiological and emotional reactions was a statistically significant predictor of whether participants were placed in remedial or college-level courses in mathematics (Cox & Snell \(R^2 = .17\), Nagelkerke \(R^2 = .23\), \(p < .05\)). The Cox and Snell \(R^2\) and the Nagelkerke \(R^2\) values indicated that between 17\% and 23\% of the variations in participants’ placement test results could be explained by variations in participants’ physiological and emotional reactions.
composite scores. Due to the low R Square measures of accuracy found in this model, the physiological and emotional reactions explanatory variable was a less strong predictor than the performance experiences explanatory variable of whether participants were placed in remedial courses in mathematics or college-level courses in mathematics.

Table 5

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Model 4</th>
<th>$e^B$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physiological and emotional reactions</td>
<td>-0.12***</td>
<td>0.89</td>
</tr>
<tr>
<td>Cox &amp; Snell $R^2$</td>
<td>.17</td>
<td></td>
</tr>
<tr>
<td>Nagelkerke $R^2$</td>
<td>.23</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>191</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* $e^B$ = exponentiated $B$.

*$p < .05$. **$p < .01$. ***$p < .001$

**Full model: multiple sources of self-efficacy.** A binary logistic regression model (see Table 6, Model 20) revealed that the explanatory variables for performance experiences and physiological and emotional reactions were still both statistically significant predictors of whether participants were placed in remedial or college-level courses in mathematics, even after controlling for the other sources of self-efficacy and controlling for demographic variables (Cox & Snell $R^2 = .42$, Nagelkerke $R^2 = .56$, $p < .05$). The Cox and Snell $R^2$ and the Nagelkerke $R^2$ values indicated that between 42% and 56% of the variations in participants’ placement test results could be explained by variations in all of the explanatory variables that were included in the regression model. The coefficient of the explanatory variable performance experiences had a value of 0.201. According to the odds ratio indicated by this exponentiated coefficient ($e^B = 1.223$ from Model 20 in Table 6), on average, after controlling for participants’ demographic variables and after controlling for all three other sources of self-efficacy considered as
explanatory variables, each point accrued in the performance experiences composite score affected the likelihood of being placed in a college-level course instead of a remedial course in mathematics by a factor of 1.223. In other words, when participants’ composite scores for performance experiences increased by one point, the likelihood of participants being placed in college-level courses in mathematics instead of remedial courses in mathematics increased by about 22.3% (see Model 20 in Table 6). In addition, the coefficient of the explanatory variable physiological and emotional reactions had a value of –0.089. According to the odds ratio indicated by the exponentiated coefficient from Model 20 ($e^B = 0.915$ in Table 6), on average, after controlling for participants’ demographic variables, and after controlling for all three other sources of self-efficacy considered as explanatory variables, each point accrued in the physiological and emotional reactions composite score affected the likelihood of being placed in a college-level course instead of a remedial course in mathematics by a factor of 0.915. In other words, when participants’ composite scores for physiological and emotional reactions increased by one point, the likelihood of participants being placed in college-level courses in mathematics instead of remedial courses in mathematics decreased by about 8.5% (see Model 20 in Table 6). The odds ratio of $e^B = 0.915$ indicated a factor of less than 1.0 (100%). Therefore, the percentage of the decrease in likelihood was equal to $1.0 – 0.915 = 0.085$, which corresponded to an 8.5% decrease.
Table 6

Summary of Logistic Regression Analysis for Variables Predicting Placement Test Results Based on Four Sources of Self-efficacy, Controlling for Gender, Ethnicity, and Parent’s or Guardian’s Level of Education

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>B</th>
<th>Model 20</th>
<th>( e^B )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Experiences</td>
<td>0.20***</td>
<td>0.06</td>
<td>1.22</td>
</tr>
<tr>
<td>Vicarious Experiences</td>
<td>0.00</td>
<td>0.07</td>
<td>1.00</td>
</tr>
<tr>
<td>Verbal Persuasion</td>
<td>0.04</td>
<td>0.04</td>
<td>1.04</td>
</tr>
<tr>
<td>Physiological and Emotional Reactions</td>
<td>–0.09**</td>
<td>0.03</td>
<td>0.92</td>
</tr>
<tr>
<td>Gender(^a)</td>
<td>–0.85*</td>
<td>0.43</td>
<td>0.43</td>
</tr>
<tr>
<td>White(^b)</td>
<td>0.83</td>
<td>1.25</td>
<td>2.30</td>
</tr>
<tr>
<td>Black(^b)</td>
<td>0.37</td>
<td>1.25</td>
<td>1.45</td>
</tr>
<tr>
<td>American Indian or Alaskan Native(^b)</td>
<td>1.42</td>
<td>1.60</td>
<td>4.12</td>
</tr>
<tr>
<td>Asian(^b)</td>
<td>0.06</td>
<td>1.48</td>
<td>1.07</td>
</tr>
<tr>
<td>Latino(^b)</td>
<td>0.48</td>
<td>1.28</td>
<td>1.61</td>
</tr>
<tr>
<td>Parent Edu: Middle School(^c)</td>
<td>–1.38</td>
<td>0.79</td>
<td>0.25</td>
</tr>
<tr>
<td>Parent Edu: High School(^c)</td>
<td>0.88</td>
<td>0.72</td>
<td>2.40</td>
</tr>
<tr>
<td>Parent Edu: College(^c)</td>
<td>0.42</td>
<td>0.76</td>
<td>1.52</td>
</tr>
<tr>
<td>Parent Edu: Graduate School(^c)</td>
<td>–0.11</td>
<td>0.92</td>
<td>0.89</td>
</tr>
<tr>
<td>Constant</td>
<td>–3.77</td>
<td>2.05</td>
<td>0.02</td>
</tr>
<tr>
<td>Cox &amp; Snell ( R^2 )</td>
<td>(.42)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nagelkerke ( R^2 )</td>
<td>(.56)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( N )</td>
<td>191</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. \( e^B \) = exponentiated \( B \).

\(^a\) Gender was coded as 1 = male, 0 = female.
\(^b\) Ethnicity variables are coded as 0 = the participant was not the ethnicity specified, 1 = the participant was the ethnicity specified. The excluded factor level for this dummy variable is the response of “Other.”
\(^c\) Parent’s or guardian’s level of education variables are coded as 0 = the participant’s parent or guardian has not attained this education level specified as highest, 1 = the participant’s parent or guardian has attained this education level specified as highest. The excluded factor level for this dummy variable is the response of “Elementary School,” which was the lowest level of education available among the options presented to participants.

\( *p < .05. \quad **p < .01. \quad ***p < .001 \)

It is important to note that Chi-square tests of independence had revealed that gender was not a statistically significant predictor of placement test results, \( \chi^2 (1) = 2.68, p = .102 \), and parent’s or guardian’s level of education was a statistically significant predictor of placement test results, \( \chi^2 (4) = 22.33, p < .001 \) (see Table E1 in Appendix E and Table E3 in Appendix E).

However, based on Regression Model 20 in Table 6, after controlling for the four sources of self-efficacy and after controlling for the other demographic variables, gender became a statistically significant predictor of whether participants were placed in remedial courses in mathematics or college-level courses in mathematics (\( p < .05 \)) and parent’s or guardian’s level of education was no longer a statistically significant predictor of whether participants were placed in remedial...
courses in mathematics or college-level courses in mathematics ($p > .05$). This change in statistical significance could be best explained by the presence of collinearity, or interaction between explanatory variables. Collinearity occurs when two or more explanatory variables are closely related (i.e., the value of one explanatory variable is related to the value of another explanatory variable). In this study, gender may have been correlated with one or more of the other explanatory variables, even to a small degree, thus affecting the significance of its effect on placement test results.

Gender was not significantly correlated with any of the four sources of self-efficacy ($p > .05$, see Table F1 in Appendix F). Nevertheless, the mean performance experiences source of self-efficacy was found to be slightly higher for females ($M = 24.86, SD = 6.45$, see Table F1 in Appendix F) as compared to males ($M = 24.59, SD = 6.32$, see Table F1 in Appendix F). In addition, the mean physiological and emotional reactions source of self-efficacy was found to be slightly lower for females ($M = 19.29, SD = 8.03$, see Table F1 in Appendix F) as compared to males ($M = 19.32, SD = 8.06$, see Table F1 in Appendix F). Furthermore, the mean scores for vicarious experiences were found to be higher for females ($M = 25.85, SD = 4.76$, see Table F1 in Appendix F) than for males ($M = 25.69, SD = 5.04$, see Table F1 in Appendix F), and the mean scores for verbal persuasion were found to be higher for females ($M = 24.96, SD = 7.17$, see Table F1 in Appendix F) than for males ($M = 24.42, SD = 7.41$, see Table F1 in Appendix F).

The binary logistic regression models have concluded that a higher level of performance experiences and a lower level of physiological and emotional reactions both lead to higher performance on placement tests in mathematics showing that these results are significant ($p < .05$, see Model 20 in Table G10 in Appendix G). In addition, it was found that a higher level of vicarious experiences and a higher level of verbal persuasion both lead to higher performance on
placement tests in mathematics, although these results were not significant ($p > .05$, see Model 20 in Table G10 in Appendix G). Therefore, although the differences in the sources of self-efficacy were not found to be statistically significant between males and females individually, the small differences in multiple explanatory variables taken as an aggregate may in fact indicate that in general, females are more likely to be placed in college-level courses instead of remedial courses in mathematics than their male counterparts. These significant differences apply only after holding other variables constant (i.e., demographic variables of ethnicity and parent’s or guardian’s level of education, as well as explanatory variables of all four sources of self-efficacy). Considering the potential collinearity effects, this aggregated combination of factors helps to better explain the significance of the gender variable in the binary logistic regression models. The theoretical implications of these demographic effects will be discussed in Chapter 5.

**Summary**

Using survey data collected from recent urban high school graduates who had taken the mathematics portion of a Massachusetts community college placement test, this study examined the relationship between the four sources of efficacy and whether participants were placed in remedial courses in mathematics or college-level courses in mathematics. After all of the binary logistic model assumptions were met, and all of the Chi-square test of independence, independent samples t-test, and ANOVA assumptions were met or handled, the study revealed that only two of the four sources of self-efficacy, performance experiences and physiological and emotional reactions, were found to be statistically significant predictors of whether participants were placed in remedial courses in mathematics or college-level courses in mathematics ($p < .05$). The other two sources of self-efficacy, vicarious experiences and verbal persuasion, were found not to be statistically significant predictors of whether participants were placed in remedial
courses in mathematics or college-level courses in mathematics \((p > .05)\). In summary, these results supported the study’s hypothesis in part and failed to support the study’s hypothesis in part. In addition, Chi-square tests of independence revealed that: (a) gender was not significantly correlated with placement test results; (b) ethnicity was not significantly correlated with placement test results; and (c) parent’s or guardian’s level of education was significantly correlated with placement test results. Furthermore, after controlling for the four sources of self-efficacy and for the other demographic variables, gender became statistically significant regarding whether participants were placed in remedial courses in mathematics or college-level courses in mathematics \((p < .05)\). Also, parents’ or guardians’ level of education was no longer a statistically significant predictor regarding whether participants were placed in remedial courses in mathematics or college-level courses in mathematics \((p > .05)\). The theoretical explanations and implications of these demographic effects will be discussed along with the rest of this study’s findings in Chapter 5.
Chapter 5: Discussion of Research Findings

The overriding aim of this quantitative study was to determine the relationship between each of the four sources of self-efficacy and student community college mathematics placement test performance. Through binary logistic regression tests, the research further determined any associations between the independent variables (i.e., composite scores of the four sources of self-efficacy) and the dependent variable (i.e., whether participants were placed in remedial courses in mathematics or college-level courses in mathematics). In addition, Chi-square tests of independence, independent samples t-tests and analyses of variance (ANOVAs) were used to identify the differences, if any, in the four sources of self-efficacy among the different demographic groups.

This chapter discusses the study’s findings in five sections. The first section provides the results and examines how the four sources of self-efficacy converge to or diverge from the theoretical framework and the results from the extant literature review. The second section discusses the implications for theory, research, and practice. The third section presents limitations. The fourth section provides recommendations for areas of further research based on the study’s findings. The last section presents the study’s conclusions.

Results and Discussion of the Research Question

According to the binary logistic regression models used in this study, three explanatory variables were identified as significant predictors of placement test results, including performance experiences, physiological and emotional reactions, and gender ($p < .05$, see Model 20 in Table G10 in Appendix G). Furthermore, the Chi-square tests of independence had revealed that parent’s or guardian’s level of education was a statistically significant predictor of placement test results, $\chi^2 (4) = 22.33, p < .001$ (see Table E1 in Appendix E and Table E3 in
Appendix E). Results from the extant empirical studies, examined in Chapter 2, revealed evidence that each of the four sources of self-efficacy generally is a strong predictor of mathematics achievement. However, the results of this study show that a significant relationship was found between only two of the four sources of self-efficacy as they relate to college students’ performances on math placement tests. Performance experiences, physiological and emotional reactions, and gender showed a significant relationship to students’ placement test results, while vicarious experiences and verbal persuasion did not show a significant relationship to students’ placement test results leading to the conclusion that the hypothesis is supported in part and unsupported in part. Forthwith, the researcher will analyze the results of this study in the context of the four sources of self-efficacy.

