

EFFECTS ON STUDENTS' SELF-EFFICACY IN A MATHEMATICS BRIDGE
PROGRAM

by

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ABSTRACT

Many beginning college students have historically struggled with both developmental and college-level mathematics. This study investigated whether students' self-efficacy for accomplishing mathematics tasks was increased after participating in a mathematics bridge program. The study also explored whether students gained more self-efficacy as a result of participating in an enhanced intervention designed to increase mathematics self-efficacy. Participants included 246 community college students placed into a developmental mathematics course and subsequently enrolled in the college's mathematics bridge program. The bridge program was designed to provide a one-week review session on high school mathematics topics with the goal of students placing into higher-level courses at the end of the session. A survey measuring mathematics self-efficacy was administered to participants both at the beginning and at the end of the bridge program in order to measure the change in math self-efficacy for each participant. The subsequent statistical analysis included a two-way mixed ANOVA focusing on effects of time, group (traditional intervention group or enhanced intervention group), and first-generation student status (first-generation, continuing-generation, or unknown) to examine if students experienced an increase in self-efficacy upon completion of the bridge program. Students provided open-ended responses to the question, "What did you find most helpful about the Math Refresher course?" A content analysis determined the themes that emerged from the data. Students had a significant increase in self-efficacy ($p < .01$) after participating in the bridge program and there was a significant interaction

effect between time and first-generation status ($p = .032$), with continuing-generation students having a slightly higher increase in self-efficacy. The study contributes to the literature on college readiness and best practices for supporting developmental students.

I. INTRODUCTION

Recent educational attainment predictions estimate that 65% of U.S. jobs will require some form of postsecondary education. Nationally, professional and technical occupations in healthcare services will be the highest in demand through 2020, with a 31% increase. Healthcare support; community services & arts; and science, technology, engineering, mathematics (STEM) occupations are also predicted to increase by 26% (Carnevale, Strohl, & Smith, 2013). Unfortunately, the country's college attainment has steadily declined compared to other nations. In 1990, the U.S. ranked first in the world in 4-year degree attainment among 25- to 34-year-olds. Since then, however, the U.S. has fallen to twelfth in the world (Bailey & Dynarski, 2011). While approximately 50% of all people from high-income families in the U.S. have a bachelor's degree by age 25, just one in 10 people from low-income families do (Bailey & Dynarski, 2011). Back in 2009, President Barack Obama stated that by 2020, America should once again have the largest proportion of college graduates as compared to other nations (Fry, 2017). The U.S. Department of Education estimated that the president's goal would be met if 60% of 25- to 34-year-olds had completed at least an associate degree by 2020 (Fry, 2017). Unfortunately, the U.S. will fall short by 5 million workers if, by 2020, the current graduation attainments rates do not increase as estimated (Carnevale, Strohl, & Smith, 2013).

Background of the Problem

Demographics in the United States are swiftly changing. As of 2010, Hispanics became the largest minority group in the country, making up 16.3% of the population (United States Census Bureau, 2011), and it is estimated that by the year 2050, Hispanics

will comprise 30% of the nation's population (Centers for Disease Control, 2013a). In 2011, African Americans were 13.6% of the total U.S. population (U.S. Census Bureau, 2011), also accounting for a large portion of the nation's population. By the year 2060, it is estimated that African Americans will be 17.6% of the population (Centers for Disease Control, 2013b). While African American population growth is not expected to grow as rapidly as for Hispanics, one troubling truth still remains. Both Hispanics and Blacks are underrepresented in postsecondary settings.

The demographics in American postsecondary institutions do not mirror those of the population at large. In 2010, 13% of college students were Hispanic, 14% were Black (United States Department of Education, 2012), and these percentages are projected to increase. These statistics may reflect the negative practice of "tracking," in which White students are disproportionately placed into advanced level courses offered in high school settings, while minority students are underrepresented in those courses (Stinson, Bidwell, & Powell, 2012). In some of these cases, minority students may have similar placement scores, as compared to their White counterparts, yet tracked into less advanced classes (Barrington, 2018; Oakes, Joseph, & Muir, 2004). Another possible explanation for the underrepresentation of minorities in higher education is the inequity of resources available to primary and secondary schools in poorer school districts; those schools may not be able to offer advanced or AP classes to students, again reducing chances for them to be accepted to college (Barrington, 2018; Kelly, 2009).

In addition and related to minority populations, many first-year students entering 2- and 4-year postsecondary colleges can be classified as college students who are first-generation (FG). FG students are college students whose parents did not complete a four-

year college degree. By contrast, continuing-generation (CG) college students are ones who have at least one parent who earned at least a bachelor's degree. Studies have found that first-generation college students experience more struggles in their college careers because they begin college with many disadvantages. For instance, higher percentages of FG college students take remedial courses upon entering college when compared to their CG counterparts (Chen, 2016). Also, a larger percentage of FG students come from lower-earning households than CG college students (Postsecondary National Policy Institute [PNPI], 2016; Redford, Hoyer, & Ralph, 2017), and among students who were not college ready, CG students were more likely to return to school after their first year of college than FG students (Redford et al., 2017). FG students are predominantly non-White (PNPI, 2016). Additionally, 34% of undergraduate students in the 2011-2012 academic school year were first in their families to attend college, while an additional 28% had parents with some college experience, but no bachelor's degree (PNPI, 2016).

Many FG students have challenges entering college life, navigating the college system, maintaining academic success, and, in general, thriving in college life (Stebbleton & Soria, 2012). While many students have a difficult time adjusting when leaving high school and beginning postsecondary schooling, for FG students, the transition may be much more challenging. FG students' parents may not have the knowledge and understanding of college life to serve as anchors of support for their children, or to provide them with motivation to persist and succeed in college. Thus, these students have fewer role models at home and less help, support, and encouragement from home (Stebbleton & Soria, 2012). Many FG students struggle academically when beginning postsecondary education; that is, they receive lower grades (Stebbleton & Soria, 2012).

Furthermore, specifically related to this study, FG students often have lower math skills than their CG counterparts (Stebbleton & Soria, 2012).

Additional differences between FG and GG students include competing job responsibilities, family responsibilities, weak math skills, weak English skills, inadequate study skills, feeling stress, and developing depression (Stebbleton & Soria, 2012).

Moreover, these factors are likely to compound on one another, presenting several obstacles at the same time (2012), and this may cause greater challenges for FG students to reach their goals (Engle & Tinto, 2008). The number of FG students will likely increase, and educators and learning assistance professionals must be aware of this trend and advocate for these students (Stebbleton & Soria, 2012).

Regardless of minority or FG status, most students who are referred to basic skills instruction, such as remedial or developmental courses, upon beginning college coursework have struggled to complete their sequences (Asera, 2011; Bailey, Jeong, & Cho, 2010; Ganga, Mazzariello, & Edgecombe, 2018), and those that begin at the lowest levels of remediation are less likely to complete the desired college-level course (Hern, 2012). Additionally, researchers have found that students who are referred to developmental courses may never enroll in the course, or if students do enroll in the first developmental level course, they do not enroll in the next subsequent level course (Rutschow & Schneider, 2011). Estimates are that less than 25% of students who begin college in developmental courses will ever complete a degree (Bailey, 2009; King, McIntosh, & Bell-Ellwanger, 2017), making developmental education courses seem problematic instead of helpful for students.

Of particular concern for this study are the number of students who struggle with completing their developmental mathematics sequence, which is the most heavily populated developmental education arena (Fong & Visser, 2008; King et al., 2017). In fact, only about 33% of students who place into and enroll in developmental level mathematics will ever complete the sequence of prescribed mathematical classes (Bailey et al., 2010; Ganga et al., 2018). Even further, a 2014 study conducted by the Community College Research Center found that only 11% of students who begin at the lowest levels of developmental math will ever complete the required college level math course (Jaggars & Stacey, 2014).

Recent pedagogical teaching reforms are being employed to improve students' success and lessen the length of time needed for students to complete their developmental course sequence. For mathematics in particular, these reforms include initiatives such as co-requisite course models in which students are enrolled in a developmental mathematics course and are co-enrolled with the matching college credit course, integrated and paired models such as pairing a developmental mathematics course with a study skills course, and various math pathway courses such as Statway, Quantway (Hoang, Huang, Sulcer, & Suleyman, 2017), and the Mathematics Pathways to Completion Program (Dana Center, 2016).

Statway is a year-long, college-level statistics course which incorporates developmental and college-level content (Huang, 2018). Similar in structure, Quantway is typically a two-term quantitative reasoning pathway course comprised of a developmental math course (Huang, 2018). Both of these pathways allow students to employ statistical and quantitative reasoning concepts in their studies that are more

relevant to their educational and career goals than current traditional algebraic sequences (Huang, 2018). The Dana Center's Mathematics Pathways to Completion program matches specific math subjects to specific majors (Dana Center, 2016).

In addition, accelerated initiatives such as summer bridge programs are being utilized to help students to expedite and complete these sequences. Summer bridge programs are designed to help students move through their developmental course sequences more quickly. In a summer bridge program, students can take summer courses at their college for several weeks before they begin fall classes. Summer bridge programs are usually voluntary and differ by length, but most often share a target population (e.g., students first in their generation to attend college, students from low-income family backgrounds, and students from minority backgrounds) (Barnett, Bork, Mayer, Pretlow, Wathington, Weiss, 2012 ; Wathington, Barnett, Weissman, Teres, Pretlow, Nakanishi, 2011).

These reforms require careful study and may not offer a solution to all problems that developmental students face (Edgecombe, 2011). For example, some students may be inappropriately placed into a developmental course level upon initial assessment, therefore leading to boredom for the student inappropriately placed into a lower course level (Jaggars & Stacey, 2014). Secondly, some students may actually benefit more from a decelerated course pace, instead of an accelerated pace, where the college-level course is offered along with developmental content, giving the student more time to master competencies (Edgecombe, 2011). Thirdly, developmental students are less likely to elect to participate in such a program because they often do not see the benefit of doing so, and others will drop out early unless the program is mandated (Frost & Dreher, 2017).

Additionally, upon implementation of programs such as Statway and Quantway, Carnegie researchers began to study the success and failures of students in these pathways. Faculty members from colleges that were implementing these programs were asked what factors lead some students to succeed while others were not successful. Successful students, the faculty reported, have faith that they can succeed as math students. They persevere despite challenges or failures, use goal-setting techniques, are not shy to ask questions, and build interdependent relationships with their classmates (Silva & White, 2013). In other words, motivational factors may significantly contribute to the successes or failures of students participating in any kind of program or reform.

Hence, the study of self-efficacy is an important construct for understanding entering college students' behaviors and especially their study behaviors in developmental mathematics coursework. Self-efficacy, a sub-construct of motivation, refers to an individual's belief in his or her capacity to execute and accomplish certain behaviors, and to exert control over his or her motivation and social environment (Bandura, 1997). Educators are primarily concerned with how self-efficacy can influence students' selection of goals, their energy, effort, and persistence toward goals achievement, and their beliefs that vary depending on the occurrence of past and current behavior (Bandura, 1997; Schunk, Meece, & Pintrich, 2014; Zimmerman & Cleary, 2006).

A student's belief that they can accomplish a particular academic goal is crucial to their success (Bandura, 1997). Without this belief, students may not be willing to put forth the required effort to persist and accomplish their academic goals. In addition, if students experience success in achieving one goal, their outcome expectancies may be

positively affected (Eccles & Wigfield, 2002), and they may be enticed to try to reach more advanced goals (Bandura, 1997; Eccles & Wigfield, 2002; Schunk et al., 2014; Zimmerman & Cleary, 2006).

Statement of the Problem

Postsecondary education is experiencing a large influx of students that need developmental mathematics courses, even though many of these students have graduated from accredited high schools and are believed to be college-ready (Bonham & Boylan, 2011). Much attention has been placed recently on different modalities of course offerings to help accelerate students through their developmental education sequences, and summer bridge programs are gaining popularity as one such intervention (California Community Colleges Chancellor's Office [CCCCO], 2013; Hern, 2012). However, the question remains: do these summer bridge programs work? This study will investigate if summer bridge programs help FG students to increase their self-efficacy so that they may be more likely to continue in their college pursuits.

Research Questions

Question 1

Does self-efficacy (SE) for accomplishing mathematics tasks change over Time (from Mathematics Self-Efficacy Scale pretest to Mathematics Self-Efficacy Scale posttest) for students taking the math refresher course, and is the change moderated by Group (traditional intervention vs. enhanced intervention or TI vs. EI), by first-generation student status (first-generation status vs. continuing-generation status vs. students who don't know their parents' educational backgrounds or FG vs. CG vs. Unknown), or by both variables?

Hypothesis 1(a). Students participating in the math refresher course are hypothesized to experience a change in mathematics self-efficacy affected by Time (from pretest to posttest).

Rationale 1(a). According to self-efficacy theory, students may experience gains in self-efficacy through four main sources, with mastery experiences being the most effective. During the course of the math refresher course, students will review math topics and are likely to experience mastery of these topics. If students create a mastery experience for themselves, efficacy for accomplishing these math tasks is likely to increase. However, the possibility that students do not create a mastery experience for themselves also exists. A mastery experience may not be created if the student does not put forth much effort while in the course of the bridge program, and in this case the students may not see a change in SE for math tasks. The third possibility is that the student could see a decrease in SE for math tasks. Although this scenario is unlikely, a decrease in SE is still a possibility nonetheless.

Hypotheses 1(b). FG students are hypothesized to have a greater change in SE from pretest to posttest as compared to CG students.

Rationale 1(b). Current research on FG college students posits that they are at a great disadvantage for successfully completing college when compared to students who are CG students. FG students often feel less prepared for college work and less confident in their abilities to succeed in college life than do their CG counterparts. Hence, the mathematics refresher course can potentially give FG students an increase in SE for achieving mathematics tasks. This increase in math SE can then help them to succeed in their college mathematics courses.

Hypothesis 1(c). Students in the EI (enhanced intervention) group are hypothesized to have a greater change in SE from pretest to posttest than those in the TI (traditional intervention) group.

Rationale 1(c). Many students who participate in the math refresher course will advance in course level as a result of participating in the program. Hence, the act of participation is considered to be the TI (traditional intervention), designed to help students to accelerate through developmental mathematics. Referring to Hypothesis 1(a), my analysis will determine if there was a change in SE for all students in the program regardless of Group membership. Students participating in the EI (enhanced intervention) will participate in the program and complete the basic program materials, but in addition they will also complete three more activities designed to target the other three sources of self-efficacy. Therefore, students in the EI group are likely to see a greater change in SE as compared to the students in the TI group. However, two other possibilities exist. The next possibility is that results could show no change in SE when comparing students in the TI and EI groups. This could occur if the additional activities completed by students in EI are not effective in addressing the three additional sources of SE, thus providing no catapult for an increase in math SE. Finally, students in EI could see a lesser change in math SE as compared to the students in the TI group. However, this situation is not theoretically likely to happen.

Hypothesis 1(d). It is hypothesized that the interaction of FG and Group will affect SE.

Rationale 1(d). As mentioned above, there is a need to investigate interventions that will be beneficial to FG students. The purpose for examining the effects of the

interaction between FG and Group is to pinpoint which SE interventions work best for what subgroups of students, if any. In other words, since FG students are typically less prepared for college than CG students, there may be a combined effect of FG status and Group on change in math SE. It is possible that FG students may need an additional intervention above the normal math refresher course activities in order to make a difference in SE as measured from pretest to posttest.

Question 2

What are students' perceptions of the helpfulness of the math refresher course?

Hypothesis 2. For Question 2, there is no hypothesis. Students' open-ended responses were recorded. Afterwards, the focus was on categorizing the responses.

Rationale 2. The rationale for asking this question comes from the desire to understand more clearly what characteristics of the program factor most into its success. As stated earlier, most bridge programs report good success. That is, most programs produce advancement rates above 60%. Answers to Question 2 will help to narrow the reasons why programs similar to the one in this study are successful. Such knowledge can offer creators of newer initiatives ideas to which they may draw upon for their designs.

Purpose of the Study

Through this research, my intent was to determine whether students experience a change in self-efficacy as a result of participating in the summer bridge program. The Mathematics Self-Efficacy Scale was administered to students as a pretest and a posttest in order to measure the difference in Math SE scores for completing mathematics tasks before and after participating in the program. Factors that contribute to students' success

in the bridge program were also examined. Statistical analyses were used to determine if there is an increase in self-efficacy for the participants due to solely participating in the program, due to group status (EI vs. TI), or due to first generation (FG vs. CG vs. Unknown) status. Factors that are probabilistic to student advancement in the bridge program will also be determined, and student perceptions regarding their success in the program will be explored.

Significance of the Study

While some research studies have found that summer bridge programs have positive outcomes for student advancement (Barnett et al., 2012; Rodgers, Posler, & Tribble, 2011), few studies have been conducted to explore the effects of summer bridge programs on students' self-efficacy; with even fewer studies targeted specifically for students enrolled in developmental education courses. There are many studies on summer bridge programs that focus on academic success, but few that focus specifically on mathematics self-efficacy. This study attempts to explore changes in self-efficacy between students who are identified as FG college students and those who are CG students after participating in a summer bridge program. This knowledge will be helpful for future incoming college students and for administrators of developmental education programs. By identifying initiatives that work best for FG student, program administrators will be able to more successfully help FG students to succeed academically. Differences, if any, in self-efficacy change were explored for students who participated in the TI group, which included the only math bridge program, and for those who participate in an EI group, designed to increase students' math self-efficacy.

Students gave open-ended responses to what they felt was most helpful about the bridge program.

The results of this study may add to the existing literature on college readiness and developmental education initiatives, specifically as they relate to practices that are used to accelerate students through developmental math sequences. This study will provide information on students' possible increase in math self-efficacy after participating in the summer bridge program and on specific aspects of the summer bridge program students perceived were most helpful. Additionally, the outcome of this study may provide information about the benefits of summer bridge programs to not only community college districts but also to the educational community at large.

Definition of Terms

Since some terms may have different meanings according to the context of the given problem, the following definitions should be established for purposes of this research.

- *Continuing-generation (CG) college students* are students who enrolled in postsecondary education and who have at least one parent who had some postsecondary education experience (Redford et al., 2017).
- *Developmental education* is a comprehensive process that focuses on the intellectual, social, and emotional growth and development of all students. Developmental education includes, but is not limited to, tutoring, personal/career counseling, academic advisement, and coursework (National Association for Developmental Education, n.d.).

- *First-generation (FG) college students* are those whose parents have some higher education experience (Redford et al., 2017). For purposes of this study, I will define first-generation students as those who do not have at least one parent with a bachelor's degree or higher.
- *Quantway* is a two-term quantitative reasoning pathway comprised of a developmental math course, Quantway 1, and a college-level course, Quantway 2. Quantway 1 is a single-semester quantitative reasoning course that fulfills the requirements for students' developmental mathematics sequence and prepares them for success in subsequent college-level math. Quantway 2 is a college credit-bearing quantitative reasoning course that can be taken subsequent to Quantway 1 or as a standalone course. Quantway 1 and 2 embrace productive persistence and supports for quality teaching in its theory of improvement (Huang, 2018).
- *Remedial education* is a group of courses and/or activities to assist learners to achieve secondary school-level basic skills in their identified academic deficit areas (Arendale, 2007).
- *Self-efficacy* is defined as a person's beliefs for accomplishing a specific task (Zimmerman, 1990). It is a component of social cognitive theory which operates along with other determinants to govern human thought, motivation, and action (Bandura, 1997). Within this study, students' SE will be measured before and after completing the bridge program to calculate any changes.
- *Statway* is a year-long, college-level statistics sequence designed with supports for developmental math students. It integrates developmental and college-level

content so students who complete the entire pathway fulfill both their remedial and college-level mathematics requirements, earning a college-level math credit. It replaces the traditional algebra sequence with a year-long statistics sequence, allowing developmental math students to earn college-level credit for statistics in a single academic year. Statway embraces productive persistence and supports for quality teaching in its theory of improvement (Huang, 2018).

- *Summer bridge programs* are designed to help students move through their developmental course sequences more quickly than taking all developmental level courses prescribed to them. In a summer bridge program, students take summer courses at their college for several weeks before they begin fall classes. Bridge programs are usually voluntary, and the target population usually includes first-generation, low-income, and minority students.

Assumptions

It is assumed that students gave truthful responses to the entry survey and exit survey, and honestly rated themselves on the Mathematics Self-Efficacy Scale. This is a necessary assumption to make or else the findings of the study will be of no value. Students were promised (by way of consent form) that their responses would be kept confidential, and therefore, there is reason to believe all responses were truthful.

Scope

The scope of this study includes changes in students' self-efficacy for completing math tasks as measured before and after participating in a summer mathematics bridge program. The sample of students includes those entering community college who placed into a developmental education math course upon initial placement testing. University

students were not included in the study, nor were students who initially placed into college level math courses.

Conclusion

Many college students—and especially first-generation students—struggle to obtain a degree due to a myriad of reasons. In community colleges, developmental education is prominent, but findings on its effectiveness have not been consistently positive. In mathematics, a large number of students fail to finish their developmental education sequences, and subsequently, these students also fail to finish their college-level math courses. Educators must attempt to find ways to expand the number of students who are successful in developmental education and who complete college-level math courses. Various initiatives have been created over the years in an attempt to accelerate students through their developmental education sequences and into college-level courses. Several studies have shown that summer bridge programs show positive results for helping to accelerate students through development education, but this study will examine whether students also gain an increase in self-efficacy for completing math tasks as a result of participating in a summer bridge program.

II. REVIEW OF THE LITERATURE

This chapter is a review of the extant literature that relates to first generation students and their participation in a developmental mathematics refresher summer program using a self-efficacy intervention. The review of literature will highlight seminal and recent works on first generation students, developmental mathematics, and refresher program interventions for mathematics, with emphasis on the construct of self-efficacy and social cognitive theory to underpin this study.

First-Generation Students

The United States is currently experiencing a change in demographics as minority groups are becoming more populous. According to the U.S. Census Bureau (2015), by the year 2060, the minority population in the nation is expected to increase by 18.6% from the year 2014 (with Hispanics expecting the largest growth), and minorities will have surpassed the White population by 12.8%. As a result of these changing demographics, the population of entering college students from minority groups is expected to continue to grow on college campuses. Many minority students are also first-generation (FG) college students. In this chapter, I will (a) provide a definition for FG college students, (b) discuss aspirations for future FG college students, (c) give characteristics of FG students, (d) review current interventions for FG students, and (e) discuss the academic success of FG students.