**Performance experiences.** The results of this study, which deal with performance experiences, confirmed Bandura’s theory (1977, 1986, 1997) as well as studies by Emmett et al. (2014), which found that improved performance experience is directly linked to students’ improved performance in mathematics. The study results also supported a study by Andrade et al. (2009) that demonstrated increased performance experiences when elementary and middle school students practiced extensively. These results were also consistent with the findings of Hailikari et al. (2008), wherein they found a direct relationship between prior success in mathematics courses and predictable student achievement in college level mathematics. These findings are also consistent with a study by Middleton and Spanias (1999), who found that students that develop an interest in mathematics through effective learning experiences predictably attain mastery of the subject matter.

By way of explanation for the results of these studies, some educational psychologists believe that mathematical activities likely represent real challenges, which increase intrinsic
motivation, foster the sense of accomplishment when the tasks are solved, and lead to the
development of positive attitudes towards mathematics (Schiefele & Csikszentmihalyi, 1995). Bandura (1997) stated the development of internal competencies necessitates continued involvement in activities. When the conditions are well structured, these activities enable individuals to accumulate intrinsic interest and efficacy. Conversely, when failures continue to be exhibited, students lose interest in challenging activities such as mathematics (Pajares & Schunck, 2001). For students with low performance in mathematics, tasks are likely experienced as too challenging for the minimal success it yields leading to low self-belief in abilities and negative attitudes towards mathematics (Klinger, 2006). As such, the aforementioned studies supported the findings of this study.

On the other hand the results of this research disagreed with Norwich (1987) who assessed self-efficacy repeated-measures designed for 72 children, aged 9-10 years old. The researcher investigated the relationship between self-efficacy and mathematics achievement including self-concept of math ability, prior task achievement, and prior self-efficacy. Norwich found that regression analysis suggested small or no predictive relationship between self-efficacy and task performances, particularly when other factors were integrated in the analysis. In another study where experimental evaluation was used to improve career decision-making, Dawes et al. (2000) found no significant impact on performance experience on self-efficacy in middle school technology students. One possible explanation for this disagreement in findings could potentially be how the term performance experiences has been defined, studied, and measured by various researchers. For example, this research study used the Sources of Middle School Mathematics Self-Efficacy survey developed by Usher and Pajares (2009) and did not embed any other factors within the performance experience. However, Norwich focused on a much younger population
than the one involved in the current study. Additionally, Dawes et al. used self-efficacy in an experimental methodology.

**Physiological and emotional reactions.** The results of this study which deal with physiological and emotional experiences confirmed Bandura’s theory (1977, 1986, 1997), as well as previous studies by Close and Solberg (2008), which found that students who reported higher self-efficacy beliefs described less physical and psychological distress and showed higher levels of mathematics achievement. Additionally, the findings also supported a study by Vukovic et al. (2013) who established that a reduction in physiological and emotional anxiety coupled with more parental involvement improved student performance in mathematics. The results of this study also supported Usher and Pajares (2009) who discovered that physical anxiety, due to students’ fearful attitudes and past negative experiences toward mathematics, resulted in lower performance scores. In his study, Mandler (1989) posited that students’ negative attitudes toward mathematics are a result of frequent failures, further supporting Usher and Pajares’ findings.

The results of this study and the research indicate that physiological and emotional reactions have an impact on learners’ math performance. Ashcraft and Krause (2007) found that poor mathematical knowledge and low course grades correlated directly with students’ anxiety levels, which in turn led to continually poor mathematics performance scores. Math anxiety can develop at any age, which makes it difficult to determine when intervention measures should be implemented (Geist, 2010). In their study, Young, Yu and Menon (2012) noted that students with math anxiety usually do not present with any anxiety or disorder; their poor math performance is the result of an interruption in the working memory in the brain. Physiologically, any math activity triggers an increase of heart rate, sweating, and discomfort and consequently, students learn to avoid math activities to alleviate their discomfort (Lyons & Beilock, 2012). Sparks
(2011) posited that students’ math anxiety is compounded when their teachers also have math anxiety. With teachers representing both the solution and potential cause of math anxiety, further attempts to help students be successful could be complicated.

Conversely, results of this research disagree with findings by Cates and Rhymer (2003) who stated that anxiety, as part of physiological and emotional experience, had little effect on the relationship between mathematics anxiety and performance. Cates and Rhymer investigated the relationship between mathematics anxiety, fluency, and error rates in basic mathematical operations among college students. One explanation for the difference could be that Cates and Rhymer’s study utilized anxiety as a stand alone construct, while this study utilized a psychological and emotional construct which included psychosomatic symptoms such as anxiety, pain, or fatigue as defined by Bandura (1997).

**Vicarious experiences.** In this study, the vicarious experiences source of self-efficacy was inconsistent in showing a correlation with whether students are placed in remedial or college level mathematics courses. The results of this research were consistent with a previous study conducted by Lent, Lopez, and Bieschke (1991) in which the authors found that vicarious experiences did not significantly account for additional variances in mathematics self-efficacy, which occurred only after controlling for performance experience. Other researchers found that vicarious experiences have a *slightly* positive impact on the development of self-efficacy, but this was often found to be a weak source of self-efficacy as compared to performance experiences and physiological and emotional experiences (Loo & Choy, 2013).

Usher and Pajares (2009) cautioned that the vicarious experiences source of self-efficacy may boost the mathematics efficacy beliefs of some students while lowering the beliefs of other students. However, there was not a significant correlation between the vicarious experiences
source of self-efficacy and the mathematics performance of urban high school graduates who were entering community college. Additionally, the findings did not agree with Bandura’s (1977) hypothesized theory of self-efficacy in terms of vicarious experiences. The results of this study stem from the fact that urban students who hail from a low socioeconomic status lack the vicarious experiences such as competent math peers or family members who pursue STEM majors (Leslie, McClure, & Oaxaca, 1998).

The outcomes also contradict findings by Noble’s (2011) biographical study on the impact of self-efficacy and mathematics performance with college students. Noble found that vicarious experiences were significant where students observed the achievements of their peers and developed the confidence to attempt similar tasks. Noble’s findings are interesting given that they contradict with this study, a phenomenon that may be explained by the sample size used ($N=6$) and the methods that were performed. The participants of Noble’s study were part of a cohesive group of students who regularly competed with one another and relied upon this competition for status as high African American achievers in mathematics. In contrast, this study’s results were generated through quantitative methods with a significantly larger sample size of urban high school graduates.

**Verbal persuasion.** While the results of this study that dealt with verbal persuasion do not confirm Bandura’s theory (1977, 1986, 1997), these results do confirm studies about the ineffectiveness of verbal persuasion. Verbal persuasion is more effective when used with other methods of enhancing self-efficacy since the positive feedback can help student achievement (Goddard et al., 2000; Hoy, Sweetland, & Smith, 2002). However, this study’s results contradict a study by Hill et al. (2004) who found that parents who gave their children verbal persuasion and encouragement in mathematical achievement not only increased their children’s aspirations,
but also improved behavior and increased achievement. Likewise, in a 2002 study, Walker observed that parents, teachers, and peers played an essential role in inspiring students to achieve academic success, and when parents shared the notion of high expectations with their children, mainly in mathematics, those children thrived and improved their mathematics skills. A study by Siegle and McCoach (2007) also found that mathematics teachers’ encouragement and persuasion, particularly specific compliments for achieving specific tasks in mathematics, do have a positive impact on a student’s performance. The contradiction between the aforementioned studies and the findings of the verbal persuasion portion of this study might be explained by the lack of attention and encouragement from students’ teachers in urban schools (Ferguson 2002; Hackett & Betz, 1989) particularly in the subject of mathematics.

Additionally, Bandura (1986) was wary of positive findings about verbal persuasion and stated, “[Verbal persuasion] contributes to successful performance if the heightened appraisal is within realistic bounds” (p. 400). As such, another explanation for the disagreement of the findings of this study could potentially be that for the majority of study participants, verbal persuasion was either lacking or not implemented within realistic bounds, such as complementing students on general academic performance instead of specific tasks. Schunk (1989a) found that the short-term effects of persuasion must be accompanied with actual successes. Parent or guardian and teacher credibility is also an important factor with verbal persuasion (Hill et al., 2004). Students experience greater benefits in self-efficacy when individuals believed to be trustworthy persuade them (Siegle & McCoach, 2007).

**Demographic Variables Effects.**

**Gender.** Without considering any other demographics and without considering the effects of the sources of self-efficacy, a model with gender as the only explanatory variable (i.e.,
a Chi-square test of independence) showed that gender was not significantly correlated with participants’ placement test results, meaning that the likelihood of being placed in a remedial course or a college-level course in mathematics is not generally driven by gender ($\chi^2 (1) = 2.68$, $p = .102$, see Table E1 in Appendix E). This result indicated that in general, a randomly selected male had approximately the same likelihood of being placed in a remedial course or college-level course as does a randomly selected female. This result is in agreement with current trends in the literature in which researchers have concluded that gender is not a factor in student mathematics performance and the gender gap has closed in recent years (Hyde et al., 2008; Lindberg et al., 2010). This portion of the findings is also in agreement with Mullis, Martin, and Foy (2008) who indicated that although females often outperform males at an early age, this performance tended to disappear at the high school level (Mullis et al., 2008). In addition, Dalton, Ingels, Downing, and Bozick (2007) indicated that high school students who have taken more courses in mathematics have shown no differences in performance between genders.

In contrast, after inclusion into models that considered multiple variables (i.e., the binary logistic regression models), gender became a significant explanatory variable in predicting placement test results ($p < .05$, see Model 20 in Table G10 in Appendix G). The change in the significance of the effect of gender on placement test results, which was found after controlling for the four sources of self-efficacy and the other demographic variables of ethnicity and parent’s or guardian’s level of education, indicated that if one were to randomly select one male and one female who both had the same ethnicity, the same parent’s or guardian’s level of education, and the same composite scores for each of the four sources of self-efficacy, the male would be significantly more likely than the female to be placed in a remedial course instead of a college-level course in mathematics. For example, according to a study by Shettle et al. (2007) that
collected data over the course of 15 years and merged data with the High School Transcript Study (HSTS) (National Assessment of Educational Progress (NAEP), 2005b), females outperformed their male counterparts in mathematics. Interestingly, Pajares (1996b) reported that though girls received higher mathematics scores on problem solving than boys did, their overall self-efficacy was lower.

To summarize, gender was not found to be significantly correlated with placement test results in a single-variable test (i.e., a Chi-square test of independence); however, gender was found to be significantly correlated with placement test results in multiple-variable tests (i.e., the binary logistic regression models). This change in statistical significance could be best explained by the presence of collinearity, or interaction between explanatory variables. Collinearity occurs when two or more explanatory variables are closely related (i.e., the value of one explanatory variable is related to the value of another explanatory variable). Based on Creswell (2012), it can be concluded that in this study, gender may be acting as a mediating or intervening variable, which “stands between the independent and dependent variables and influences both of them” (p. 348). In fact, it does not take very much correlation between explanatory variables in a binary logistic regression model for there to be collinearity effects between explanatory variables. For example, the correlation between gender and the four sources of self-efficacy, although not significant when taken individually or as a whole ($p > .05$, see Table F1 in Appendix F), may have affected the significance of other explanatory variables included in the binary logistic regression model (Lo, Li, Tsou, & See, 1995). In this study, gender may have been correlated with one or more of the other explanatory variables, even to a small degree, thus affecting the significance of its effect on placement test results.
More specifically, as explained in Chapter 4, the mean scores for performance experiences, vicarious experiences, and verbal persuasion all were found to be slightly higher among female participants as compared to male participants, although none of these differences were statistically significant. In addition, the mean scores for physiological and emotional reactions were found to be slightly lower among female participants as compared to male participants, although this difference was not statistically significant. The positive or negative direction of each of these differences correlated with increases in performance on mathematics placement tests. Therefore, these differences, although insignificant when taken individually, resulted in females outperforming males in placement test performance when considered in aggregate.

**Parent’s or guardian’s level of education.** Without considering any other demographics and without considering the effects of the sources of self-efficacy, a model with parent’s or guardian’s level of education as the only explanatory variable (i.e., a Chi-square test of independence) showed that parent’s or guardian’s level of education was significantly correlated with participants’ placement test results, meaning that the likelihood of being placed in a remedial course or a college-level course in mathematics is significantly different for students whose parents or guardians have different levels of education ($\chi^2 (4) = 22.33, p < .001$, see Table E3 in Appendix E). More specifically, the results of this study reveal that the likelihood of being placed in a college-level course in mathematics as opposed to a remedial course in mathematics is significantly lower for participants whose parents or guardians had only attained an education level of middle school or lower, as compared to those respondents whose parents or guardians had attained an education level of high school or higher. This result is consistent with the literature, which emphasizes the significant role of parents’ or guardians’ level of education and
its impact on their children’s mathematics performance (Smith, Brooks-Gunn, & Klebanov, 1997; Jordan, Kaplan, Locuniak, & Ramineni, 2007). One explanation of such phenomenon could be that students who hailed from low SES with less educated parents or guardians are often not surrounded by inspirational adult role models and as such tend to emulate individuals which may have a negative impact on their learning experience (Jeynes, 2002). Other studies found that highly educated parents, due to their increased parental involvement and high academic expectations for their children, have a positive influence on their children’s academic achievement (Topor, Keane, Shelton, & Calkins, 2010) and mathematics performance in particular (Eccles, Jacobs, & Harold, 1990).