Definition of First-Generation College Students

According to the literature, many definitions of FG students exist. For example, Nunez and Cuccaro-Alamin (1998) and Choy (2001) identified students as FG if neither parent enrolled in any postsecondary institution. Other researchers, such as Collier and Morgan (2008) and Pike and Kuh (2005), only referred to students as FG if neither parent

earned a bachelor's degree. More recently, Aspelmeier, Love, McGill, Elliott and Pierce (2012) defined FG college students as those students with no member of their immediate family having earned at least an associate's or a bachelor's degree. Often the definition of FG students reflects how parental education status was collected within specific studies. For example, a survey asked a group of ninth-graders, "Has one or both of your parents or guardians graduated from a four-year college or university?" (Toutkoushian, Hossler, DesJardins, McCall, & Canche, 2015). When attempting to answer surveys on FG status, some students reported having difficulties interpreting what is truly being asked about their parents' level of education. Even when more detailed questions are used, surveying students about their parent's education can yield missing and inaccurate data because respondents may not always know the precise education levels of each of their parents (Toutkoushian et al., 2015).

With regard to the growing Hispanic population in the U.S., parental education levels, on average, have been relatively low (Vargas & Conlon, 2011; Woosley & Shepler, 2011). A common definition would aid researchers, as the connection between parent level of education and postsecondary students' enrollment decisions will grow in importance. For purposes of this investigation, FG college students are defined as college students with neither parent having earned a bachelor's degree.

Characteristics of First-Generation College Students

FG students comprise 34% of undergraduate students enrolled in U.S. postsecondary institutions. One-third of FG students are at least 30 years or older and most are predominantly non-White and from low income backgrounds with households

with fewer resources. FG students also tend to be older, to have dependent children, and to be female (PNPI, 2016; Redford et al., 2017).

Comparison to Continuing-Generations Students. FG student enrollment and completion tends to differ from CG students (PNPI, 2016). FG students are more likely than their CG peers to enroll in a 2-year institution rather than a 4-year institution, enroll in for-profit institutions, attend college part-time, and participate in distant education. FG students, in general, work more hours per week and have less financial support than their CG peers (Mehta, Newbold, & O'Rourke, 2011), and FG students are less likely to complete their college degree in a timely manner than are CG students (DeAngelo, Franke, Hurtado, Pryor, & Tran, 2011; Redford et al., 2017).

First-generation college students' assets. Often, literature concerning FG college students describes a deficit model. However, it is important to provide a balanced view as FG students bring many assets with them to college (Yosso, 2005). For example, FG college students bring with them firsthand knowledge of the challenges faced by the majority of people (White, 2016). Many have succeeded in challenging economic and social conditions, most likely sharpening their sense of grit and tenacity (Saenz, Garcia-Louis, Drake, & Guida, 2018). They can be highly aware of and bring insight to issues of equity and justice (White, 2016). Many of these students also bring a high appreciation for familial and communal collaboration (Saenz et al, 2018). They are more likely than CG students to want to help their family members by being a role model (White, 2016) and are more likely to pursue degrees to honor their families and to help them financially (Banks-Santilli, 2015; Engle & Tinto, 2008).

Despite the strengths that FG students bring with them, they often have difficulty adjusting to postsecondary schooling (Cataldi, Bennett, & Chen, 2018). In fact, this study is primarily concerned with exploring an intervention that may help FG students to be successful in the transition from developmental mathematics to college-level mathematics. A description of FG students' struggles follows.

First-Generation college students' struggles. Without interventions, many FG college students struggle academically when beginning postsecondary education. That is, they receive lower grades and rank below CG college students in GPA (Chen & Carroll, 2005; Stebleton & Soria, 2012). Some researchers have reported that some but not all FG students to have inadequate study skills, emergent English language skills (for those that are English Language Learners), and lower math skills (Stebleton & Soria, 2012). According to Reyes and Nora (2012), FG students take significantly fewer credit hours and take fewer courses in areas such as social sciences and humanities than CG students. FG students traditionally rank below their CG counterparts in completion of academically rigorous courses and performance on standardized tests, and typically exhibit a lower level of confidence (Atherton, 2014). Additionally, researchers have found that FG college students may take longer than six years to complete a degree (Cahalan, Perna, Yamashita, Ruiz, & Franklin, 2016). For math and science, FG college students have been shown to have fewer and lower-quality learning experiences than their CG peers, experience less support for attending college, report lower confidence in academic performance, and show less of a preference for active coping skills (Bloom, 2007; Bui, 2002; DeFritas & Rinn, 2013; Mehta et al., 2011).

FG college students also show lower levels of extracurricular involvement, athletic participation, volunteer work, and extracurricular interactions with peers (Pascarella, Pierson, Wolniak, & Terenzini, 2004; Reyes & Nora, 2004), and thus have less social capital (i.e., the networks of relationships among people who live and work in a particular society, enabling that society to function effectively) than CG students (Mehta et al., 2011). For example, Nuñez and Cuccaro-Alamin (1998) note that FG college students are more likely to report low levels of academic engagement, which includes attending career-related events, meeting with academic advisors, participating in study groups, going places with friends from school, and participating in school clubs (Reyes & Nora, 2012). Such findings are significant since FG college students begin college with lower confidence in their abilities to complete college work (Bui, 2002; DeFritas & Rinn, 2013; Saenz, Hurtado, Barrera, Wolf, & Yeung, 2007) and may benefit more than CG students from extracurricular activities and social interaction (Banks-Santilli & Villegas-Reimer, 2013; Pascarella et al., 2004), as having more social interactions can help students to better cope in stressful situations (Mehta et al., 2011).

FG students are more likely to consider proximity and financial issues as important factors in their decisions of where to attend college. Many students report feeling guilt for leaving their families behind to attend college (Banks-Santilli, 2015; Covarrubias & Fryberg, 2015). In fact, many FG college students choose to enroll in postsecondary institutions within 50 miles of home to stay close to their families (Saenz et al., 2007). FG students are also more likely to work as college students (Saenz et al., 2007). Unfortunately, working can also act as a detriment to academic success, drawing students away from engaging college experiences, such as extracurricular involvement,

athletic participation, volunteer work, and non-course related interactions with peers (Reyes & Nora, 2012).

FG students' parents may not have the knowledge and understanding of college climate to firmly support their children, or to provide them with motivation to persist and succeed in college. Hence FG students enter college with less navigational capital (i.e., the skills required to maneuver through social institutions [Yosso, 2005]), than do CG students (Mehta et al., 2011). Familiarity of college culture is developed and passed from interactions with others and is most often learned from parents and/or peers who attended or are currently attending college. Because of FG parents' lack of postsecondary experience, FG students typically have fewer role models at home and less help, support, and encouragement than their CG counterparts (Collier & Morgan, 2008). The social and family characteristics may further impact FG students' motivations to enroll in college, their decisions on where to enroll, and their academic success and social integration while in college (PNPI, 2016).

Considering the challenging conditions under which FG students begin postsecondary schooling, many are required to take at least one developmental course upon beginning college. This study focuses on the fact that many FG students need developmental education, yet developmental education courses are not shown to be consistently successful for these students. Hence, a large portion of FG students are possibly being negatively affected in developmental education, especially in developmental mathematics.

These various factors are likely to compound one another, presenting several obstacles at the same time (Stebbleton & Soria, 2012) and causing greater challenges for

FG college students in reaching their goals (Engle & Tinto, 2008). A greater percentage of FG college students leave higher education without obtaining a degree than do their CG counterparts (Engle & Tinto, 2008). Of those FG students who leave college, many cite financial troubles as their reason for leaving (Redford et al., 2017), while others cite a change in family status as their reason for leaving college (Redford et al., 2017). As mentioned previously, the number of FG college students is predicted to increase, and educators and learning assistance professionals must be aware of this trend and increase advocacy for these students (Stebbleton & Soria, 2012).

Interventions Specifically for First-Generation College Students

Over the past half-century there have been multiple interventions presented with the aim of aiding FG students as they begin and continue in college life. However, because FG students begin the college process with less social and navigational capital than their CG peers, it is likely that the FG students who have benefitted from these interventions have done so because targeted and intervention program options were offered to them upon arrival to the postsecondary setting. This section provides a cross-section of the interventions that have been implemented and that exist today for FG college students, programs that commonly include academics, counseling, mentoring, tutoring, social factors, cultural factors, and motivation. Highlighted are Federal TRiO programs, the PUENTE Project, and programs that emphasize socio-psychological factors, skills and support, and lay theory interventions.

TRiO. The Federal TRiO programs were established in 1964 and are the primary federal programs providing support services to disadvantaged students, including low-income and FG college students, for the purpose of promoting achievement in

postsecondary education and easing the transitions from high school to undergraduate and graduate education (Dortch, 2018). The TRIO programs serve not only low-income and FG students, but they also serve veterans, homeless youth, foster youth, and individuals underrepresented in graduate education. Initially, three TRIO programs were established, but there are now four additional programs, each with a specific mission for underserved student populations, along with one training program for TRIO staff (United States Department of Education [USDOE], 2018).

As TRiO programs, *Educational Opportunity Centers*, *Talent Search*, *Upward Bound*, *Upward Bound Math and Science*, and *Veterans Upward Bound* all offer services to middle, high school, and adult students. The goal of these programs is to encourage students to graduate from high school and pursue a postsecondary education, as well as to provide them with multiple forms of assistance, such as academic, career, financial aid counseling, tutoring, and support during the application process (USDOE, 2018). These programs are designed to compensate for students' lack of cultural and social capital, as a result of racism, poverty, lack of familial support, and low literacy development (Espillat, Moorer, & Abreu, 2017).

Upward Bound (UB) and Upward Bound for Math and Science (UBMS) have been the most researched (Dortch, 2018). The Pell Institute for the Study of Opportunity in Higher Education, for example, found when comparing UB/UBMS participants to non-participants: 75% of UB/UBMS participants entered higher education within one year of high school graduation (compared to 45%) and were 3.3 times more likely to obtain a bachelor's degree within six years (Cahalan & Goodwin, 2014). This corroborates other significant research findings of UB and UBMS participants compared to similar non-

participants in terms of higher enrollment rates and higher levels of postsecondary educational degree completion (Balz & Esten, 1998; Burkheimer, Riccobono, & Wisenbaker, 1979; McElroy & Armesto, 1998; Research Triangle Institute International [RTI], 2018; Seftor & Calcagno, 2010). Seftor and Calcagno (2010) also found that for UBMS participants, enrollment shifted from 2-year to 4-year institutions, enrollment increased at more selective institutions, students took more science and math courses, and the likelihood of earning a degree in a science related field increased.

While published research studying the outcomes of Talent Search (TS) has been limited, researchers have reported that in 2013-2014, TS helped more than 79% of participating students become college-ready and enroll in postsecondary education (RTI, 2018). Earlier researchers also reported TS students were more likely to graduate from high school, apply for financial aid, and enroll in 2- and 4-year institutions than similar students not participating in TS (Schulz & Mueller, 2007). Veterans Upward Bound supports thousands of veterans annually to prepare for, enroll in, and succeed at postsecondary education (RTI, 2018). For Educational Opportunity Centers, during fiscal year 2013–2014, participating institutions assisted about 57% of their college-ready adult participants with economic and financial enrollment and with preparation into postsecondary education (RTI, 2018).

Once students enter postsecondary education, *Students Support Services (SSS)* and the *Ronald E. McNair Post-Baccalaureate Achievement Program* (McNair) provide qualified students with academic and personal support. SSS is most closely related to this study as the program was also designed to assist low-income and FG undergraduate postsecondary students. The SSS program supports many low-income and FG students

in transferring from 2-year to 4-year programs (Chaney, 2010), and persisting and completing degrees (Chaney, 2010; RTI, 2018). The program specifically assists with basic college applications, ongoing advising, academic tutoring, success coaching, and affective personal development programs (Agee, Hodges, & Castillo, 2018). For example, Dortch (2018) reported that students participating in SSS in the 2007-2008 academic year (AY) had higher persistence and completion rates at both 2-year and 4-year institutions than did similar students who did not participate in SSS. For first-time, full-time students at 2-year institutions in during 2007-2008 AY, 86% persisted to the next AY and had a 3-year degree completion rate of 41%. At 4-year institutions, first-time, full-time SSS students persisted at a rate of 93% and had a 6-year completion rate of 48% (Dortch, 2018). Similarly, the U.S. Department of Education (2015) researchers found that SSS first-time freshmen persisted at a rate of 86%, compared to 65% of those in the sample group (Zeiser, Chan, Heuer, & Cominole, 2015).

McNair programs assist students from disadvantaged backgrounds to enroll in and complete graduate programs (Agee, Hodges, & Castillo, 2018; Gittens, 2014). In fact, of the McNair participants who earned bachelor's degrees in 2010–2011, 71.8 % enrolled in graduate school within three years (RTI, 2018).

In summary, the federal TRiO programs have provided a tremendous amount of assistance to low-income and FG students over the past 50 years (Dortch, 2018). However, there is still a great need for assistance for FG students, particularly since many FG students come from underrepresented populations. The following intervention addresses the needs of FG and underrepresented students.

PUENTE. The PUENTE Project, established in 1981 at Chabot College in Hayward, California, is an award-winning program that has improved the college-going rate for U.S. first-generation students and students of other underrepresented populations. The mission is to increase the number of educationally disadvantaged students who enroll in 4-year colleges and universities, earn college degrees, and return to the community as mentors and leaders to future generations. The program is inclusive of all students and has an interdisciplinary approach, offering students with assistance in writing and providing counseling and mentors. The PUENTE Project has program sites available in campuses throughout the United States. Staff and instructors from middle schools, high schools, and community colleges are trained to provide support in academics, counseling, and mentoring (PUENTE Project, 2018a). For example, in 2009-2010, the transfer rate from 2-year to 4-year institutions of PUENTE participants was 56%, compared to 44% for all California community college students and compared to 34% of similar non-participating PUENTE students (PUENTE Project, 2018b). To that end, PUENTE has been distinguished as an exemplary socialization model for FG students entering postsecondary education by several studies, as it combines mentoring, coaching, and academics (Laden, 1999; Gandara & Moreno, 2002, Gandara, 2002; Rendon 2002).

Both the TRiO and PUENTE Programs are large college support programs that have been implemented throughout the United States. Through a combination of techniques such as counseling, tutoring, and mentoring, these two programs have been able to assist many FG students to complete high school, enter college, and complete bachelor's and graduate programs.

Interventions that combine skill development and affective support. In addition to benefits students receive from programs such as TRiO or PUENTE, many institutions have created unique programs that are specific to their needs and to their students' needs. The programs described in this section range from bridge programs to learning communities, all designed to help FG students acclimate to campus life and succeed academically.

Skills Learning Support Program. The Skills Learning Support Program (SLSP) was designed and implemented (at a university in the northeast area of the United States) with a focus on supporting FG college students' motivation, use of self-regulatory strategies, and academic achievement (Wibrowski, Matthews, & Kitsantas, 2017). The program required students to attend a 6-week intensive summer academic program prior to admission as regular students in their freshman year. The goal of the program was to prepare students for the academic and social demands of college life; the program provided college preparatory coursework, study skills instruction, tutorial assistance, and extensive counseling services. In this longitudinal study, students in the SLSP program reported significant positive changes in motivation ($p = .001$), increased use of learning strategies ($p = .001$) and resource management strategies ($p = .001$), higher levels of goal mastery orientation ($p = .01$), and lower levels of performance-approach ($p = .05$) and performance-avoidance orientations ($p = .001$). SLSP students achieved at significantly higher levels than students who were regularly admitted, and those students continued to do so until the fourth year of study (Wibrowski et al., 2017).

Counseling and support intervention. A study conducted in California sought to test the effect of increasing supportive relationships on campus through a counseling and

support services intervention. Students were offered services through the Educational Opportunity Program, the Academic Support Program for Intellectual Rewards Enhancement, and the Faculty Mentoring Program, with the hope that participating students would be able to develop significant relationships with peers and mentors and, in turn, feel more integrated into the campus. Results showed that students who reported higher levels of self-esteem and more peer support had better academic and social adjustment. In addition, students who utilized student support services and counseling reported better adjustment to campus life. Finally, those students who were better adjusted to campus life were more likely to be committed to the university and to completing a degree (Grant-Vallone, Reid, Umali, & Pohlert, 2003-2004).

Collegiate Bridge Research Program. The Collegiate Bridge Research Program is a course-based introduction for first-year students that encourages undergraduate research opportunities and provides out-of-class events, tutoring, and academic coaching. The researchers reported that student participants had higher retention rates and, in subsequent years, and had a higher 4-year graduation rate than non-participants (Olson-McBride, Hassemer, & Hoepner, 2016).

Interventions that utilize skill-building combined with academic and social support can also be effective. The use of tutoring and counseling can help students to adjust and persist in college life (Cerezo & McWhirter, 2012; Gonzales, Brammer, & Sawilowsky, 2015; Grant-Vallone et al., 2003-2004; Olson-McBride et al., 2016) and learn to strategize well (Arco-Tirado, Fernandez-Martin, & Fernandez-Balboa, 2011; Wibrowski et al., 2017). Tutoring and counseling can also increase students' motivation (Wibrowski et al., 2017) and ultimately, help to increase academic achievement and

graduation rates (Grant-Vallone et al., 2003-2004; Olson-McBride et al., 2016; Tuckman & Kennedy, 2011; Wibrowski et al., 2017).

Interventions that specifically address social-psychological issues. Given that FG students begin postsecondary education with less social capital than CG students, researchers such as Yeager and Walton (2011) have designed small social-psychological interventions to address these issues. These interventions include brief exercises that target students' thoughts, feelings, and beliefs in and about school. These interventions do not teach students academic content but instead target students' psychology, including their beliefs about whether or not they have the potential to improve their intelligence or they belong and are valued in school. Although the exercises are brief, these interventions can lead to large gains in student achievement and sharply reduce achievement gaps seen between FG and CG students that can still be seen months and years later (Yeager & Walton, 2011).

Lay theory interventions. Similar in ideology to social-psychological interventions, Yeager (2016) later defined what he calls *lay theory interventions*. A lay theory is a set of beliefs that is used to interpret one's experiences (Yeager, Walton, Brady, Akcinar, Paunesku, Keane, Kamentz, Ritter, Duckworth, Urstein, Gomez, Markus, Cohen, & Dweck, 2016). In the case of college, two beliefs have been flagged as especially important: that the transition to college inevitably involves setbacks, and that these setbacks are temporary (Strauss, 2016). For example, when a student begins college, it is not unusual for the student to be affected by negative or critical feedback from a professor. However, for FG students, such negative remarks can be misconstrued or internalized by the student as feelings that they don't belong in college or that the

professor does not like them. These negative feelings can lead to disengagement from the academic or social environments and can eventually lead to withdrawal of the student from college (Yeager et al., 2016). Both lay theory and socio-psychological interventions are designed with the intent to disrupt this negative cycle by creating a different narrative, one in which challenges are understood as a common part of the college experience and that these challenges can be overcome by hard work and by utilizing college resources. This proactive thinking can encourage more academic and social engagement, resulting in higher achievement and persistence for FG students (Yeager et al., 2016). The following are examples of lay theory and socio-psychological interventions.

A recent lay theory intervention was designed for FG students to (a) promote a growth mindset (b) acclimate to the campus climate, and (c) encourage FG students to foster new and former social relationships (Yeager et al., 2016). For students exiting a high-performing charter high school network and entering a public flagship university, results showed that the lay theory interventions raised first-year, full-time college enrollment among students from socially and economically disadvantaged backgrounds. For those entering a selective private university, the intervention raised disadvantaged students' cumulative first-year grade point average. These gains correspond to more than a 30% reduction of the achievement gaps between students from disadvantaged and non-disadvantaged backgrounds at those institutions. Data from follow-up surveys given at a later date suggested that the interventions improved disadvantaged students' overall college experiences, as they reported a higher use of student support services and tended to develop more friendship networks and mentor relationships (Yeager et al., 2016).

Difference-education intervention. Closely related to lay theory interventions, a difference-education intervention was created and offered within a bridge program setting to incoming FG college students in order to ease the transition into higher education. Students were shown that their backgrounds can be thought of as both a source of challenge as well as a strength, and the intervention provided them with strategies they can use to be successful in college. In both the treatment and control groups of the study, junior and senior level college students, or panelists, shared stories with the participating FG students about their transitions to college with the FG students. For students in the treatment group, panelists' stories highlighted how their backgrounds mattered for their college experience, while students in the control group were exposed to stories about transition, but not ones that pertained to background information, and they were not offered strategies for success that differed according to social class. The researchers reported that the difference-education intervention benefitted FG students by increasing their tendency to seek out college resources, improved first-year GPA, and improved their college transition in both mental health and engagement capacities (Stephens, Hamedani, & Destin, 2014).

Utility-value intervention. In a utility-value intervention, underrepresented minority (URM) and FG students in STEM majors wrote about the personal relevance of course material in an undergraduate biology class. The goal of the intervention was to help students change how they think about course topics, to foster student engagement, and to find personal value in the material. Upon completion of the UV intervention, the researchers reported that the achievement gap between URM-FG and continuing

generation (CG)-Majority students was reduced by 61% (Harackiewicz, Canning, Tibbetts, Prinski, & Hyde, 2016).

Social capital intervention. The Connected Scholars Program is a social capital intervention that is focused on development of skills and attitudes to empower FG college students. The intervention consisted of group-based lessons with the following objectives: (a) instruction and discussion of the role of social capital in advancing goals, (b) activities designed to help students identify current and potential connections, and (c) experiential activities and real-world practice cultivating supportive relationships. The intervention helped students to improve attitudes and behaviors around seeking support in college, develop closer relationships with instructors, and earn higher GPAs by the end of their first year in college (Schwartz, Kanchewan, Rhodes, Gowdy, Stark, Horn, Parnes, & Spencer, 2018).