In contrast, after inclusion into models that consider multiple variables (i.e., the binary logistic regression models), parent’s or guardian’s level of education actually became an insignificant explanatory variable in predicting placement test results ($p > .05$, see Model 20 in Table G10 in Appendix G). The change in the significance of the effect of parent’s or guardian’s level of education on placement test results, which was found after controlling for the four sources of self-efficacy and the other demographic variables of gender and ethnicity, indicated that if one were to randomly select two students who both had the same gender, the same ethnicity, and the same composite scores for each of the four sources of self-efficacy, the students would both have the same likelihood of being placed in a remedial course instead of a college-level course in mathematics, regardless of their parents’ or guardians’ level of education. This portion of the findings is in agreement with the literature, in which researchers have suggested that the relationship between parental involvement and mathematics achievement is not significant (Mattingly, Prislin, McKenzie, Rodriquez, & Kayzar, 2002). The inconsistency in findings could be due to the type of research assessed and the various ways in which parental
influence and mathematics research has been conducted. In fact, Mattingly et al. (2002) recognized that their data and techniques were not sufficiently rigorous including evaluation design and data collection techniques.

To summarize, participants’ parent’s or guardian’s level of education was found to be significantly correlated with placement test results in a single-variable test (i.e., a Chi-square test of independence); however, participants’ parent’s or guardian’s level of education was found to not be significantly correlated with placement test results in multiple-variable tests (i.e., the binary logistic regression models). This change in statistical significance could be best explained by the presence of collinearity, or interaction between explanatory variables, in which case parent’s or guardian’s level of education is correlated with one or more of the other explanatory variables, thus affecting the significance of its effect on placement test results. For example, it was found that parent’s or guardian’s level of education was significantly correlated with three of the four sources of self-efficacy: (a) performance experiences ($F(4, 186) = 6.27, p < .001$, see Table F5 in Appendix F), (b) vicarious experiences ($F(4, 186) = 2.94, p = .022$, see Table F5 in Appendix F), and (c) verbal persuasion ($F(4, 186) = 3.55, p = .008$, see Table F5 in Appendix F). Due to these significant relationships between these variables, much of the effect that parent’s or guardian’s level of education had on placement test results was shifted to be better explained by the four sources of self-efficacy instead. This means that after considering the four sources of self-efficacy, a participant’s parent’s or guardian’s level of education did not offer any new information regarding their likelihood to be placed in remedial or college-level courses in mathematics.
Research Implications

Implications for theory. The research results helped clarify that certain self-efficacy factors correlated with certain types of mathematics performance while others did not. As such, the findings disproved blanket statements that self-efficacy correlates with performance (Bandura, 1977, 1986, 1997).

Implications for research. These research results failed to prove that all of the four sources of self-efficacy correlate with student mathematics placement test performance; however, the findings do indicate which factors play an important role in college mathematics placement test performance. As such, future research should be conducted to determine why some of the sources of self-efficacy correlate with mathematics performances while others do not. For example, under what circumstances could vicarious experience have an influence on student’ mathematics performances? Or under what circumstances, if any, could verbal persuasion lead to improved student mathematics test performance?

Implications for practice. In order to improve recent high school graduates’ college placement test scores, which are based upon this study’s findings that performance experiences correlate strongly with mathematics achievement, the author suggests that curriculum developers should bear in mind performance experiences in designing mathematics curricula. Since it was concluded in the regression models that performance experiences play a significant role in whether a recent urban high school graduate will be placed in a remedial or college level mathematics courses, it is clear that students rely heavily on confidence in their knowledge and skills for becoming better prepared for community college placement tests. For instance, when students are engaged in certain math tasks or assessments, they mainly use their accumulated learning from their previous experiences. Unfortunately, these students come to the classroom
with inadequate prior knowledge to decipher these instructions and the new knowledge (Fay, Bickerstaff, & Hodara, 2013). In addition, educators and curriculum developers often make the assumption that students come to class already possessing the skills and information to succeed. However, teachers and curriculum developers should include revisions of previous topics in their instructions and textbooks before tackling new concepts in mathematics. When students recognize previous knowledge progressively, it tends to give them confidence in their abilities in accomplishing tasks and increases their self-efficacy at all grade levels of high school education (Loo & Choy, 2013).

Given the importance of physiological and emotional reactions, all stakeholders involved in the education of urban high school graduates entering community colleges should encourage students to prepare well for placement tests to avoid the interference of physiological and emotional feelings. Usher and Pajares (2008) remarked that a positive mood accompanied by academic success could provide increases in personal efficacy beliefs. In his study, Plaisance (2009) noted that anxiety could be lessened when students walk in with confidence and an “I can do this” attitude by employing meditation. Providing students with ample time to complete certain assignments or tests and reassuring students by utilizing alternative testing opportunities may also lessen their heightened anxiety (Beilock, 2008). Cavanaugh (2007) suggested taking many practice exams to acclimate to mathematics problems as another way to lessen anxiety. In this way teachers are providing students more opportunities to master ideas and to consistently experience mathematical success. Zimmerman and Kitsantas (2005) recommended incorporating rote activities like repetitive homework, which they found to be related to increased self-efficacy. Furthermore, teachers should explain to their students that anxiety is a beneficial sign for a better performance when the assessment can be seen as a challenge rather a threat (Mattarella-Micke,
Mateo, Kozak, Foster, & Beilock, 2011). When emotional-physiological states are interpreted as challenging experiences, then self-efficacy beliefs should be positively influenced (Bandura, 1997).

Researchers have surmised that teachers need to instill confidence in students’ abilities such as complimenting their competence with praise (Usher & Pajares, 2008). However, in this study, social and persuasive experiences were not found to be a strong predictor of students’ performance on community college placement tests in mathematics. Based on the findings of this study, the researcher suggests that teachers, educators and parents should not rely solely on social and persuasive experiences to help the learning process in the subject of mathematics; instead, stakeholders should appraise and complement students on specific tasks within realistic bounds. In addition, teachers should give the students clear and constructive feedback, which may be the most over-looked strategy that an instructor can utilize (Schraw & Brooks, 1999). For example, if a student needs more practice with solving quadratic equations, a teacher can point out that the student did a great job using arithmetic operations, but an appropriate method should be utilized to obtain the correct solution.

The results of this study showed that vicarious experiences were not demonstrated in this study to be a strong predictor of students’ performances on community college placement tests in mathematics. However, it is recommended for teachers to shift their attention to more productive activities in the classroom that better influence students’ performance. For example, teachers should assign high achievers to serve as alternative teachers in classroom, because often these peers are more able to assess what sort of explanation struggling students would best understand (Schunk, 1989).
As previously mentioned, parents and guardians play an important role in their children’s academic performance. School administrators and teachers could educate students’ parents or guardians regarding the importance of their involvement. This may be accomplished by inviting them to school to address concerns and provide strategies on how to help their children. Administrators and teachers may provide workshops to parents or guardians. For example, they could offer training for parents or guardians on how to use the Internet to check their children’s progress reports or to obtain mathematics resources and information. In order to solicit parents or guardians to buy in into these workshops, administrators should accommodate their schedules and incentivize them through raffles, snacks, or gift cards.

**Research Limitations**

Although this research is based on a well-recognized theory, there are limitations in this research that should be considered and discussed. First, the research conclusions are limited since the data is specific to a certain group of participants, setting and methodology, and time period. In this particular study there were 191 recent urban high school graduates who had taken the mathematics portion of a Massachusetts community college placement test in 2014 and 2015; thus, the study may not be generalized to other communities that are not urban, not of low socioeconomic status, not entering community colleges, and geographically not located in Massachusetts.

Secondly, as is true in most studies that involve a survey instrument, this study relied on the respondents’ honesty in their opinions, self-perceptions, and thoughtful considerations regarding each statement posed in the survey. Every response to every statement was a self-reported response recorded by the participants. The study depended upon the honesty of respondents, and this factor might slightly impact the accuracy of participants’ responses. While
this limitation could not be avoided completely, to help mitigate this potential problem, an email was sent to all respondents via SurveyMonkey to instruct respondents of the importance of the study and to honestly answer each question and statement to the best of their recollections.

Lastly, another limiting factor of this research is the inherent nature of the quantitative statistical analysis that was performed. The analysis, including the multiple linear regressions, was able to confirm that the explanatory variables for performance experiences and physiological and emotional reactions were statistically significant predictors of whether participants were placed in remedial or college-level mathematics courses. This does not mean, however, that the relationship is causal. For example, while this research found a correlation between two sources of self efficacy and student mathematics placement tests, it is not definitive that any of the performance experiences and physiological and emotional reactions caused better student mathematics performance on placement tests. Experimental research would be needed to help determine the degree of causality between any of the variables identified in this study and urban student with low SES performance in mathematics placement tests.

**Recommendations for Future Research**

Additional research is needed to confirm and advance the understanding of each of the four sources of self-efficacy and their relationship with mathematics performance at the college level. It would be useful to replicate and extend the findings to other populations, such as a homogeneous group or private, nonurban school setting. The focus of this study was on recent urban high school graduates who were of a low socioeconomic status. It would be helpful to investigate theories on the four sources of self-efficacy with a homogenous population to avoid the effects of confounding variables such as students’ ethnicities and socioeconomic statuses. While this study focused on recent urban high school graduates of low socioeconomic status in
Massachusetts, it would be useful to consider recent nonurban high school graduates who have a high socioeconomic status to determine if the sources of self-efficacy are an indication of community college placement test performance among non-urban graduates.

Furthermore, an experimental quantitative study may be helpful in determining the differences in student performance in regard to specific interventions that seek to improve the four sources of self-efficacy among the participants. This potential study would first measure participants’ responses to the same survey instrument used in this study and to record their sources of self-efficacy and measure the same participants’ performance on a community college mathematics placement test as a pre-test. Then, the researcher would conduct different intervention methods with participants that have been found to be effective at improving students’ sources of self-efficacy. Finally, the same participants would respond to the same survey instrument again to record their sources of self-efficacy and would take another mathematics placement test as a post-test. Through a matched-pairs statistical analysis, these potential study results might help shed light on the impact that self-efficacy improvement methods and interventions may have on students’ sources of self-efficacy in regard to their performance on community college mathematics placement tests. It would be interesting to conclude whether with individual students, marked improvement in sources of self-efficacy would lead to marked improvement in performance on community college mathematics placement tests.

The last area for future research is to explore the four sources of self-efficacy constructs from a qualitative perspective. According to Creswell (2012) this methodology should be considered and is recommended here because theoretical concepts can often be difficult, if not impossible, to observe, measure, and base conclusions. A better and more in-depth understanding
may be gained possibly via a different research approach. That is, students’ self-efficacy could be further explored through a qualitative lens because it would allow the researcher to conduct interviews in more naturalistic settings and record how the participants interpret their own self-efficacy. Interviews with urban students who are entering community college as well as interviews with focus groups could be used to potentially determine how best to help students be better prepared for mathematics placement tests given the quantitative findings from this research study. A qualitative research study may also allow researchers to discover new intrinsic and extrinsic factors influencing urban student performance through small groups of participants including parents and guardians. In short, it is recommended that qualitative research be conducted in an effort to determine how best teachers and parents or guardians can leverage the results from this quantitative study to improve urban students’ mathematics performance.

Conclusion

U.S. urban high school student graduates are lagging behind their suburban peers in mathematics achievement, particularly in their community college placement test performances (Bailey et al., 2010; Jones, 2012). As such, the purpose of this quantitative correlational study was to determine the relationship between each of the four sources of self-efficacy and college mathematics placement test performance as stated in the research question. In order to answer this question, Bandura’s four sources of self-efficacy were used as a theoretical framework.

Numerous studies have revealed that the four sources of self-efficacy strongly affect student learning outcomes in various subject areas including: student academic success (Bandura, 1977, 1986, 1997; Chen & Zimmerman, 2007; Pajares & Miller, 1997), their choices (Hackett, 1985), and on mathematics achievement (Hackett, 1986; Lent & Hackett, 1987; Hackett & Betz, 1989; Luzzo et al., 1999), during early education (Pajares, 1996; Raffini, 1993),
high school (Kitsantas et al., 2011; Trautwein et al., 2002; Xu, 2009), and at university levels (Hackett & Betz, 1989; Hailikari et al., 2008). This current study found that two of the four sources of self efficacy, performance experiences and physiological and emotional experiences, were found to be statistically significant factors that influenced the performance of recent low socioeconomic status urban high school graduates on their community college mathematics placement tests. Conversely, vicarious experiences and verbal persuasion were not found to be statistically significant factors in affecting the performance of recent urban high school graduates on community college placement tests in mathematics. Such a finding is not surprising given that the subjects involved in this study were urban, low socioeconomic status students whose parents’ or guardians’ levels of education was limited.