Multicultural learning community. A longitudinal study of a multicultural learning community (MLC) was designed to combat isolation and marginalization students may experience on campus. The study explored whether multicultural curriculum and critical pedagogy created awareness for intrapersonal self-authorship—that is, one’s internally defined beliefs, goals, and sense of self—for historically marginalized students in a TRiO program. The MLC consisted of three credit-bearing courses linked together by themes of identity, community, and social agency. The courses included a first-year composition course, a creative arts course, and a social science course focused on race, class, gender, and inequality in the United States. Qualitative data were collected from students who participated in the MLC as freshmen and again as third-and fourth-year students. Through interviews, the researchers sought

to understand how students thought the MLC experience had affected their university experience. Researchers found that by drawing on students' lived experiences during the learning process and by scaffolding opportunities to reflect on one's multiple identities, students' self-beliefs were positively impacted (Jehangir, Williams, & Jeske, 2012).

Lay theory interventions and other similarly structured interventions have also helped FG students to overcome some of the hardships they have faced. As a result of participating in a lay theory intervention, students have commented that they felt encouraged and had more confidence (Hulleman, Kosovich, Barron, & Daniel, 2016; Stephens et al., 2014), tended to persist more in higher education (Yeager et al., 2016), and were more engaged in their studies (Harackiewicz, Canning, Tibbetts, Giffen, Blair, Rouse, & Hyde, 2014; Stephens et al., 2014). Lay theory interventions have contributed to closing achievement gaps (Harackiewicz et al., 2014; Hullman et al., 2018), and encouraged students to seek out college resources (Schwartz et al., 2018; Stephens et al., 2014).

All of the aforementioned interventions address struggles that FG students have faced for several decades. These interventions demonstrate several similarities, such as addressing academics, mentoring, providing social and cultural activities, and counseling, and even though not all interventions address all of the themes, each intervention is unique in its approach. What has not been addressed specifically within any of these interventions is how to best help FG students to be more successful in developmental mathematics and the transition to college-level mathematics.

Developmental Mathematics

There has been an ongoing national debate in recent years as to whether DE classes should continue to be offered. Connecticut and Florida, for example, have now

adopted an agenda to discontinue offering traditional forms of DE courses (Boylan & Goudas, 2012; Cafarella, 2014), while other states are experimenting by using various instructional reforms (Cafarella, 2014).

The traditional sequence of developmental mathematics is basic arithmetic, pre-algebra, elementary algebra, and intermediate algebra. All courses in this sequence must be passed before students can enroll in a college mathematics course. Opponents of DE focus on the fact that only 30% of students who enroll in developmental mathematics complete the sequence (Asera, 2011; Bonham & Boylan, 2011) and therefore, they claim that DE does not help students to successfully complete college mathematics courses. On the other hand, advocates of traditional forms of DE mathematics maintain that students who have completed the developmental mathematics sequences have also completed subsequent college level courses in mathematics (Bonham & Boylan, 2011; Waycaster, 2001) and these students are as successful in college level math courses as those not needing DE (Bahr, 2008; Bonham & Boylan, 2011). Advocates for DE, then, assert that DE has helped students to succeed in college mathematics (Attewell, Lavin, Domina & Levey, 2006; Chen, 2016; Goudas & Boylan, 2012).

To that end, the research results are still mixed with some claiming that developmental mathematics does not increase students' success in college math classes (Calcagno & Long, 2009; Ngo & Kosiewicz, 2017), while other studies show that developmental mathematics does increase success in college mathematics courses (Bailey, 2009; Bonham & Boylan, 2011). The assertion that these courses have failed, some believe, is based on flawed interpretations of data and unsupported assertions (Boylan & Goudas, 2012).

For example, a 2007 Martorell and McFarlin (2011) study used a regression-discontinuity design to examine a sizeable sample of Texas college students whose scores placed them just above and just below the placement level for developmental courses in mathematics and reading. They reported that students who just missed the cutoff score and placed into developmental courses did no better in college-level classes, graduation rates, transfer rates, and earnings than those students who scored just above the cutoff score. The researchers then concluded that developmental education courses were of questionable value.

Later, Calcagno and Long, in the conclusion of their 2009 quasi-experimental regression discontinuity design study (RDD), argued that students gain little from taking developmental mathematics courses and fail to reach college-level math proficiency (Calcagno & Long, 2009). This study compared first-time Florida community college students who attended between fall 1997 and fall 2000 and followed them for six years. These were also students who placed just above the statewide cutoff score (who do not enroll in remedial education) and those placed just below the score (who do enroll in remedial education). Students below the cutoff score and students above the cutoff scores had gains that were very similar. Calcagno and Long (2009) concluded that the results suggested that mathematics remediation slightly promoted early persistence in college, but it did not necessarily help students who are on the margin of passing the cutoff make progress toward a degree. In essence, they concluded that developmental mathematics courses were not effective (Calcagno & Long, 2009).

The fallacy in this argument, according to Goudas & Boylan (2012, 2013), is that some researchers consider developmental mathematics courses to be a treatment. In

other words, the researchers expected students who took developmental mathematics to perform better in college-level mathematics and in graduation rates compared to students who did not take developmental mathematics. Therefore, the faulty expectation is that students who take and are successful in developmental mathematics should be better prepared for and/or perform better in college-level mathematics than students not needing developmental mathematics (Goudas & Boylan, 2012). In Calcagno and Long's 2009 study, for example, students who scored just above the cutoff score (who did not take developmental mathematics) and just below the cutoff score (who did take developmental mathematics) did not perform differently in college level math or in graduation rates and faulted the developmental mathematics treatment. However Goudas and Boylan (2013) said this was to be expected because developmental mathematics courses consist of the same content from high school mathematics. Therefore, once completed successfully, developmental students should be at the same level as those students not needing developmental mathematics.

Considering the extant research on developmental mathematics education, one opinion is highly agreed upon by experts. The need to explore new initiatives and effective delivery practices is paramount in order to increase the success of students in developmental mathematics (Bonham & Boylan, 2011; Fong, Melguizo & Prather, 2015). Moreover, for FG students who face many more challenges than do CG students, success in mathematics is a greater issue.

Instructional Designs and Reforms for Developmental Mathematics

Various initiatives have been employed by institutions of higher education in an attempt to help increase the success of students in developmental courses. Accelerated

courses require the reorganization of instruction and curricula in ways that expedite the completion of coursework or credentials. In many accelerated course formats, the number of required instructional contact hours is not reduced (CCCCO, 2013). This format involves a departure from the traditional, usually lengthy, course sequence and is replaced with a shorter sequence that supports students' learning objectives. Further, by reducing the time required to complete degree requirements, the sequence is better suited for students juggling multiple school and work commitments (CCCCO, 2013). Other programs involve a course redesign with a significant reduction in the required number of contact hours for remediation. Reducing contact hours could involve combining several developmental level courses or developing new pathways to satisfy college math requirements with fewer courses required.

Colleges are incorporating accelerated strategies for DE math using various models. These models include the following: (a) compressed courses, (b) paired courses, (c) curricular restructuring, (d) course redesign, (e) mainstreaming with supplemental support (CCCCO, 2013; Fong & Visser, 2013; Edgecombe, 2011), (f) modular courses (Fong & Visser, 2013; Rutschow & Schneider, 2011), and (g) bridge programs (Bailey, 2009).

Compressed courses. Compressed courses allow students to complete multiple sequences of courses in one semester. For example, if a course is normally offered in 16 weeks, a compressed course would be given in an 8-week time frame so that a student can also take a second DE course in the second 8 weeks for a total of two completed courses within the same 16-week time frame. Some campuses compress courses so that

students can complete 3 levels of developmental courses within one 16-week term (Rutschow & Schneider, 2011).

Fast-Track Math. An example of this type of course includes Fast-Track Math offered at Mountain Empire Community College in Big Stone Gap, Virginia. This course is designed for students who are better prepared; the school implements a screening process to ensure that the student meets the necessary criteria (Rutschow & Schneider, 2011).

New Mexico State University-Alamogordo. At New Mexico State University-Alamogordo, developmental students were offered the chance to take two levels of developmental math in one 16-week semester, including Algebra Skills and Intermediate Algebra. Students who completed the two compressed 8-week courses saw a greater pass rate than their non-participating counterparts. Students in the compressed Algebra Skills class passed the course at a rate of 85.8% compared to 79.8% for students who took the course in the normal 16-week modality. Participants in the compressed Intermediate Algebra course passed at a rate of 83.3%, whereas students in the 16-week course passed at a rate of 73.5% (Walker, 2017).

FastStart. At Denver Community College, a study was completed on the college's FastStart program. FastStart also offers students the opportunity to complete two levels of developmental courses on one 16-week semester. Results of the study support the fact that an accelerated course structure helps to fulfill developmental mathematics education requirements (Edgecombe, Jaggars, Baker, & Bailey, 2013).

Co-requisite models. Students in the co-requisite model, also referred to as mainstreaming, are placed in college level courses while they are given supplemental

assistance to help with skills that are typically taught in the developmental level courses. This model is based on the belief that students in DE are capable of college-level work with simultaneous extra support (Fong & Visser, 2013). The support may require students to spend extra time in the tutoring lab for help on certain basic skills through “just-in-time” tutoring (Hern, 2012). One alternative to this tutoring support model is to have students co-enroll in a study skills course, allowing students to receive college credit sooner (Fong & Visser, 2013).

AIM program. For example, San Jacinto College offers the AIM program to its developmental math students required to complete college algebra. The program consists of a three-hour developmental course and a four-hour college algebra course. Classes meet Monday through Friday and is team-taught by two professors. The program includes “just-in-time” remediation, streamlining, active learning, prompt feedback, reviews, and learning resources. A study of seven semesters showed that students in the AIM program passed college algebra at a rate of 64.1% compared to 44.8% for students not in AIM, a promising result (Texas Success Initiative, 2016).

Oklahoma State University. A co-requisite model program for college algebra at Oklahoma State University offers extended meeting times (5 hours) per week, help from undergraduate learning assistants, and “just-in-time” tutoring. The program has seen promising results, with two-thirds of students in the co-requisite section earning a “C” or better in college algebra and more than 80% of students in the Math Modeling (college algebra for non-STEM students) pathway earning a “C” or better (Keadle, 2017a).

College of Coastal Georgia. At the College of Coastal Georgia, students who are not college ready can begin in a gateway course (either college algebra or quantitative

reasoning) and also take a co-requisite course that provides just-in-time remediation. Students that score further below the cut off score for college readiness must take a Foundation course before the gateway course, making their journey a year-long pathway. After three years of at-scale implementation, students are passing the gateway courses at a rate of 68.8% (for quantitative reasoning) and 54.6% (for college algebra), as compared to rates of 66.9% and 62.3%, respectively, for college ready students (Keadle, 2017b).

Modular programs. Modular programs are designed by dividing a traditional semester-long course into discrete learning units, or modules, that are designed to improve particular competencies or skills through a series of short, focused assessments (Rutschow & Schneider, 2011). Although constructing these new pathways is not a simple undertaking (Asera, 2011), they have been found to be successful at various institutions (Levin & Calcagno, 2008). These programs tend to utilize tutorial software packages such as MyMathLab, Plato, ALEKS, or MathZone (Rutschow & Schneider, 2011), and students complete only the modules that they need (Fong & Visser, 2013). Below are some examples of modular programs.