Based on the results of this study, which show a correlation between two sources of self-efficacy, performance experiences and physiological and emotional reactions, and students’ mathematics placement test performance, the researcher recommends that teachers in urban settings should engage students in reviewing previously learned topics in mathematics as a starting point in order to build upon what students know, to accumulate more knowledge, and to receive more complex constructs which allow them to master the subject matter (Emmett et al., 2014; Hailikari et al., 2008). Curriculum developers should include introductory examples and concepts within each chapter to facilitate the understanding of the upcoming math concepts so as to improve student understanding and performance in mathematics (Loo & Choy, 2013). Educators should find new ways to positively impact students’ physiological and emotional conditions in order to reduce stress associated with mathematics such as using various techniques in grading and assessing students. Based on the demographic results, schools should take extra time to offer training to low SES parents about the benefits of performing and excelling in
mathematics. This also will help parents to be involved in their students’ lives inside and outside the classroom, thus contributing to their children’s academic success (Hancock, 1999). Finally, the results of this study indicate: (a) that future researchers should attempt to duplicate these findings using a homogeneous population in order to expand the generalizability of these research findings; (b) an experimental study with a pretest and posttest should be used to compare the influence of the forces of self-efficacy on students’ performance in mathematics; and (c) qualitative research through small groups of participants including parents and guardian would help to obtain a better interpretation of the constructs of the forces of self-efficacy and its impact academic performance.

To conclude, it is the hope of this researcher that the findings of this study will not only show the importance of the four sources of self-efficacy regarding students’ performance experiences and their physiological and emotional reactions, but that schools in urban districts work toward educating their teachers and parents or guardians on how to increase overall student self-efficacy with the goal of improving test performance. Finally, with each student’s best interest at hand, administrators and teachers should work closely with parents or guardians by building programs to keep parents or guardians informed and updated with their student’s performance, as well as to provide an encouraging and conducive learning environment for students.

*Self-belief does not necessarily ensure success, but self-disbelief assuredly spawns failure.*

– Albert Bandura,
Professor Emeritus of Psychology at Stanford University
References


doi:10.1037//0033-2909.107.2.139


Pape, S. J., & Smith, C. (2002). Self-regulating mathematics skills. Theory into Practice, 41, 93-


Appendix A

Survey Instrument: Self-efficacy in Mathematics Survey

1. After your math placement test, were you placed in a:
   1. Mathematics remedial course
   2. Mathematics college-level course

2. I make excellent grades on math tests. (PE)
   1. Strongly disagree
   2. Disagree
   3. Somewhat disagree
   4. Somewhat agree
   5. Agree
   6. Strongly agree

3. I have always been successful with math. (PE)
   1. Strongly disagree
   2. Disagree
   3. Somewhat disagree
   4. Somewhat agree
   5. Agree
   6. Strongly agree

4. Even when I study very hard, I do poorly in math. (PE)
   1. Strongly disagree
   2. Disagree
   3. Somewhat disagree
   4. Somewhat agree
   5. Agree
   6. Strongly agree

5. I got good grades in math on my last report card. (PE)
   1. Strongly disagree
   2. Disagree
   3. Somewhat disagree
   4. Somewhat agree
   5. Agree
   6. Strongly agree

6. I do well on math assignments. (PE)
   1. Strongly disagree
   2. Disagree
   3. Somewhat disagree
   4. Somewhat agree
   5. Agree
6. Strongly agree

7. I do well on even the most difficult math assignments. (PE)
   1. Strongly disagree
   2. Disagree
   3. Somewhat disagree
   4. Somewhat agree
   5. Agree
   6. Strongly agree

8. Seeing adults do well in math pushes me to do better. (V)
   1. Strongly disagree
   2. Disagree
   3. Somewhat disagree
   4. Somewhat agree
   5. Agree
   6. Strongly agree

9. When I see how my math teacher solves a problem, I can picture myself solving the problem in the same way. (V)
   1. Strongly disagree
   2. Disagree
   3. Somewhat disagree
   4. Somewhat agree
   5. Agree
   6. Strongly agree

10. Seeing kids do better than me in math pushes me to do better. (V)
    1. Strongly disagree
    2. Disagree
    3. Somewhat disagree
    4. Somewhat agree
    5. Agree
    6. Strongly agree

11. When I see how another student solves a math problem, I can see myself solving the problem in the same way. (V)
    1. Strongly disagree
    2. Disagree
    3. Somewhat disagree
    4. Somewhat agree
    5. Agree
    6. Strongly agree

12. I imagine myself working through challenging math problems successfully. (V)
    1. Strongly disagree
2. Disagree
3. Somewhat disagree
4. Somewhat agree
5. Agree
6. Strongly agree

13. I compete with myself in math. (V)
   1. Strongly disagree
   2. Disagree
   3. Somewhat disagree
   4. Somewhat agree
   5. Agree
   6. Strongly agree

14. My math teachers have told that I am good at learning math. (P)
   1. Strongly disagree
   2. Disagree
   3. Somewhat disagree
   4. Somewhat agree
   5. Agree
   6. Strongly agree

15. People have told me that I have a talent for math. (P)
   1. Strongly disagree
   2. Disagree
   3. Somewhat disagree
   4. Somewhat agree
   5. Agree
   6. Strongly agree

16. Adults in my family have told me what a good math student I am. (P)
   1. Strongly disagree
   2. Disagree
   3. Somewhat disagree
   4. Somewhat agree
   5. Agree
   6. Strongly agree

17. I have been praised for my ability in math. (P)
   1. Strongly disagree
   2. Disagree
   3. Somewhat disagree
   4. Somewhat agree
   5. Agree
   6. Strongly agree
18. Other students have told me that I’m good at learning math. (P)
   1. Strongly disagree
   2. Disagree
   3. Somewhat disagree
   4. Somewhat agree
   5. Agree
   6. Strongly agree

19. My classmates like to work with me in math because they think I’m good at it. (P)
   1. Strongly disagree
   2. Disagree
   3. Somewhat disagree
   4. Somewhat agree
   5. Agree
   6. Strongly agree

20. Just being in math class makes feel stressed and nervous. (PH)
   1. Strongly disagree
   2. Disagree
   3. Somewhat disagree
   4. Somewhat agree
   5. Agree
   6. Strongly agree

21. Doing math work takes all of my energy. (PH)
   1. Strongly disagree
   2. Disagree
   3. Somewhat disagree
   4. Somewhat agree
   5. Agree
   6. Strongly agree

22. I start to feel stressed-out as soon as I begin my math work. (PH)
   1. Strongly disagree
   2. Disagree
   3. Somewhat disagree
   4. Somewhat agree
   5. Agree
   6. Strongly agree

23. My mind goes blank and I am unable to think clearly when doing math work. (PH)
   1. Strongly disagree
   2. Disagree
   3. Somewhat disagree
   4. Somewhat agree
   5. Agree
6. Strongly agree

24. I get depressed when I think about learning math. (PH)
   1. Strongly disagree
   2. Disagree
   3. Somewhat disagree
   4. Somewhat agree
   5. Agree
   6. Strongly agree

25. My whole body becomes tense when I have to do math. (PH)
   1. Strongly disagree
   2. Disagree
   3. Somewhat disagree
   4. Somewhat agree
   5. Agree
   6. Strongly agree

26. What is your age?
   1. 18-20 years old
   2. 21-24 years old
   3. 25-30 years old

27. Gender:
   1. Female
   2. Male

28. Ethnicity:
   1. Black
   2. White
   3. Latino
   4. Asian
   5. American Indian or Alaskan Native
   6. Other

29. Socioeconomic Status:
   1. Free Lunch
   2. Reduced Price Lunch
   3. Full Price Lunch

30. Parent or Guardian Educational Level (highest of either parent):
   1. Elementary School
   2. Middle School
   3. High School
   4. College
   5. Graduate School
31. First Generation College Student:
   1. Yes
   2. No

PE: Performance Experiences
V: Vicarious Experiences
P: Verbal Persuasion
PH: Physiological and Emotional Reactions
Appendix B

IRB Approval

Notification of IRB Action

Date: June 15, 2015
IRB #: CPS15-05-10

Principal Investigator(s): Yufeng "Jennifer" Qian
Mustapha Benaoui

Department: Doctor of Education
College of Professional Studies

Address: 20 Belvidere
Northeastern University

Title of Project: The Impact of Self-Efficacy in Mathematics on Urban High
School Students Performance on Mathematics Placement Test

Participating Sites: N/A

Informed Consent: One (1) unsigned consent

DHHS Review Category: Expedited #6, #7
Monitoring Interval: 12 months

Approval Expiration Date: JUNE 14, 2016

Investigator’s Responsibilities:
1. Informed consent form bearing the IRB approval stamp must be used when recruiting participants into the study.
2. The investigator must notify IRB immediately of unexpected adverse reactions, or new information that may alter our perception of the benefit-risk ratio.
3. Study procedures and files are subject to audit any time.
4. Any modifications of the protocol or the informed consent as the study progresses must be reviewed and approved by this committee prior to being instituted.
5. Continuing Review Approval for the proposal should be requested at least one month prior to the expiration date above.
6. This approval applies to the protection of human subjects only. It does not apply to any other university approvals that may be necessary.

C. Randall Colvin, Ph.D., Chair
Northeastern University Institutional Review Board

Nan C. Regina, Director
Human Subject Research Protection

Northeastern University FWA #4630
Northeastern University
Institutional Review Board

ASSURANCE OF PRINCIPAL INVESTIGATOR

Investigator(s): Dr. Jennifer Yuleng Qian & Mustapha Benaoui
Title of Proposal: The Impact of Self-Efficacy in Mathematics on Urban High School Students
Performance on Mathematics Placement Test

To give assurance, please read and initial each statement, then sign below.

1. I have read and understand Northeastern University’s Policies and Procedures Concerning the Protection of Human Subjects and the Federal Wide Assurance. I give my assurance that I, and all members of the research team, will adhere to the policies in this research.

2. I assure that no participants will be recruited or enrolled, and no data will be collected, without current, written approval from Northeastern University, and other sites as required.

3. I assure that the rights and welfare of all participants will be protected according to the procedures approved for this project by the NU IRB.

4. I assure that all risks or discomforts to subjects will be clearly explained, and that I will demonstrate how risks are outweighed by potential benefits to the subject or by the importance of the knowledge to be gained.

5. I assure that the informed consent of all participants will be obtained by methods that meet the requirements of Northeastern University's policy and assurance procedures.

6. I assure that no changes in research activity will be initiated without prior NU IRB review and approval, except where necessary to eliminate apparent immediate hazard to the subjects.

7. I assure that I will report any problems involving risks to human subjects or others promptly to the Office of Human Subject Research Protection.

8. I assure that there are no financial or other relationships (e.g., stock ownership, advisory board, speaker’s bureaus, honoraria) that might be viewed as creating a conflict of interest.

Signature: Jennifer Qian
Date: 5/21/2015
Principal Investigator / Faculty Advisor

For student research, the faculty advisor is the principal investigator for the study and is primarily responsible for the ethical conduct of the research. Faculty must review and approve student research prior to submission for NU IRB review. Student investigators must sign this Assurance also.

Signature: Mustapha Benaoui
Date: 05/19/2015
Student Investigator

DEPARTMENT CHAIR/PROGRAM DIRECTOR SIGNATURE (Required)

I am aware that this protocol is being submitted to the Northeastern University IRB. I do not make any assertions about human subject protections for this research project.

Signature: Department Chair or Program Director

Please return completed form to Nan C. Regina, Director, Human Subject Research Protection with the exception of forms from faculty and students of the College of Professional Studies, which should be submitted to Kate Skophammer, IRB Coordinator for CPS.

Nan C. Regina, Director
Northeastern Univ., Human Subject Research Protection
360 Huntington Avenue, Mailstop: 490 Renaissance Park
Boston, MA 02115-5000
Tel: 617.373.4588; Fax: 617.373.4595; n.regina@neu.edu

Kate Skophammer, IRB Coordinator
Northeastern University, College of Professional Studies
Tel: 617.390.3450; k.skophammer@neu.edu

NU HSRP - Rev. 4-21-2015
Informed Consent and Confidentiality

Participants must give voluntary informed consent to participate in most studies. I intend to follow the appropriate guidelines to ethically administer my study. The U.S. Office for Human Research Protections (OHRP) and the Code of Federal Regulations (CFR) requires that the following information must be provided to research subjects before they participate in a study:

1. Participants were informed that they were being asked to participate in a research study.
2. Participants were provided an explanation of the purposes of the research and the expected duration of their participation.
3. Participants were given a description of the procedures to be followed and any experimental procedures were identified.
4. Participants were given a description of any reasonably foreseeable risks or discomforts they may experience.
5. Participants were given a description of any benefits to themselves or others that may reasonably be expected from the results of the study.
6. Appropriate alternative procedures or courses of treatment, if any, that might be advantageous to the subject of an experimental or quasi-experimental study, were disclosed.
7. Participants were given a statement describing the extent, if any, to which confidentiality of records identifying the subject/participant will be maintained.
8. For research involving more than minimal risk, participants were given an explanation about any treatments or compensation if injury occurs and, if so, what they consist of, or
where further information may be obtained. (Note: A risk is considered "minimal" when the probability and magnitude of harm or discomfort anticipated in the proposed research are not greater, in and of themselves, than those ordinarily encountered in daily life or during the performance of routine physical or psychological examinations or tests).

9. Participants were told whom to contact for answers to pertinent questions about the research and research subjects'/participants' rights, and whom to contact in the event of a research-related injury.

10. Participants were given a statement that participation is voluntary, refusal to participate will involve no penalty or loss of benefits to which the subject/participants is otherwise entitled, and the subject/participant may discontinue participation at any time without penalty or loss of benefits to which the subject/participant is otherwise entitled.