SMART. Jackson State Community College in Jackson, Tennessee, offers SMART, a modularized developmental math program to its students. SMART includes twelve online instructional modules with supplemental assistance from instructors in a math lab in which students are required to work at least three hours per week (Bassett & Frost, 2010). This program allows the possibility for students to complete all three levels of the developmental math sequence in one semester (Rutschow & Schneider, 2011).

ModMath. A modular course, ModMath, was created at Tarrant County College in which course designers organized the developmental mathematics content into a set of

six 5-week modules. Students begin with a diagnostic assessment that places students in a starting module. Individual registration into three modules per course section each semester is required by the students. Computer-based instruction is delivered online through an instructional software program and students receive personalized assistance in class from an instructor and class aide. MDRC (formerly known as Manpower Demonstration Research Corporation) used a randomized controlled trial to study the effects on students' academic outcomes. For students enrolled in the first three semesters of the study, findings indicated that after one semester in the program, students randomly assigned to ModMath were slightly closer to completing the developmental math sequence than were students randomly assigned to traditional, lecture-based courses ($p < .01$). This progress was the result of ModMath (treatment group) students getting credit for completing one or two modules but not the equivalent of an entire course. However, ModMath students were not more likely to pass the halfway mark in the developmental math sequence than the students assigned to traditional, lecture-based courses (control group). More than 70% of students in the study, in either group, were unable to pass this benchmark in the first semester ($p < .01$). ModMath had a small negative effect on the percentage of students who completed the developmental math sequence during their first semester, with 0.4 % of program group students completing compared with 1.9 % of the control group completing the program (Gardenhire, Diamond, Headlam, & Weiss, 2016).

Miami-Dade College-Kendall. At Miami Dade College-Kendall, a modular developmental mathematics program design was implemented with specific consideration of the fact that students often require specialized interventions. The modular strategy allows for targeting of students' specific learning needs and creates a customized course

plan to address those areas. As such, students only work on skills they still need to master. Program reports claim that 76% of students in the pilot program successfully completed the modules and all other course requirements, such as lab hours and the exit exam (McTiernan & Fulton, 2013).

Course restructuring/design. Course restructuring occurs when institutions reduce the number of levels of developmental courses that are in the sequence. For example, if a program offers a DE mathematic sequence of developmental courses, and if a student places at the lowest level of DE, he or she will be required to complete all levels. By restructuring the sequence, courses are combined, and the number of levels required to advance through remediation is lowered. After restructuring, if a student places at the lowest level of developmental math, they will not have to complete four or more levels to exit developmental math. By course restructuring, the student may only have to complete two courses.

Statway/Quantway. For example, the Statway and Quantway initiatives were designed to accelerate developmental students through completion of college-level math courses in one year or less. Instead of taking the traditional developmental mathematics curriculum, Statway provides students in non-STEM fields of study an alternative pathway involving a basic statistics sequence. Quantway provides an alternative pathway through quantitative reasoning. Both programs also provide strategies to reduce math anxiety and increase motivation and persistence.

Developing Mathematical Thinking. Developing Mathematical Thinking is an alternative pathway based on Statway that replaces the developmental algebra sequence for many students at Austin Community College. Students take a 4-unit statistics course

and utilize collaborative learning techniques. Students enrolled in the pilot course showed a completion success rate of 69%, while students who enrolled in the traditional course had a 48% success rate, and of the students who completed the pilot, 71% also completed the subsequent course, compared to 64% for the general population (McTiernan & Fulton, 2013).

SUNY. The State University of New York (SUNY) began implementing both Quantway and Statway in 2012. Results after the first semester showed were promising, with a 57% completion rate in Quantway (completing their developmental math requirements in one semester) and a completion rate of 52% for Statway (receiving college credit in one year) (SUNY, 2012). Furthermore, based on a 2015 research study, faculty reported significant changes in student attitudes, perceptions, and engagement as they advanced through Quantway (Howington, Hartfield, & Hillyard, 2015).

Path2Stats. Additionally, course redesign has been used to create new pathways to college level mathematics that also combine levels. Currently there are several programs with this goal. One example is the program entitled Path2Stats, currently being implemented in California postsecondary institutions, in which students take a one-semester developmental course leading to college statistics with no pre-requisite or minimum placement score (Hern, 2012). In addition, the program offers students just-in-time tutoring and intentional support for affective issues. According to Hern, students participating in Path2Stats are more successful at completing college math and completing sooner than students in traditional pathways. For example, Path2Stats students who began in Elementary Algebra finished College Statistics at rate of 78%

within one year, while students in the traditional pathway completed college level math at a rate of 17% within three years (Hern, 2012).

New Mathways. The New Mathways Project is another example of a course redesign created by the Dana Center on the University of Texas campus in an attempt to make “mathematics a gateway, not a gatekeeper course” (Bryk & Treisman, 2010). This program provides a pathway that is more aligned with social sciences, health, and liberal arts professions while also providing a revised model for the algebra pathway for students in science, technology, engineering, and math careers. It allows community college students who place into developmental mathematics courses and are not pursuing a math-intensive degree to complete a transferable mathematics course (relevant to their future career goals) in one year (Rutschow & Diamond, 2015). This design has seen some minor challenges, but initial evaluations show that it is a promising design (Rutschow & Diamond, 2015).

Cleveland Community College. Cleveland Community College began a course redesign for developmental math in 2008. The redesign project involved three developmental math courses (basic math, elementary algebra, and intermediate algebra) and three college-level math courses (college algebra, introductory statistics, and finite math). The redesign mirrored NCAT’s emporium model of instruction, with students meeting in a class one hour each week and working in a computer lab (using an online learning system) outside of class two hours each week. The redesign also incorporated mini-modules, with each course requiring students to complete 10-12 modules per semester, including videos for each module. It also implemented a change in the grading structure, with students receiving points for attendance, homework, quizzes, and tests. A

mastery approach for success was adopted, meaning students had to complete all aspects of the course with a score of 70 or better. Students are expected to pass all assignments; hence, they are allowed to redo problems and quizzes, and the assignments are created to keep students on-task and foster an atmosphere of continuous assessment. For the semester that the redesign was implemented, the rate of students completing developmental math increased by 47% compared to previous semesters. College algebra had completion rate of 65%, and it has improved to 74% as a result of the redesign of the course.

Refresher Mathematics Course Interventions

As part of the developmental mathematics instructional reforms, refresher mathematics course interventions include summer bridge programs, boot camps, and other types of brush-up programs that provide a short-term review of mathematic skills to facilitate mathematic college readiness. These programs are typically offered in the summer, between high school and the first semester of college, and vary in content, program size, and length (Quiroz, & Garza, 2018; Sablan, 2013).

Bridge programs and boot camps are very similar, and sometimes colleges use the terms interchangeably, but boot camps tend to be shorter in duration than bridge programs and primarily focus on building students' math skills and improving their performance on placement tests (Scherer & Grunow, 2010). Bridge programs, on the other hand, offer a condensed, intensified review of high school math concepts, and at the end of the review session, students take a placement exam in hopes of placing into a higher-level developmental course or placing out of developmental coursework and into a college level course. Additionally, some institutions offer refresher workshops year-

round to accommodate all new students, whether attending college for the first time in the fall, spring, or summer semesters.

Summer Bridge Programs

Summer Bridge Programs offer an introduction to college culture by providing intensive and short-term academic and social resources. These programs typically recruit senior high school students who are on track for remediation or individuals who, upon acceptance into an institution, place into remediation. Bridge programs are designed to serve students who are newly admitted to an institution and who have placed into a developmental course. Occasionally, current students who have been working within a prescribed developmental course sequence are invited to participate in the program as well. While the primary focus of bridge programs is to provide a review of high school math topics, implementation of bridge programs can vary from institution to institution. Many programs are offered on a weekly basis, while some are offered within a three or four-week period or even for longer periods. In addition, some programs will offer technology-based instruction, while others will offer face-to-face instruction, or a hybrid of the two. Still, other institutions offer programs that involve active learning or offer field trips to encourage problem-based learning. Most bridge programs involve five characteristics: (a) an in-depth orientation to college life and resources, (b) academic advising, (c) academic coursework, (d) academic support, and (e) social support (Quiroz & Garza, 2018). Research on these programs is mostly descriptive with some exceptions. Examples of studies reporting descriptive statistics will be given first followed by some reporting inferential statistics.

Texas developmental summer bridge program. For example, The National Center for Postsecondary Research conducted a study in 2009 that included eight summer bridge programs in Texas designed to help underprepared students build competencies and accelerate through DE courses. The treatment group students were placed in the summer bridge program treatment group, while the control group students were allowed to use any other college resources except the summer bridge program. Results showed that students in the treatment group successfully completed their college-level mathematics course at the same rate as did the students in the control group in the first year-and-a-half (Barnett et al., 2012), but were more likely to pass college level math and writing in the fall semester following the summer program (Wathington et al., 2011).

Kallison and Stader (2012) also conducted a study on Texas developmental summer bridge programs, but according to the researchers, it has limited internal validity. They examined gains in placement test scores among summer bridge participants who took a pretest and posttest. Only four institutions collected math test score data, and at these colleges there was no statistical difference in the math placement exam performance of students before and after participating in the summer bridge program (Kallison & Stader, 2012).

University of Alabama. The Engineering Math Advancement Program (E-MAP) program was developed at the University of Alabama and targeted incoming STEM majors who place below calculus. Students who participated in this summer bridge program received accelerated instruction in pre-calculus content, including college algebra and trigonometry, so that students could place into the calculus course by fall. The bridge program was a 4-week program in which students learned math skills by

morning and applied them to real world problems by afternoon. At the end of the program, students who participated in the years 2005 to 2007 significantly increased their math placement scores ($p < .01$), but not all students were able to place into calculus (Gleason, Boykin, Johnson, Bowen, Whitaker, Micu, Raju, & Slappey, 2010).

Participants who placed into pre-calculus courses performed significantly worse in pre-calculus courses than did non-participants, and there was no statistical difference in grades of program-students who placed into calculus versus students who placed directly into calculus. The meaning of these results is unclear because it is unknown how the program-students would have fared in their first-semester math course in the absence of participating in the summer bridge program. Regarding retention, however, 92% of students in the pilot program were still in a STEM degree program three years later, compared to 63% of STEM students who entered in the same year with similar placement test scores. The researchers found this difference to be statistically significant ($p < .05$). Although this difference in STEM retention is quite large, it could be due entirely to the higher motivation of students who chose to participate in the summer bridge program (Gleason et al., 2010).

STEM summer bridge program. A study of a STEM bridge program at the University of Wisconsin-Milwaukee tracked the relationship between features of the program and gains in students' mathematics placement test scores (Reisel, Jablonski, Hosseini, & Munson, 2012). Students who placed below calculus were identified and recruited to participate in either the residential program or the online program. Similar to the University of Alabama program, in the morning session, students worked through individualized, self-paced math content using ALEKS (Assessment and Learning in

Knowledge Spaces), a computer-adaptive, online assessment and learning program.

Results showed that students in the residential program improved their math placement scores more than students in the online program, and students with more ALEKS time-on-task had greater improvements in their placement test scores (Reisel et al, 2012).