Consent forms were written in plain language that research subjects/participants could understand. In addition, the consent form did not contain any exculpatory language. That is, subjects/participants were not asked to waive (or appear to waive) any of their legal rights, nor were they asked to release the investigator, sponsor, or institution (or its agents) from liability for negligence (U.S. Department of Health & Human Services, 2014).
Appendix D

Data and Figures for Testing of Assumptions

A Chi-square test of independence revealed that 0% of the expected values for each of the four composite scores was less than 5.0 (see Table D1).

Table D1

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>Performance Experiences</th>
<th>Vicarious Experiences</th>
<th>Verbal Persuasions</th>
<th>Physiological and Emotional Reactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chi-Square</td>
<td>61.29(^a)</td>
<td>130.88(^b)</td>
<td>103.44(^c)</td>
<td>62.68(^d)</td>
</tr>
<tr>
<td>Degrees of Freedom</td>
<td>27</td>
<td>22</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>(p)</td>
<td>&lt; .001</td>
<td>&lt; .001</td>
<td>&lt; .001</td>
<td>&lt; .001</td>
</tr>
</tbody>
</table>

\(^a\) 0 cells (0%) have expected frequencies less than 5.0. The minimum expected cell frequency is 6.8.

\(^b\) 0 cells (0%) have expected frequencies less than 5.0. The minimum expected cell frequency is 8.3.

\(^c\) 0 cells (0%) have expected frequencies less than 5.0. The minimum expected cell frequency is 7.3.

\(^d\) 0 cells (0%) have expected frequencies less than 5.0. The minimum expected cell frequency is 6.2.

A Box-Tidwell test revealed that the interaction term between each composite score and its logistic transformation was statistically not significant (\(p > .05\)), and thus all four composite score explanatory variables were linearly related to their respective logistic transformations (see Table D2).
Table D2

**Box-Tidwell Test (Dependent Variable: Placement Test Results)**

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>B</th>
<th>SE(B)</th>
<th>$e^B$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Experiences</td>
<td>0.066</td>
<td>1.368</td>
<td>1.069</td>
</tr>
<tr>
<td>Vicarious Experiences</td>
<td>1.906</td>
<td>1.628</td>
<td>6.727</td>
</tr>
<tr>
<td>Verbal Persuasion</td>
<td>-0.198</td>
<td>0.677</td>
<td>0.820</td>
</tr>
<tr>
<td>Physiological and Emotional Reactions</td>
<td>-0.133</td>
<td>0.602</td>
<td>0.876</td>
</tr>
<tr>
<td>Ln(Performance Experiences) * Performance Experiences</td>
<td>0.042</td>
<td>0.332</td>
<td>1.042</td>
</tr>
<tr>
<td>Ln(Vicarious Experiences) * Vicarious Experiences</td>
<td>-0.463</td>
<td>0.391</td>
<td>0.629</td>
</tr>
<tr>
<td>Ln(Verbal Persuasion) * Verbal Persuasion</td>
<td>0.061</td>
<td>0.171</td>
<td>1.062</td>
</tr>
<tr>
<td>Ln(Physiological and Emotional Reactions) * Physiological and Emotional Reactions</td>
<td>0.017</td>
<td>0.151</td>
<td>1.017</td>
</tr>
<tr>
<td>Constant</td>
<td>-12.822</td>
<td>10.371</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

*Note. $e^B$ = exponentiated B.*

None of the explanatory variables were significant at the $p < .05$ level.

* $p < .05$. ** $p < .01$. *** $p < .001$

A Levene’s test for homogeneity of variances for each of the composite scores for the four sources of self-efficacy revealed that performance experiences, vicarious experiences, verbal persuasion, and physiological and emotional reactions resulted in $p$-values of .803, .424, .865, and .854, respectively, and thus, the variances of the composite scores were not significantly different from each other ($p > .05$, see Table D3).

Table D3

**Levene’s Test of Homogeneity of Variances for Participants’ Composite Scores for Each of the Sources of Self-efficacy**

<table>
<thead>
<tr>
<th>Levene Statistic</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Experiences</td>
<td>.062</td>
</tr>
<tr>
<td>Vicarious Experiences</td>
<td>.643</td>
</tr>
<tr>
<td>Verbal Persuasion</td>
<td>.029</td>
</tr>
<tr>
<td>Physiological and Emotional Reactions</td>
<td>.034</td>
</tr>
</tbody>
</table>

Within the demographic factors of gender, ethnicity, and parent’s or guardian’s level of education, each of the four composite scores was found to be approximately normally distributed. A Shapiro-Wilk test for normality of the composite score and the demographic variables revealed that each of the four composite scores was found to be normally distributed (see Table D4). However, these violations of the normality assumption were considered
acceptable because the one-way ANOVA is considered to be a robust test against the normality assumption, meaning that it tolerates violations to this assumption rather well (Laerd Statistics, n.d.). To further illustrate this, normality plots are reproduced below for the distributions of the composite scores of each of the four sources of self-efficacy, relative within the demographic factors of gender, ethnicity, and parent’s or guardian’s level of education.
### Table D4

**Shapiro Wilk Test for Normality for Participants’ Composite Scores for Each of the Sources of Self-efficacy, Distributed Across the Demographic Variables of Gender, Ethnicity, and Parent’s or Guardian’s Level of Education**

#### By Gender

<table>
<thead>
<tr>
<th></th>
<th>Demographic</th>
<th>Shapiro-Wilk</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Experiences</td>
<td></td>
<td>.98</td>
<td>98</td>
<td>.168</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>.98</td>
<td>98</td>
<td>.095</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>.98</td>
<td>93</td>
<td>.071</td>
</tr>
<tr>
<td>Vicarious Experiences</td>
<td></td>
<td>.98</td>
<td>98</td>
<td>.116</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>.97</td>
<td>98</td>
<td>.014</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>.96</td>
<td>93</td>
<td>.003</td>
</tr>
<tr>
<td>Verbal Persuasion</td>
<td></td>
<td>.97</td>
<td>98</td>
<td>.020</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>.97</td>
<td>98</td>
<td>.014</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>.96</td>
<td>93</td>
<td>.003</td>
</tr>
<tr>
<td>Physiological and Emotional Reactions</td>
<td></td>
<td>.97</td>
<td>98</td>
<td>.007</td>
</tr>
</tbody>
</table>

#### By Ethnicity

<table>
<thead>
<tr>
<th></th>
<th>Demographic</th>
<th>Shapiro-Wilk</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Experiences</td>
<td></td>
<td>.97</td>
<td>67</td>
<td>.142</td>
</tr>
<tr>
<td></td>
<td>White</td>
<td>.97</td>
<td>67</td>
<td>.160</td>
</tr>
<tr>
<td></td>
<td>Black</td>
<td>.97</td>
<td>61</td>
<td>.807</td>
</tr>
<tr>
<td></td>
<td>American Indian or Alaskan Native</td>
<td>.96</td>
<td>8</td>
<td>.381</td>
</tr>
<tr>
<td></td>
<td>Asian</td>
<td>.93</td>
<td>11</td>
<td>.703</td>
</tr>
<tr>
<td></td>
<td>Latino</td>
<td>.98</td>
<td>37</td>
<td>.189</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>.87</td>
<td>7</td>
<td>.003</td>
</tr>
<tr>
<td>Vicarious Experiences</td>
<td></td>
<td>.97</td>
<td>67</td>
<td>.099</td>
</tr>
<tr>
<td></td>
<td>White</td>
<td>.97</td>
<td>67</td>
<td>.071</td>
</tr>
<tr>
<td></td>
<td>Black</td>
<td>.96</td>
<td>61</td>
<td>.071</td>
</tr>
<tr>
<td></td>
<td>American Indian or Alaskan Native</td>
<td>.96</td>
<td>8</td>
<td>.463</td>
</tr>
<tr>
<td></td>
<td>Asian</td>
<td>.94</td>
<td>11</td>
<td>.476</td>
</tr>
<tr>
<td></td>
<td>Latino</td>
<td>.96</td>
<td>37</td>
<td>.199</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>.93</td>
<td>7</td>
<td>.542</td>
</tr>
<tr>
<td>Verbal Persuasion</td>
<td></td>
<td>.97</td>
<td>61</td>
<td>.992</td>
</tr>
<tr>
<td></td>
<td>White</td>
<td>.97</td>
<td>61</td>
<td>.171</td>
</tr>
<tr>
<td></td>
<td>Black</td>
<td>.97</td>
<td>61</td>
<td>.082</td>
</tr>
<tr>
<td></td>
<td>American Indian or Alaskan Native</td>
<td>.97</td>
<td>8</td>
<td>.621</td>
</tr>
<tr>
<td></td>
<td>Asian</td>
<td>.95</td>
<td>11</td>
<td>.256</td>
</tr>
<tr>
<td></td>
<td>Latino</td>
<td>.97</td>
<td>37</td>
<td>.282</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>.96</td>
<td>7</td>
<td>.002</td>
</tr>
<tr>
<td>Physiological and Emotional Reactions</td>
<td></td>
<td>.97</td>
<td>67</td>
<td>.070</td>
</tr>
</tbody>
</table>

#### By Parent’s or Guardian’s Level of Education

<table>
<thead>
<tr>
<th></th>
<th>Demographic</th>
<th>Shapiro-Wilk</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Experiences</td>
<td></td>
<td>.94</td>
<td>20</td>
<td>.241</td>
</tr>
<tr>
<td></td>
<td>Elementary School</td>
<td>.94</td>
<td>20</td>
<td>.479</td>
</tr>
<tr>
<td></td>
<td>Middle School</td>
<td>.97</td>
<td>31</td>
<td>.644</td>
</tr>
<tr>
<td></td>
<td>College</td>
<td>.95</td>
<td>54</td>
<td>.016</td>
</tr>
<tr>
<td></td>
<td>Graduate School</td>
<td>.92</td>
<td>26</td>
<td>.052</td>
</tr>
<tr>
<td>Vicarious Experiences</td>
<td></td>
<td>.96</td>
<td>20</td>
<td>.500</td>
</tr>
<tr>
<td></td>
<td>Elementary School</td>
<td>.96</td>
<td>20</td>
<td>.007</td>
</tr>
<tr>
<td></td>
<td>Middle School</td>
<td>.90</td>
<td>31</td>
<td>.406</td>
</tr>
<tr>
<td></td>
<td>College</td>
<td>.94</td>
<td>54</td>
<td>.004</td>
</tr>
<tr>
<td></td>
<td>Graduate School</td>
<td>.92</td>
<td>26</td>
<td>.035</td>
</tr>
<tr>
<td>Verbal Persuasion</td>
<td></td>
<td>.96</td>
<td>20</td>
<td>.552</td>
</tr>
<tr>
<td></td>
<td>Elementary School</td>
<td>.96</td>
<td>20</td>
<td>.497</td>
</tr>
<tr>
<td></td>
<td>Middle School</td>
<td>.97</td>
<td>31</td>
<td>.004</td>
</tr>
<tr>
<td></td>
<td>College</td>
<td>.95</td>
<td>54</td>
<td>.028</td>
</tr>
<tr>
<td></td>
<td>Graduate School</td>
<td>.87</td>
<td>26</td>
<td>.003</td>
</tr>
<tr>
<td>Physiological and Emotional Reactions</td>
<td></td>
<td>.91</td>
<td>20</td>
<td>.064</td>
</tr>
</tbody>
</table>

**Note.** Significant p-values ($p < .05$) indicate non-normality.
Normal Q-Q Plot of Verbal_Persuasions for Ethnicity: Asian

Normal Q-Q Plot of Verbal_Persuasions for Ethnicity: Other

Normal Q-Q Plot of Physiological_and_Emotional_Reactions for Ethnicity: Latino

Normal Q-Q Plot of Physiological_and_Emotional_Reactions for Ethnicity: White

Normal Q-Q Plot of Physiological_and_Emotional_Reactions for Ethnicity: Black

Normal Q-Q Plot of Physiological_and_Emotional_Reactions for Ethnicity: American Indian or Alaskan Native
Appendix E

Chi-square Tests of Independence for Placement Test Results

The researcher found a Chi-square test of independence comparing the frequency of different placement test results across the factor levels within each of the demographic variables of gender, ethnicity, and parent’s or guardian’s level of education, respectively. These tests are reproduced below.

Gender

A Chi-square test of independence revealed that gender was not significantly correlated with placement test results, $\chi^2 (1) = 2.68, p = .102$, indicating that male participants were not significantly more or significantly less likely than female participants to be placed in college-level courses in mathematics instead of remedial courses in mathematics (see Table E1).

Table E1

<table>
<thead>
<tr>
<th>Placement Test Results</th>
<th>Gender</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Males</td>
<td>Females</td>
<td></td>
</tr>
<tr>
<td>Remedial Courses in Mathematics</td>
<td>44 (44.9%)</td>
<td>31 (33.3%)</td>
<td></td>
</tr>
<tr>
<td>College-level Courses in Mathematics</td>
<td>54 (55.1%)</td>
<td>62 (66.7%)</td>
<td></td>
</tr>
</tbody>
</table>

Note. $\chi^2 (1) = 2.68, p = .102.$
Numbers in parentheses indicate column percentages.
0 cells (0.0%) have expected frequencies less than 5.0. The minimum expected frequency is 36.52.

Ethnicity

A maximum-likelihood ratio Chi-square test of independence revealed that ethnicity was not significantly correlated with placement test results, $\chi^2 (5) = 8.97, p = .110$, indicating that participants of each ethnicity were not significantly more or significantly less likely than participants of other ethnicities to be placed in college-level courses in mathematics instead of remedial courses in mathematics (see Table E2).
Table E2

*Chi-square Test of Ethnicity and Placement Test Results*

<table>
<thead>
<tr>
<th>Placement Test Results</th>
<th>White</th>
<th>Black</th>
<th>American Indian or Alaskan Native</th>
<th>Asian</th>
<th>Latino</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remedial Courses in Mathematics</td>
<td>18 (26.9%)</td>
<td>28 (45.9%)</td>
<td>4 (50.0%)</td>
<td>3 (27.3%)</td>
<td>19 (51.4%)</td>
<td>3 (42.9%)</td>
</tr>
<tr>
<td>College-level Courses in Mathematics</td>
<td>49 (73.1%)</td>
<td>33 (54.1%)</td>
<td>4 (50.0%)</td>
<td>8 (72.7%)</td>
<td>18 (48.6%)</td>
<td>4 (57.1%)</td>
</tr>
</tbody>
</table>

*Note.* $\chi^2 (5) = 8.80, p = .117$.

Maximum-likelihood ratio $\chi^2 (5) = 8.97, p = .110$.

Numbers in parentheses indicate column percentages.

5 cells (41.7%) have expected frequencies less than 5.0. The minimum expected frequency is 2.75.

**Parent’s or Guardian’s Level of Education**

A Chi-square test of independence revealed that parent’s or guardian’s level of education was significantly correlated with placement test results, $\chi^2 (4) = 22.33, p < .001$, indicating that participants whose parents or guardians had attained certain levels of education were significantly more or significantly less likely than participants whose parents or guardians had attained different levels of education to be placed in college-level courses in mathematics or remedial courses in mathematics (see Table E3). The average likelihood of being placed in a college-level course in mathematics as opposed to a remedial course in mathematics was significantly lower for participants whose parents or guardians had attained only an elementary school level or a middle school level of education, as compared to those participants whose parents or guardians had attained an education of high school level, college level, or graduate school level of education (see Table E3).
Table E3

**Chi-square Test of Parent’s or Guardian’s Level of Education and Placement Test Results**

<table>
<thead>
<tr>
<th>Placement Test Results</th>
<th>Parent’s or Guardian’s Level of Education</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Elementary School</td>
</tr>
<tr>
<td>Remedial Courses in Mathematics</td>
<td>13 (65.0%)</td>
</tr>
<tr>
<td>College-level Courses in Math</td>
<td>7 (35.0%)</td>
</tr>
</tbody>
</table>

*Note. \( \chi^2 \) (4) = 22.33, \( p < .001 \).*

Numbers in parentheses indicate column percentages.
0 cells (0.0%) have expected frequencies less than 5.0. The minimum expected frequency is 7.85.
Appendix F

Independent Samples t-tests and ANOVAs for Each Source of Self-efficacy

The researcher found an independent samples t-test for each source of self-efficacy, compared across gender, as well as an ANOVA for each source of self-efficacy, compared across the factor levels within each of the demographic variable factors of ethnicity and parent’s or guardian’s level of education, respectively. These tests and their respective post hoc tests are reproduced below.

Gender

An independent samples t-test for each source of self-efficacy revealed that the demographic variable of gender was not significantly correlated with composite scores of any of the four sources of self-efficacy ($p > .05$). This indicated that gender was not a significant factor in determining a participants’ composite score within any of the four sources of self-efficacy (see Table F1).

<table>
<thead>
<tr>
<th>Source of Self-efficacy</th>
<th>Gender</th>
<th>n</th>
<th>Mean</th>
<th>SD</th>
<th>t</th>
<th>df</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Experiences</td>
<td>Male</td>
<td>98</td>
<td>24.59</td>
<td>6.32</td>
<td>-0.29</td>
<td>189</td>
<td>.772</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>93</td>
<td>24.86</td>
<td>6.45</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vicarious Experiences</td>
<td>Male</td>
<td>98</td>
<td>25.69</td>
<td>5.04</td>
<td>-0.22</td>
<td>189</td>
<td>.827</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>93</td>
<td>25.85</td>
<td>4.76</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbal Persuasion</td>
<td>Male</td>
<td>98</td>
<td>24.42</td>
<td>7.41</td>
<td>-0.51</td>
<td>189</td>
<td>.610</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>93</td>
<td>24.96</td>
<td>7.17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physiological and Emotional Reactions</td>
<td>Male</td>
<td>98</td>
<td>19.32</td>
<td>8.06</td>
<td>0.02</td>
<td>189</td>
<td>.982</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>93</td>
<td>19.29</td>
<td>8.03</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

No post hoc tests were needed for analyzing gender because there were only two categorical groups within this factor (male or female).
Ethnicity

**Performance experiences.** An ANOVA revealed that ethnicity was significantly correlated with the performance experiences source of self-efficacy, $F(5, 185) = 3.13, p = .010$ (see Table F2). Post hoc analyses using Tukey’s post hoc criterion for significance indicated that the average composite score in the performance source of self-efficacy was significantly higher for Asian participants ($M = 28.64, SD = 6.07$) as compared to American Indian or Alaskan Native participants ($M = 21.88, SD = 7.92$). All other ethnicities did not have any statistically significant differences from each other in terms of composite scores in the performance experiences source of self-efficacy. This result indicated that Asian participants generally are more confident than their peers in their skills and capacities in handling mathematical tasks (see Table F3).

**Vicarious experiences.** An ANOVA was calculated and revealed that ethnicity was significantly correlated with participants’ responses regarding the vicarious experiences source of self-efficacy, $F(5, 185) = 2.58, p = .028$ (see Table F2). Post hoc analyses using the Duncan post hoc criterion for significance indicated that the average composite score in the vicarious experiences source of self-efficacy was significantly higher for White participants ($M = 26.42, SD = 5.34$), Black participants ($M = 26.41, SD = 4.45$), and Latino participants ($M = 25.51, SD = 3.72$), as compared to American Indian or Alaskan Native participants ($M = 21.38, SD = 4.78$) (see Table F4).

**Verbal persuasion.** An ANOVA revealed that ethnicity was not significantly correlated with the verbal persuasion source of self-efficacy, $F(5, 185) = 2.00, p = .080$ (see Table F2).
**Physiological and emotional reactions.** An ANOVA revealed that ethnicity was not significantly correlated with participants’ responses regarding their physiological and emotional reactions source of self-efficacy, $F(5, 185) = 1.42, p = .220$ (see Table F2).

Table F2

<table>
<thead>
<tr>
<th>Source of Self-efficacy</th>
<th>Source</th>
<th>$df$</th>
<th>$SS$</th>
<th>$MS$</th>
<th>$F$</th>
<th>$p$</th>
<th>$\eta^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Experiences</td>
<td>Between Groups</td>
<td>5</td>
<td>601.46</td>
<td>120.29</td>
<td>3.13</td>
<td>.010</td>
<td>.078</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>185</td>
<td>7114.84</td>
<td>38.46</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>190</td>
<td>7716.29</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vicarious Experiences</td>
<td>Between Groups</td>
<td>5</td>
<td>297.20</td>
<td>59.44</td>
<td>2.58</td>
<td>.028</td>
<td>.065</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>185</td>
<td>4256.66</td>
<td>23.01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>190</td>
<td>4553.86</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbal Persuasion</td>
<td>Between Groups</td>
<td>5</td>
<td>516.43</td>
<td>103.29</td>
<td>2.00</td>
<td>.080</td>
<td>.051</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>185</td>
<td>9547.09</td>
<td>51.61</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>190</td>
<td>10063.52</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physiological and Emotional Reactions</td>
<td>Between Groups</td>
<td>5</td>
<td>450.89</td>
<td>90.18</td>
<td>1.42</td>
<td>.220</td>
<td>.037</td>
</tr>
<tr>
<td></td>
<td>Within Groups</td>
<td>185</td>
<td>11777.50</td>
<td>63.66</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>190</td>
<td>12228.39</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table F3

**Post Hoc Tests for Performance Experiences by Ethnicity**

<table>
<thead>
<tr>
<th>Post Hoc Test</th>
<th>Ethnicity</th>
<th>$N$</th>
<th>Subset 1 (alpha = .05)</th>
<th>Subset 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tukey HSD$^{a, b}$</td>
<td>American Indian or Alaskan Native</td>
<td>8</td>
<td>21.88</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Latino</td>
<td>37</td>
<td>22.65</td>
<td>22.65</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>7</td>
<td>23.43</td>
<td>23.43</td>
</tr>
<tr>
<td></td>
<td>Black</td>
<td>61</td>
<td>24.05</td>
<td>24.05</td>
</tr>
<tr>
<td></td>
<td>White</td>
<td>67</td>
<td>26.31</td>
<td>26.31</td>
</tr>
<tr>
<td></td>
<td>Asian</td>
<td>11</td>
<td>28.64</td>
<td></td>
</tr>
<tr>
<td>$p$</td>
<td></td>
<td>.394</td>
<td>.105</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Means for groups in homogeneous subsets are displayed.

$^{a}$ Uses Harmonic Mean Sample Size = 14.39.

$^{b}$ The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.
Table F4

Post Hoc Tests for Vicarious Experiences by Ethnicity

<table>
<thead>
<tr>
<th>Post Hoc Test</th>
<th>Ethnicity</th>
<th>N</th>
<th>Subset (alpha = .05)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Subset 1  Subset 2</td>
</tr>
<tr>
<td>Duncan(^a,b)</td>
<td>American Indian or Alaskan Native</td>
<td>8</td>
<td>21.38</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>7</td>
<td>22.86  22.86</td>
</tr>
<tr>
<td></td>
<td>Asian</td>
<td>11</td>
<td>24.18  24.18</td>
</tr>
<tr>
<td></td>
<td>Latino</td>
<td>37</td>
<td>25.51</td>
</tr>
<tr>
<td></td>
<td>Black</td>
<td>61</td>
<td>26.41</td>
</tr>
<tr>
<td></td>
<td>White</td>
<td>67</td>
<td>26.42</td>
</tr>
<tr>
<td>(p)</td>
<td></td>
<td></td>
<td>.141  .077</td>
</tr>
</tbody>
</table>

Note. Means for groups in homogeneous subsets are displayed.
\(^a\) Uses Harmonic Mean Sample Size = 14.39.
\(^b\) The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

No post hoc tests were needed for verbal persuasion or for physiological and emotional reactions because there was not a statistical significance between any of the groups for these two sources of self-efficacy compared across ethnicities.

Parent’s or Guardian’s Level of Education

Performance experiences. An ANOVA revealed that the effect of a parent’s or guardian’s highest level of education was statistically significant for the performance experiences source of self-efficacy, \(F(4, 186) = 6.27, p < .001\) (see Table F5). Post hoc analyses using the Scheffé post hoc criterion for significance indicated that the average composite score in the performance source of self-efficacy was significantly lower for participants whose parents or guardians had only attained an elementary school level of education \((M = 20.1, SD = 4.22)\) as compared to those whose parents or guardians had attained an education of college level \((M = 26.56, SD = 6.80)\) or graduate school level \((M = 27.46, SD = 6.20)\). Other levels of participants’ parent’s or guardian’s highest levels of education did not result in significantly different results in composite scores for the performance experiences source of self-efficacy. This result indicated that holding all other variables constant, those participants whose parents or guardians had attained college level or higher in education felt significantly more confident in their skills...
and capacities in handling mathematical tasks, but only significantly more confident than those whose parents or guardians had only attained an elementary school level of education (see Table F6).

**Vicarious experiences.** An ANOVA revealed that respondents’ parent’s or guardian’s level of education was significantly correlated with respondents’ vicarious experiences source of self-efficacy, \( F(4, 186) = 2.94, p = .022 \) (see Table F5). Post hoc analyses using the Scheffé post hoc criterion for significance indicated that the average composite score in the vicarious experiences source of self-efficacy was significantly lower for participants whose parents or guardians had only attained an elementary school level of education (\( M = 23.75, SD = 3.08 \)) as compared to those whose parents or guardians had attained an education of graduate school level (\( M = 28.15, SD = 5.87 \)). Other factor levels of respondents’ parent’s or guardian’s level of education did not result in significantly different results in composite scores for the vicarious experiences source of self-efficacy. This result indicated that holding all other variables constant, those participants whose parents or guardians had attained graduate school or higher in education not only felt a more positive influence from their peers and teachers on their mathematics study, but also significantly more than those participants whose parents or guardians had only attained an elementary school level of education (see Table F7).

**Verbal persuasion.** An ANOVA revealed that respondents’ parent’s or guardian’s level of education was significantly correlated with respondents’ verbal persuasion source of self-efficacy, \( F(4, 186) = 3.55, p = .008 \) (see Table F5). Post hoc analyses using the Scheffé post hoc criterion for significance indicated that the average composite score in the verbal persuasion source of self-efficacy was significantly lower for participants whose parents or guardians had only attained an elementary school level of education (\( M = 19.60, SD = 6.48 \)) as compared to
those whose parents or guardians had attained an education of college level \( (M = 26.02, SD = 7.22) \) or graduate school level \( (M = 26.46, SD = 9.45) \). Other factor levels of respondents’ parent’s or guardian’s level of education did not result in significantly different results in composite scores for the verbal persuasion source of self-efficacy. This result indicated that holding all other variables constant, those participants whose parents or guardians had attained college level or higher in education not only had received significantly more praise regarding their skills in mathematics, but also significantly more than those participants whose parents or guardians had only attained an elementary school level of education (see Table F8).