College algebra summer bridge program. A 4-week long online summer mathematics bridge program was offered to students attending a U.S. Midwestern university. Program participants had an increase in their math placement scores from pretest to posttest ($p < .01$). Students who completed the program passed college algebra at a rate of 66.7% and intermediate algebra at a rate of 68.6%. Both rates are higher than completion rates for students who did not participate in the summer bridge program (Frost & Dreher, 2017).

Texas developmental summer bridge program. Few studies have been done on summer bridge programs that have reported inferential statistics. One recent longitudinal experiment of this nature was completed in Texas. Barnett et al. (2012) conducted a randomized experiment for students enrolled in a developmental summer bridge program. The program was offered to recent high school graduates at two open-admissions, four-year colleges and six community colleges across the state of Texas. Students who agreed to participate were randomly assigned to the control and treatment groups. Students attended the summer bridge programs for three to six hours daily for four to five weeks. The programs at each college varied, but they shared similar features, including (a) accelerated instruction in math, reading, and/or writing; (b) academic support outside of class; (c) a college knowledge component provided through advisors, mentors, and financial aid staff through a college success course or more informal presentations and

workshops; and (d) student stipends (\$150 delivered at the start of the program to improve recruitment efforts and \$250 delivered after completion of the program to encourage students to complete the program). After two years, the study revealed that the summer bridge programs had extremely modest impacts (Barnett et al., 2012). A higher proportion of students in the treatment group than the control group passed a college-level math course through the fall of 2010, but by the spring of 2011, there was no significant difference in the proportion of treatment group students (46.5 %) and control students (43 %) who passed college math. Differences in persistence, the number of college credits earned, and the number of college credits attempted by students in the treatment and control groups were also not statistically different from zero. Finally, the study reported that the treatment group intervention had no impact on helping students pass college math, suggesting that programs that focus on improving placement-test performance may not have a meaningful impact on improving students' performance in college math nor show long-term outcomes, such as persistence and progression (Barnett et al., 2012).

Summer bridge program with supplemental instruction. A 5-week summer bridge program at a predominantly White University on the Southeastern U.S. was designed to increase students' college readiness by promoting critical skills development, acclimating them to the campus environment, and nurturing their sense of belonging in college. Participants were predominantly minority. Students were enrolled in two courses for credit. One was an academic skills/career planning seminar and the other was English Composition I. All participants were also offered weekly math supplemental instruction sessions. By the end of the study, students' mean academic self-efficacy was

significantly higher than the mean academic self-efficacy prior to the program ($p < .01$) with a medium effect size, but this study did not address mathematics self-efficacy specifically (Strayhorn, 2011).

The demonstrated benefits of bridge programs are varied. They can help students by offering support services to ease the transition, both academically and socially, from high school to college. Students have the opportunity to form relationships with mentors, peers, and faculty (Barnett et al., 2012). In addition, advocates of accelerated course options, including bridge programs, argue that a greater portion of students will be able to complete developmental courses and continue on to college-level work if students are helped to complete requirements more quickly (CCCCO, 2013; Hern, 2012; Rutschow & Schneider, 2011). Additional positive aspects of accelerated courses include cost-effectiveness, positive psychological effects, high access, high student success, and student retention (Barnett et al., 2012; Hern, 2012; Perin, 2005).

Boot Camps and Brush-Ups

The remaining studies on boot camps and brush-ups are all descriptive reports based on colleges' internal research. Boot camps at El Paso Community College (EPCC) in Texas, LaGuardia Community College in New York, Montgomery County Community College in Maryland, and Pasadena City College in California all report that a proportion of participants improved their placement exam performance and placed into a higher developmental math level or college-level math (Scherer & Grunow, 2010). Each student from EPCC participating in the PREP boot camp took a diagnostic test on A+ Advancer, an online resource aligned to the ACCUPLACER placement exam that creates an individualized test-prep course for each student, targeting their own areas of need.

Students completed the individualized course in a lab where there are tutors available, then they retook the ACCUPLACER. From 2003 and 2008, between 52% and 66% of PREP participants placed at least one level higher in math (Scherer & Grunow, 2010). However, without a comparison group, it is unknown what the outcomes of these students would be in the absence of the treatment.

Findings from a brush-up course offered to students at a North Carolina college showed a positive association between test preparation in a brush-up course and improvements in placement (Hodara, 2013). The North Carolina college utilized an online course for their reading, writing, and math placement exams, and students were able to access and complete it from any computer at their convenience. The online course provided a video of a student explaining the importance of the placement exams and the content of the review. The course includes approximately one hour and twenty minutes of content for each subject including a diagnostic pretest, information on areas where the student is weak, instructional videos that cover the test content, a posttest, and additional resources to help students prepare for the test, such as PowerPoint presentations created by faculty and links to ACT online practice materials. The college found that from fall 2010 to spring 2011, 35% of students who took the review course tested at least one level higher in the developmental math sequence and had similar or higher pass rates in the courses they retested into, compared with their counterparts who placed directly into the course (Hodara, 2013).

Summer bridge programs, including boot camps and brush-ups, are becoming relatively common at colleges across the country for developmental mathematics, as they allow for expediting the completion or credentials of developmental courses

(Edgecombe, Cormier, Bickerstaff, & Barragan, 2013; Scherer & Grunow, 2010). Most of these studies are descriptive which reported primarily institutional research (Gleason et al., 2010; Hodara, 2013; Kallison & Stader, 2012; Reisel et al., 2012, Scherer & Grunow, 2010). Those studies that are experimental in design had modest effects and most studied only academic outcomes (Sablan, 2013; Strayhorn, 2011). Two recent exceptions include a quasi-experimental study described by Strayhorn (2011) in which students who participated in a 6-week summer bridge program had positive gains in academic self-efficacy and the SLSP program where students also had positive gains in academic SE after a 5-week summer bridge program (Wibrowski et al., 2017).

Conclusion

Considering the college completion rate for students beginning in the lowest levels of DE, it has become important to explore more options for effective delivery practices in developmental level courses in order to increase the success of students in developmental mathematics (Bonham & Boylan, 2011). While FG students bring many assets with them when they begin college, historically they do not perform as well academically as do CG students (Atherton, 2014; Bui, 2002; Stebleton & Soria, 2012). Summer bridge programs have been used for the past few decades as an intervention to help FG students to be more successful in postsecondary education (Cahalan & Goodwin, 2014, Wibrowski et al., 2017; Olson-McBride et al., 2016).

There have also been several studies conducted over the last few decades that describe the positive outcomes of bridge programs, boot camps, and refresher courses for increased success in developmental mathematics. While these outcomes indicate that bridge programs allow for many students to accelerate through developmental

mathematics, the studies are mostly descriptive. Hence, the gap exists to study students' possible gains in mathematics SE, for both FG and CG students, as a result of participating in summer bridge programs.

Social Cognitive Theory

Social cognitive theory provides the lens through which this study was conceived. Social cognitive theory (SCT) focuses on “how people acquire knowledge, rules, skills, strategies, beliefs, and emotions through their interactions with and observations of others” (Schunk et al., 2014). In SCT, there exists a large set of factors that operate as regulators and motivators of established cognitive, social, and behavioral skills (Bandura, 1997). According to Bandura (2006) there is much that people can do to exercise control over their self-development, and, hence, human agency is at the core of social cognitive theory. Much of Bandura's (1997) work has led to the rise of this theory and to identifying the theory's several key assumptions which include the following: (a) reciprocal interactions among personal, behavioral, and environmental factors; (b) the development of agency; (c) the relation of learning to motivation; and (d) enactive and vicarious learning.

Reciprocal interaction, or triadic reciprocity, refers to the idea that human functioning results from bidirectional interactions among personal factors, behaviors, and environmental conditions (Bandura, 1997). In other words, behavior affects environment and environment affects behavior; behaviors affect the person and the person affects behaviors; the person affects the environment and the environment affects the person (Schunk et al., 2014). While all three factors can be present in a classroom environment, typically only one or two factors predominate. For example, in a classroom which is

highly regimented, environmental factors may take precedence. However, in a classroom in which environmental influences are weak, personal factors can take precedence. An example would be in a classroom in which students are allowed to choose their project; they are likely to choose a project they enjoy or one in which they are interested. In addition, personal factors can influence one another. For example, using an effective learning strategy will build skills and can lead a student to feel more confident about learning; in turn, such self-efficacy can affect the student's choice of strategies (Bandura, 1977).

Agency is one's belief that they can exert a degree of control over important events in their lives (Bandura, 1977). This sense of agency manifests itself in intentional acts, cognitive and affective processes, and self-regulation (Schunk et al., 2014). Among the mechanisms of personal agency, none is more central or pervasive than people's beliefs about their capabilities to exercise control over events that affect their lives. Social cognitive theory assumes a broad view of agency. According to Bandura, "people do not live their lives in isolation; they work together to produce results they desire" (1997, p. 7), a fact that is in agreement with triadic reciprocal causation.

In social cognitive theory, there is a distinction between learning and performance. People can learn by observing models, but the knowledge and skills they acquire may not be performed immediately. People will not demonstrate skills until they are motivated to display those skills (Schunk et al., 2014). Social cognitive theory maintains that motivation affects both learning and performance (Schunk et al., 2014). Motivation is not essential for learning, but it does facilitate learning. Hence, people may not demonstrate what they learn if motivation is low during the learning process.

Self-efficacy

Self-efficacy (SE) is a component of social cognitive theory which operates along with other determinants to “govern human thought, motivation, and action” (Bandura, 1997, p.34). Self-efficacy is defined as a person’s beliefs for accomplishing a specific task (Zimmerman, 1990). The relationship between self-efficacy and performance is well-documented (Bandura, 1997; Young & Ley, 2002). Additionally, efficacy beliefs affect thought patterns, and these patterns can enhance or undermine performance (Bandura, 1997; Bandura, 2006). Self-efficacy is not immutable; it is fluid (Bandura, 1997). Therefore, a negative experience may lower a person’s SE and performance on that task, but a positive experience soon afterward can raise the person’s SE and performance.

Self-efficacy is generative in that it requires cognitive, social, emotional, and behavioral skills to be “organized and effectively orchestrated” to serve a purpose (Bandura, 1997, p. 37). If cognitive, emotional, emotional, and behavioral skills work separately, the same end result may not be obtained. For instance, people often fail to perform a task optimally, even though they know what to do and have the skills to do it. In other words, SE is concerned not only with what skills a person possesses, but also with what that person can do with those skills under different circumstances. People with the same skill level or the same person under different circumstances may perform low, high, or adequately depending on their efficacy beliefs (Bandura, 1997). Skills can be overruled by low SE, but high SE can enable people to do extraordinary things (Bandura, 1997). Because self-efficacy acts on other classes of determinants, it influences the

choice of activities and motivation level; hence, it makes an important contribution to the knowledge structure on which skills are founded (Bandura, 1997).