**Physiological and emotional reactions.** An ANOVA was calculated and revealed that participants’ parent’s or guardian’s level of education had no statistically significant effect on participants’ responses regarding their physiological and emotional reactions source of self-efficacy, \( F (4, 186) = 0.93, \ p = .450 \) (see Table F5).

<table>
<thead>
<tr>
<th>Table F5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>One-way Analysis of Variance of Composite Scores of Four Sources of Self-efficacy by Parent’s or Guardian’s Level of Education</strong></td>
</tr>
<tr>
<td>Source of Self-efficacy</td>
</tr>
<tr>
<td>Performance Experiences</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Verbal Persuasion</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Physiological and Emotional Reactions</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
Table F6

**Post Hoc Tests for Performance Experiences by Parent’s or Guardian’s Level of Education**

<table>
<thead>
<tr>
<th>Post Hoc Test</th>
<th>Parent’s or Guardian’s Level of Education</th>
<th>N</th>
<th>Subset (alpha = .05)</th>
<th>Subset 1</th>
<th>Subset 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>p</td>
<td></td>
</tr>
<tr>
<td>Scheffé(^a,b)</td>
<td>Elementary School</td>
<td>20</td>
<td>20.10</td>
<td>20.10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Middle School</td>
<td>31</td>
<td>22.87</td>
<td>22.87</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High School</td>
<td>60</td>
<td>24.38</td>
<td>24.38</td>
<td></td>
</tr>
<tr>
<td></td>
<td>College</td>
<td>54</td>
<td>26.56</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Graduate</td>
<td>26</td>
<td>27.46</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note.** Means for groups in homogeneous subsets are displayed.

\(^a\) Uses Harmonic Mean Sample Size = 32.07.

\(^b\) The group sizes are unequal. The harmonic mean of the group sizes is used.

Type I error levels are not guaranteed.

Table F7

**Post Hoc Tests for Vicarious Experiences by Parent’s or Guardian’s Level of Education**

<table>
<thead>
<tr>
<th>Post Hoc Test</th>
<th>Parent’s or Guardian’s Level of Education</th>
<th>N</th>
<th>Subset (alpha = .05)</th>
<th>Subset 1</th>
<th>Subset 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>p</td>
<td></td>
</tr>
<tr>
<td>Scheffé(^a,b)</td>
<td>Elementary School</td>
<td>20</td>
<td>23.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Middle School</td>
<td>31</td>
<td>25.10</td>
<td>25.10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High School</td>
<td>60</td>
<td>25.30</td>
<td>25.30</td>
<td></td>
</tr>
<tr>
<td></td>
<td>College</td>
<td>54</td>
<td>26.28</td>
<td>26.28</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Graduate</td>
<td>26</td>
<td>28.15</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note.** Means for groups in homogeneous subsets are displayed.

\(^a\) Uses Harmonic Mean Sample Size = 32.07.

\(^b\) The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.

Table F8

**Post Hoc Tests for Verbal Persuasion by Parent’s or Guardian’s Level of Education**

<table>
<thead>
<tr>
<th>Post Hoc Test</th>
<th>Parent’s or Guardian’s Level of Education</th>
<th>N</th>
<th>Subset (alpha = .05)</th>
<th>Subset 1</th>
<th>Subset 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>p</td>
<td></td>
</tr>
<tr>
<td>Scheffé(^a,b)</td>
<td>Elementary School</td>
<td>20</td>
<td>19.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Middle School</td>
<td>31</td>
<td>23.93</td>
<td>23.93</td>
<td></td>
</tr>
<tr>
<td></td>
<td>High School</td>
<td>60</td>
<td>24.78</td>
<td>24.78</td>
<td></td>
</tr>
<tr>
<td></td>
<td>College</td>
<td>54</td>
<td>26.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Graduate</td>
<td>26</td>
<td>26.46</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note.** Means for groups in homogeneous subsets are displayed.

\(^a\) Uses Harmonic Mean Sample Size = 32.07.

\(^b\) The group sizes are unequal. The harmonic mean of the group sizes is used. Type I error levels are not guaranteed.
No post hoc tests were needed for physiological and emotional reactions because there was not a statistically significant between any of the groups for this source of self-efficacy compared by parent’s or guardian’s level of education.
Appendix G

Binary Logistic Regression Model Analysis

The researcher ran a series of 22 binary logistic regression models. For every regression model, the binary response variable was the placement test result (i.e., whether the participant was placed into a remedial course or a college-level course in mathematics), and the explanatory variables consisted of a combination of one or more of the four ordinal composite scores derived from participants’ responses within the four sources of self-efficacy. In some instances within the regression models, demographic variables have been included and controlled for. The demographic variables collected included participants’ gender, ethnicity, and their parent’s or guardian’s level of education. These 22 binary logistic regression models are reproduced below.

Table G1

Summary of Logistic Regression Analysis for Variables Predicting Placement Test Results Based on the Performance Experiences Source of Self-efficacy

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Model 1</th>
<th>SE(B)</th>
<th>eB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Experiences</td>
<td>0.27***</td>
<td>0.04</td>
<td>1.31</td>
</tr>
<tr>
<td>Cox &amp; Snell R²</td>
<td>.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nagelkerke R²</td>
<td>.44</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>191</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. eB = exponentiated B.
* p < .05. ** p < .01. *** p < .001

Table G2

Summary of Logistic Regression Analysis for Variables Predicting Placement Test Results Based on the Vicarious Experiences Source of Self-efficacy

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Model 2</th>
<th>SE(B)</th>
<th>eB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vicarious Experiences</td>
<td>0.18***</td>
<td>0.04</td>
<td>1.20</td>
</tr>
<tr>
<td>Cox &amp; Snell R²</td>
<td>.14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nagelkerke R²</td>
<td>.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>191</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. eB = exponentiated B.
* p < .05. ** p < .01. *** p < .001
Table G3

Summary of Logistic Regression Analysis for Variables Predicting Placement Test Results Based on the Verbal Persuasion Source of Self-efficacy

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Model 3</th>
<th>B</th>
<th>SE(B)</th>
<th>e^B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Verbal persuasion</td>
<td></td>
<td>0.13***</td>
<td>0.03</td>
<td>1.14</td>
</tr>
<tr>
<td>Cox &amp; Snell R^2</td>
<td>.17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nagelkerke R^2</td>
<td>.23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>191</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. e^B = exponentiated B.  * p < .05.  ** p < .01.  *** p < .001

Table G4

Summary of Logistic Regression Analysis for Variables Predicting Placement Test Results Based on the Physiological and Emotional Reactions Source of Self-efficacy

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Model 4</th>
<th>B</th>
<th>SE(B)</th>
<th>e^B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physiological and Emotional Reactions</td>
<td>-0.12***</td>
<td>0.02</td>
<td>0.89</td>
<td></td>
</tr>
<tr>
<td>Cox &amp; Snell R^2</td>
<td>.17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nagelkerke R^2</td>
<td>.23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>191</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. e^B = exponentiated B.  * p < .05.  ** p < .01.  *** p < .001

Table G5

Summary of Logistic Regression Analysis for Variables Predicting Placement Test Results Based on the Four Sources of Self-efficacy

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Model 5</th>
<th>B</th>
<th>SE(B)</th>
<th>e^B</th>
<th>Model 6</th>
<th>B</th>
<th>SE(B)</th>
<th>e^B</th>
<th>Model 7</th>
<th>B</th>
<th>SE(B)</th>
<th>e^B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance Experiences</td>
<td></td>
<td>0.22***</td>
<td>0.05</td>
<td>1.25</td>
<td></td>
<td>0.21***</td>
<td>0.05</td>
<td>1.24</td>
<td></td>
<td>0.24***</td>
<td>0.04</td>
<td>1.27</td>
</tr>
<tr>
<td>Vicarious Experiences</td>
<td>-0.02</td>
<td>0.06</td>
<td>0.98</td>
<td></td>
<td></td>
<td>0.04</td>
<td>0.04</td>
<td>1.04</td>
<td></td>
<td>0.03</td>
<td>0.03</td>
<td>1.03</td>
</tr>
<tr>
<td>Verbal Persuasion</td>
<td></td>
<td>0.04</td>
<td>0.04</td>
<td>1.04</td>
<td></td>
<td>0.03</td>
<td>0.03</td>
<td>1.03</td>
<td></td>
<td>0.03</td>
<td>0.03</td>
<td>1.03</td>
</tr>
<tr>
<td>Physiological and Emotional Reactions</td>
<td>-0.07**</td>
<td>0.03</td>
<td>0.93</td>
<td></td>
<td>-0.07**</td>
<td>0.03</td>
<td>0.93</td>
<td></td>
<td>-0.07**</td>
<td>0.03</td>
<td>0.93</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-3.80**</td>
<td>1.36</td>
<td>0.02</td>
<td></td>
<td>-4.03***</td>
<td>1.23</td>
<td>0.02</td>
<td></td>
<td>-3.81**</td>
<td>1.20</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>Cox &amp; Snell R^2</td>
<td>.35</td>
<td></td>
<td></td>
<td></td>
<td>.35</td>
<td></td>
<td></td>
<td></td>
<td>.35</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nagelkerke R^2</td>
<td>.48</td>
<td></td>
<td></td>
<td></td>
<td>.48</td>
<td></td>
<td></td>
<td></td>
<td>.47</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>191</td>
<td></td>
<td></td>
<td></td>
<td>191</td>
<td></td>
<td></td>
<td></td>
<td>191</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Note. e^B = exponentiated B.  * p < .05.  ** p < .01.  *** p < .001
Table G6

*Summary of Logistic Regression Analysis for Variables Predicting Placement Test Results Based on the Four Sources of Self-efficacy, Controlling for Gender*

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Model 8 B</th>
<th>SE(B)</th>
<th>e^β</th>
<th>Model 9 B</th>
<th>SE(B)</th>
<th>e^β</th>
<th>Model 10 B</th>
<th>SE(B)</th>
<th>e^β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance</td>
<td>0.22***</td>
<td>0.05</td>
<td>1.25</td>
<td>0.22***</td>
<td>0.05</td>
<td>1.24</td>
<td>0.24***</td>
<td>0.04</td>
<td>1.27</td>
</tr>
<tr>
<td>Emotional Reactions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vicarious Experiences</td>
<td>-0.02</td>
<td>0.06</td>
<td>0.98</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbal Persuasion</td>
<td>0.04</td>
<td>0.04</td>
<td>1.04</td>
<td>0.03</td>
<td>0.03</td>
<td>1.03</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physiological and Emotional Reactions</td>
<td>-0.07**</td>
<td>0.03</td>
<td>0.93</td>
<td>-0.07**</td>
<td>0.03</td>
<td>0.93</td>
<td>-0.07**</td>
<td>0.03</td>
<td>0.93</td>
</tr>
<tr>
<td>Gender*</td>
<td>0.59</td>
<td>0.38</td>
<td>1.80</td>
<td>0.59</td>
<td>0.38</td>
<td>1.80</td>
<td>0.60</td>
<td>0.38</td>
<td>1.83</td>
</tr>
<tr>
<td>Constant</td>
<td>-4.64**</td>
<td>1.48</td>
<td>0.01</td>
<td>-4.87***</td>
<td>1.37</td>
<td>0.01</td>
<td>-4.68***</td>
<td>1.35</td>
<td>0.01</td>
</tr>
<tr>
<td><strong>Cox &amp; Snell R²</strong></td>
<td>.36</td>
<td></td>
<td></td>
<td>.36</td>
<td></td>
<td></td>
<td>.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>N</strong></td>
<td>191</td>
<td></td>
<td></td>
<td>191</td>
<td></td>
<td></td>
<td>191</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note.** e^β = exponentiated B.

*a* Gender was coded as 1 = male and 0 = female.

*p < .05. **p < .01. ***p < .001

Table G7

*Summary of Logistic Regression Analysis for Variables Predicting Placement Test Results Based on the Four Sources of Self-efficacy, Controlling for Ethnicity*

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Model 11 B</th>
<th>SE(B)</th>
<th>e^β</th>
<th>Model 12 B</th>
<th>SE(B)</th>
<th>e^β</th>
<th>Model 13 B</th>
<th>SE(B)</th>
<th>e^β</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance</td>
<td>0.21***</td>
<td>0.05</td>
<td>1.23</td>
<td>0.20***</td>
<td>0.05</td>
<td>1.22</td>
<td>0.23***</td>
<td>0.04</td>
<td>1.26</td>
</tr>
<tr>
<td>Emotional Reactions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vicarious Experiences</td>
<td>-0.02</td>
<td>0.06</td>
<td>0.99</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbal Persuasion</td>
<td>0.05</td>
<td>0.04</td>
<td>1.05</td>
<td>0.04</td>
<td>0.04</td>
<td>1.04</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physiological and Emotional Reactions</td>
<td>-0.08**</td>
<td>0.03</td>
<td>0.92</td>
<td>-0.08</td>
<td>0.03**</td>
<td>0.92</td>
<td>-0.08</td>
<td>0.03</td>
<td>0.93</td>
</tr>
<tr>
<td>White*</td>
<td>0.62</td>
<td>1.18</td>
<td>1.87</td>
<td>0.63</td>
<td>1.18</td>
<td>1.88</td>
<td>0.72</td>
<td>1.18</td>
<td>2.06</td>
</tr>
<tr>
<td>Black*</td>
<td>-0.07</td>
<td>1.19</td>
<td>0.94</td>
<td>-0.07</td>
<td>1.19</td>
<td>0.93</td>
<td>0.11</td>
<td>1.18</td>
<td>1.12</td>
</tr>
<tr>
<td>American Indian or Alaskan Native*</td>
<td>0.70</td>
<td>1.49</td>
<td>2.02</td>
<td>0.74</td>
<td>1.48</td>
<td>2.09</td>
<td>0.72</td>
<td>1.46</td>
<td>2.06</td>
</tr>
<tr>
<td>Asian*</td>
<td>-0.28</td>
<td>1.45</td>
<td>0.76</td>
<td>-0.23</td>
<td>1.43</td>
<td>0.79</td>
<td>-0.18</td>
<td>1.43</td>
<td>0.83</td>
</tr>
<tr>
<td>Latino*</td>
<td>-0.07</td>
<td>1.21</td>
<td>0.94</td>
<td>-0.07</td>
<td>1.21</td>
<td>0.93</td>
<td>0.07</td>
<td>1.21</td>
<td>1.08</td>
</tr>
<tr>
<td>Constant</td>
<td>-3.81*</td>
<td>1.85</td>
<td>0.02</td>
<td>-3.97*</td>
<td>1.74</td>
<td>0.02</td>
<td>-3.84*</td>
<td>1.75</td>
<td>0.02</td>
</tr>
<tr>
<td><strong>Cox &amp; Snell R²</strong></td>
<td>.36</td>
<td></td>
<td></td>
<td>.36</td>
<td></td>
<td></td>
<td>.36</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>N</strong></td>
<td>191</td>
<td></td>
<td></td>
<td>191</td>
<td></td>
<td></td>
<td>191</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note.** e^β = exponentiated B.

*a* Ethnicity variables are coded as 0 = the participant is not the ethnicity specified, 1 = the participant is the ethnicity specified. The excluded ethnicity is the response of “Other.”

*p < .05. **p < .01. ***p < .001
Table G8

Summary of Logistic Regression Analysis for Variables Predicting Placement Test Results Based on the Four Sources of Self-efficacy, Controlling for Gender and Ethnicity

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Model 14</th>
<th></th>
<th></th>
<th>Model 15</th>
<th></th>
<th></th>
<th>Model 16</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>SE(B)</td>
<td>$e^B$</td>
<td>B</td>
<td>SE(B)</td>
<td>$e^B$</td>
<td>B</td>
<td>SE(B)</td>
</tr>
<tr>
<td>Performance Experiences</td>
<td>0.21***</td>
<td>0.05</td>
<td>1.23</td>
<td>0.20***</td>
<td>0.05</td>
<td>1.23</td>
<td>0.23***</td>
<td>0.04</td>
</tr>
<tr>
<td>Vicarious Experiences</td>
<td>-0.02</td>
<td>0.06</td>
<td>0.98</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbal Persuasion</td>
<td>0.05</td>
<td>0.04</td>
<td>1.05</td>
<td>0.04</td>
<td>0.04</td>
<td>1.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physiological and Emotional Reactions</td>
<td>-0.08**</td>
<td>0.03</td>
<td>0.93</td>
<td>-0.08**</td>
<td>0.03</td>
<td>0.93</td>
<td>-0.08**</td>
<td>0.03</td>
</tr>
<tr>
<td>Gender*</td>
<td>0.58</td>
<td>0.39</td>
<td>1.78</td>
<td>0.58</td>
<td>0.39</td>
<td>1.78</td>
<td>0.59</td>
<td>0.39</td>
</tr>
<tr>
<td>White*b</td>
<td>0.74</td>
<td>1.19</td>
<td>2.10</td>
<td>0.74</td>
<td>1.18</td>
<td>2.10</td>
<td>0.81</td>
<td>1.19</td>
</tr>
<tr>
<td>Black*b</td>
<td>0.07</td>
<td>1.19</td>
<td>1.07</td>
<td>0.05</td>
<td>1.19</td>
<td>1.05</td>
<td>0.21</td>
<td>1.19</td>
</tr>
<tr>
<td>American Indian or Alaskan Native*b</td>
<td>0.79</td>
<td>1.47</td>
<td>2.21</td>
<td>0.83</td>
<td>1.46</td>
<td>2.28</td>
<td>0.80</td>
<td>1.45</td>
</tr>
<tr>
<td>Asian*b</td>
<td>-0.16</td>
<td>1.45</td>
<td>0.86</td>
<td>-0.11</td>
<td>1.44</td>
<td>0.89</td>
<td>-0.08</td>
<td>1.44</td>
</tr>
<tr>
<td>Latino*b</td>
<td>0.08</td>
<td>1.22</td>
<td>1.09</td>
<td>0.07</td>
<td>1.22</td>
<td>1.07</td>
<td>0.19</td>
<td>1.22</td>
</tr>
<tr>
<td>Constant</td>
<td>-4.84*</td>
<td>2.01</td>
<td>0.01</td>
<td>-4.99**</td>
<td>1.92</td>
<td>0.01</td>
<td>-4.88*</td>
<td>1.92</td>
</tr>
</tbody>
</table>

Cox & Snell $R^2$                          | .37      | .37      | .37      |
Nagelkerke $R^2$                           | .50      | .50      | .49      |
N                                          | 191      | 191      | 191      |

Note. $e^B$ = exponentiated B.  
   * Gender was coded as 1 = male, 0 = female.  
   b Ethnicity variables are coded as 0 = the participant is not the ethnicity specified, 1 = the participant is the ethnicity specified. The excluded ethnicity is the response of “Other.”  
   *$p < .05$.  **$p < .01$.  ***$p < .001$
### Table G9

**Summary of Logistic Regression Analysis for Variables Predicting Placement Test Results Based on the Four Sources of Self-efficacy, Controlling for Parent’s or Guardain’s Level of Education**

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Model 17</th>
<th></th>
<th></th>
<th>Model 18</th>
<th></th>
<th></th>
<th>Model 19</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>SE(B)</td>
<td>e^B</td>
<td>B</td>
<td>SE(B)</td>
<td>e^B</td>
<td>B</td>
<td>SE(B)</td>
</tr>
<tr>
<td>Performance Experiences</td>
<td>0.20***</td>
<td>0.05</td>
<td>1.23</td>
<td>0.20***</td>
<td>0.05</td>
<td>1.23</td>
<td>0.23***</td>
<td>0.05</td>
</tr>
<tr>
<td>Vicarious Experiences</td>
<td>0.00</td>
<td>0.06</td>
<td>1.00</td>
<td>0.04</td>
<td>0.04</td>
<td>1.04</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Verbal Persuasion</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physiological and Emotional Reactions</td>
<td>–0.08**</td>
<td>0.03</td>
<td>0.92</td>
<td>–0.08**</td>
<td>0.03</td>
<td>0.92</td>
<td>–0.08**</td>
<td>0.03</td>
</tr>
<tr>
<td>Parent Edu: Middle School^a</td>
<td>–1.20</td>
<td>0.74</td>
<td>0.30</td>
<td>–1.20</td>
<td>0.74</td>
<td>0.30</td>
<td>–1.14</td>
<td>0.75</td>
</tr>
<tr>
<td>Parent Edu: High School^a</td>
<td>0.88</td>
<td>0.66</td>
<td>2.40</td>
<td>0.88</td>
<td>0.66</td>
<td>2.40</td>
<td>0.94</td>
<td>0.66</td>
</tr>
<tr>
<td>Parent Edu: College^a</td>
<td>0.46</td>
<td>0.69</td>
<td>1.58</td>
<td>0.46</td>
<td>0.69</td>
<td>1.58</td>
<td>0.51</td>
<td>0.70</td>
</tr>
<tr>
<td>Parent Edu: Graduate School^a</td>
<td>0.06</td>
<td>0.85</td>
<td>1.06</td>
<td>0.05</td>
<td>0.84</td>
<td>1.05</td>
<td>0.09</td>
<td>0.83</td>
</tr>
<tr>
<td>Constant</td>
<td>–3.75*</td>
<td>1.56</td>
<td>0.02</td>
<td>–3.77*</td>
<td>1.37</td>
<td>0.02</td>
<td>–3.63**</td>
<td>1.36</td>
</tr>
</tbody>
</table>

**Note.** \( e^B \) = exponentiated \( B \).

^a Parent’s or guardian’s highest education level variables are coded as 0 = the participant’s parent or guardian has not attained this education level specified as highest, 1 = the participant’s parent or guardian has attained this education level specified as highest. The excluded education level is the response of “Elementary School,” which was the lowest level of education available among the options presented to participants.

* \( p < .05 \). ** \( p < .01 \). *** \( p < .001 \)
Table G10

Summary of Logistic Regression Analysis for Variables Predicting Placement Test Results Based on the Four Sources of Self-efficacy, Controlling for Gender, Ethnicity, and Parent’s or Guardian’s Level of Education

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Model 20</th>
<th></th>
<th>Model 21</th>
<th></th>
<th>Model 22</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>SE(B)</td>
<td>e^B</td>
<td>B</td>
<td>SE(B)</td>
<td>e^B</td>
</tr>
<tr>
<td>Performance Experiences</td>
<td>0.201***</td>
<td>0.056</td>
<td>1.223</td>
<td>0.202***</td>
<td>0.052</td>
<td>1.223</td>
</tr>
<tr>
<td>Vicarious Experiences</td>
<td>0.002</td>
<td>0.065</td>
<td>1.002</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Verbal Persuasion</td>
<td>0.040</td>
<td>0.041</td>
<td>1.041</td>
<td>0.041</td>
<td>0.036</td>
<td>1.041</td>
</tr>
<tr>
<td>Physiological and Emotional Reactions</td>
<td>-0.089**</td>
<td>0.032</td>
<td>0.915</td>
<td>-0.089**</td>
<td>0.032</td>
<td>0.915</td>
</tr>
<tr>
<td>Gender^a</td>
<td>-0.854*</td>
<td>0.427</td>
<td>0.426</td>
<td>-0.854*</td>
<td>0.427</td>
<td>0.426</td>
</tr>
<tr>
<td>White^b</td>
<td>0.833</td>
<td>1.250</td>
<td>2.301</td>
<td>0.834</td>
<td>1.250</td>
<td>2.302</td>
</tr>
<tr>
<td>Black^b</td>
<td>0.374</td>
<td>1.247</td>
<td>1.453</td>
<td>0.375</td>
<td>1.247</td>
<td>1.455</td>
</tr>
<tr>
<td>American Indian or Alaskan Native^b</td>
<td>1.415</td>
<td>1.599</td>
<td>4.117</td>
<td>1.409</td>
<td>1.590</td>
<td>4.092</td>
</tr>
<tr>
<td>Asian^b</td>
<td>0.064</td>
<td>1.481</td>
<td>1.066</td>
<td>0.058</td>
<td>1.471</td>
<td>1.060</td>
</tr>
<tr>
<td>Latino^b</td>
<td>0.475</td>
<td>1.277</td>
<td>1.608</td>
<td>0.477</td>
<td>1.276</td>
<td>1.611</td>
</tr>
<tr>
<td>Parent Edu: Middle School^c</td>
<td>-1.381</td>
<td>0.793</td>
<td>0.251</td>
<td>-1.381</td>
<td>0.793</td>
<td>0.251</td>
</tr>
<tr>
<td>Parent Edu: High School^c</td>
<td>0.876</td>
<td>0.719</td>
<td>2.402</td>
<td>0.875</td>
<td>0.718</td>
<td>2.400</td>
</tr>
<tr>
<td>Parent Edu: College^c</td>
<td>0.419</td>
<td>0.761</td>
<td>1.520</td>
<td>0.417</td>
<td>0.759</td>
<td>1.518</td>
</tr>
<tr>
<td>Parent Edu: Graduate School^c</td>
<td>-0.113</td>
<td>0.920</td>
<td>0.893</td>
<td>-0.109</td>
<td>0.912</td>
<td>0.897</td>
</tr>
<tr>
<td>Constant</td>
<td>-3.771</td>
<td>2.049</td>
<td>0.023</td>
<td>-3.746</td>
<td>1.912</td>
<td>0.024</td>
</tr>
</tbody>
</table>

| Cox & Snell $R^2$                          | .42      | .42         | .41       |
| Nagelkerke $R^2$                           | .56      | .56         | .56       |
| N                                          | 191      | 191         | 191       |

Note. $e^B$ = exponentiated B.

^a Gender was coded as 1 = male, 0 = female.

^b Ethnicity variables are coded as 0 = the participant is not the ethnicity specified, 1 = the participant is the ethnicity specified. The excluded ethnicity is the response of “Other.”

^c Parent’s or guardian’s highest education level variables are coded as 0 = the participant’s parent or guardian has not attained this education level specified as highest, 1 = the participant’s parent or guardian has attained this education level specified as highest. The excluded education level is the response of “Elementary School,” which was the lowest level of education available among the options presented to participants.

*p < .05. **p < .01. ***p < .001