Bandura (1997) cited four sources through which a person's self-efficacy is affected. The sources are as follows: (a) mastery experiences; (b) vicarious experiences; (c) verbal persuasion; and (d) physiological and affective states (Bandura, 1997; Schunk, et al., 2014). Mastery experiences are defined as one's own achievements; they provide the most authentic evidence that one has the skills needed to accomplish the desired task. Vicarious experiences are other people's or peers' achievements and are also called modeled attainments. These experiences are weaker for affecting SE than are mastery experiences. With vicarious experiences, people gauge their capabilities based on the successes of people who they view to be similar to themselves. Verbal persuasion refers to words that are communicated verbally to someone about his or her ability to achieve a task. It is easier to increase one's SE if significant others verbalize faith in one's capabilities than if they verbalize doubts (Bandura, 1997). Verbal persuasion may not be able to raise one's SE alone, but it is possible if the appraisal is within realistic bounds. However, if the appraisal is perceived to be unrealistic, it discredits the persuader and can lead to failure for the recipient as well as further undermining of the recipient's beliefs. Physiological and affective states refer to one's bodily reactions, such as having sweaty palms or feeling nauseated, in the midst of trying to accomplish a task. Such indicators are relevant in domains that require physical accomplishments, health functioning, and coping with stressors. Physical reactions to high stress can debilitate performance, so people are inclined to expect success when they are not agitated. Hence, to increase SE, one's stress level and negative thoughts should be reduced.

Self-efficacy can be assessed for any goal one sets out to attain, whether academic or not. In fact, studies have been conducted to test the tenets of self-efficacy in a variety of disciplines, including clinical problems like phobias, depression, social skills, and assertiveness. Research has also been conducted on smoking behavior, pain control, health, and athletic performance (Pajares, 1996). In general, these studies have shown that the tenets of SE have been supported in these diverse situations and fields of study (Pajares, 1996).

In an academic setting, self-efficacy is a student's belief about their ability to exercise influence over the events in their lives and produce results (Westbrook, 2013). Hence, with a high sense of efficacy, students are more likely to attempt tasks they perceive as difficult and they are more likely to persist in the face of failure. The flip side of this equation, as Bandura (1997) explained, is that a lack of self-efficacy can cause people to avoid tasks they perceive as difficult and threatening, giving up quickly when faced with difficulties. In this light, self-efficacy is positively correlated to student success, (Westbrook, 2013; Ayotola & Adediji, 2009). The definition of self-efficacy, then, is particularly important to students who struggle to achieve in mathematics.

Betz and Hackett (1983) defined mathematics self-efficacy as individuals' judgments of their capabilities to solve specific math problems, perform math-related tasks, or succeed in math-related courses. Many studies have examined the relationship between mathematics achievement and self-efficacy and have found that the two are positively correlated (i.e. Hackett, 1985; Lent & Hackett, 1987; Lent, Lopez and Bieschke, 1991; Pajares, 1996; Pascarella et al., 2004; Stevens, Olivárez and Hamman, 2006; Usher and Pajares, 2009). This definition is particularly relevant to the present

study because I will be measuring mathematics self-efficacy specifically within the setting of a bridge program.

Unfortunately, considering the strong relationship between mathematics self-efficacy and achievement, many students leave high school with a low sense of self-efficacy for various reasons. For example, some students may have had negative mathematics experiences during their primary or secondary schooling, experiences that could lead to low mathematics self-efficacy and low achievement. Other factors that can affect high school student achievement are socioeconomic status (Colvin, 2003; Oaks, Joseph & Muir, 2004) and ineffective instruction (Colvin, 2003; National Council of Teachers of Mathematics, 2000). In fact, a Texas study found that if economically disadvantaged students were to experience five consecutive above-average teachers in terms of effectiveness, the link between socioeconomics and academic achievement may be broken (Colvin, 2003). Ethnicity (Stevens, Olivares, Lan, & Tallent-Runnels, 2004) and sense of belonging (Benner & Graham, 2009) have also been found to contribute to math self-efficacy. As such, it is often necessary to help new college students to increase their self-efficacy for performing math tasks so that they can be successful in their required college math courses.

The notion of reciprocal determinism, a part of Bandura's (1997) social cognitive theory, gives a theoretical framework under which students can alter both their performance and beliefs concerning mathematics tasks. According to this idea, behavioral, cognitive, and environmental influences all interact with and influence each other. This study will measure incoming students' SE levels using a pre-and posttest to determine if changes occur as a result of participating in the bridge program. In other

words, this study will provide an opportunity to determine if students' self-efficacy for performing mathematics tasks is influenced by their mastery of the mathematics tasks.

The present study will investigate whether or not changes in self-efficacy for accomplishing mathematics tasks result from participating in a bridge program. The summer bridge program examined in this study is an intervention designed to increase the success of students in developmental mathematics. It is one that is encompassed by a larger group of initiatives called "accelerated courses." The hope is that students will see a gain in SE for math. Moreover, students' self-efficacy scores will be compared based on first-generation status and intervention group. Hence, the results of the study may also provide insights into which group of students benefit most from this bridge program intervention.

III. RESEARCH METHODOLOGY

The goal of this research was to examine the effect on students' mathematics' self-efficacy after a select group of first-generation (FG) students completed a weeklong mathematics summer bridge course (henceforth referred to as a math refresher course). As described in the previous chapter, studies have shown that math refresher courses have been successful in helping students (Barnett et al., 2012; Wathington et al., 2011). When students are able to place out of several developmental math levels or are able to begin in college level math courses, they are more likely to complete a degree (Bailey, et al., 2010; Bonham & Boylan, 2011; & Ganga et al., 2018). This study can add to the research on benefits students can gain from participating in math refresher courses. This chapter describes (a) the design of the study, (b) the participants, (c) the setting, (d) the procedure, (e) the variables, (f) the measures used, (g) the IRB application process, (h) the research approach, (i) a modified version of the research questions, and (j) the data analysis.

Design of the Study

Postsecondary education is experiencing a large influx of students in developmental mathematics, even including those that have graduated from accredited high schools and are believed to be college ready (Bonham & Boylan, 2011). Much attention has been placed recently on offering different modalities of course offerings to help accelerate students through their developmental education sequences, and summer bridge programs are gaining popularity as one such modality (CCCCO, 2013; Hern, 2012). In light of the success that bridge programs and math refresher courses have been shown to have in terms of students placing out of at least one developmental level course

(Barnett et al., 2012; Hern, 2012; Hodara, 2013; Wathington et al., 2011), there are additional questions to investigate related to the efficacy of mathematics summer bridge program refresher courses.

The research questions this study addresses are:

1. Does self-efficacy (SE) for accomplishing mathematics tasks change over Time (from MSES pretest to MSES posttest) for students taking the math refresher course, and is the change moderated by Group (TI vs. EI), by first-generation student status (FG vs. CG vs. Unknown), or by both variables?
2. What are students' perceptions of the helpfulness of the math refresher course?

A mixed methods design was used in this research study. Question 1 required a quasi-experimental design. Hence, a quantitative research approach was taken using a mixed ANOVA. In this analysis, the dependent variable was SE (self-efficacy), while the independent variables included Time (named for the repeated SE measure), FG (first-generation student status), and Group (type of intervention). A content analysis, which is a qualitative approach, was used to answer Question 2. Students responded to the open-ended question: "What did you find most helpful about the math refresher course?"

All variables were measured within the time frame of the math refresher session. At the beginning of each math refresher session, a pretest of the MSES was given, students were assigned to an intervention group, FG status was reported, and all data were collected. At the end of each session, a posttest of the MSES was administered and collected. Students also submitted answers to the open-ended question. The study was designed so that the two research questions would complement each other; the qualitative

portion was included to give more meaning to the quantitative portion. Hence, the design used in this study is a convergent parallel mixed methods design (Creswell, 2014).

Because mixed method research design is a fairly new phenomenon, I will next give a brief description and history of mixed methods research.

Mixed Methods Research

The use of mixed methods is a fairly new phenomenon. As a research approach, mixed methods has undergone many developmental changes, beginning with its name. It has been called “integrated” or “combined” research, “quantitative and qualitative methods,” “hybrid,” “methodological triangulation,” “mixed methodology,” and “mixed research,” (Creswell & Clark, 2011). Today the most often used name is “mixed methods research” (2011).

Mixed methods design originated the late 1950’s and underwent a formative period up until the 1980’s (Creswell & Clark, 2011). This method emerged out of a necessity to provide the most complete analysis of problems (Creswell & Clark, 2011). The 1970’s and 1980’s saw the paradigm debate period. During this period scholars argued whether or not methods could be combined. It was believed by “purists” that methods could not be mixed because different assumptions provided the foundation for quantitative and qualitative research (Creswell & Clark, 2011).

In 1994, advocates on both sides of the debate argued their points at the American Evaluation Association meeting. This led to a shift in the original debate, the question now centering on which paradigms provide the foundation for mixed methods research. In this period, writers focused on methods of data collection, data analysis, research designs, and purposes for conducting a mixed methods study.

Mixed method research then moved into the advocacy and expansion period. Many authors advocated for mixed methods research as a separate methodology, method, or approach to research (Creswell & Clark, 2011). An interest in mixed methods extended to the fields of evaluation, management, sociology, and health sciences (Creswell, 2014). There have been an increasing number of mixed methods articles published in prestigious research journals and from authors around the world (Creswell & Clark, 2011).

In the last 5 to 7 years, mixed methods research has moved into the reflective period. A look back on its history reveals two important themes: (a) a current assessment of the field and a look into the future, and (b) constructive criticisms challenging the emergence of mixed methods and what it has become. Recently, there have been several important discussions that help to continue to map the current state of the field. These discussions include unresolved issues in the use of mixed methods in social and behavioral sciences. In the nursing field, one expert challenged claims by mixed methods writers that this approach would produce the “best of both worlds” (Creswell & Clark, 2011, p. 36), while yet another was concerned that mixed methods was about doing away with “indeterminacy and moving toward incontestability” (p. 36). Hence, although there are authors that still have not completely accepted the idea of mixed methods research, it has become a growing field.

Despite lingering concerns, a mixed methods approach is suitable for this study. The reason for using this design is for complementarity (Creswell & Clark, 2011). The quantitative piece provides the primary strand, while the qualitative piece is the secondary strand. The secondary strand helps to illuminate findings from the primary

strand. With both pieces, a more complete picture of the students' experiences in the math refresher course can be obtained.

Worldview

The design for this study stems from a pragmatic worldview, but also draws somewhat from a transformative point of view. One attribute of a pragmatic worldview is the concern with applications, determining what works, and utilizing methods that provide the best understanding of the research problem (Creswell, 2014). The application in this view is the math refresher course. In fact, math refresher courses are themselves an intervention to a problem. Whereas the aim of this study serves to provide information that can be used to refine and improve math refresher courses, this fits with the pragmatist's view.

Participants

The community college that served as the setting for this research study offered multiple math refresher course summer sessions at each of its five campuses. All students that were placed in developmental math were also encouraged to participate in a math refresher course based upon their Texas State Initiative Assessment (TSIA) score. This was required for first-time-in-college students and encouraged for all other students needing two or more levels of developmental mathematics. During summer 2016, data were collected on students from 18 of the more than 50 weeklong face-to-face refresher courses offered at four of the five institutions; all of the math refresher course sessions were offered online, thus I did not need to recruit from one campus. Each week I focused on one campus, randomly choosing a morning and an evening session being offered at the campus. I accomplished this randomization choice by drawing slips of paper with the

math refresher section numbers written on them. The weekly campus was chosen randomly in the same fashion. Each campus was studied one-at-a-time, for two non-consecutive weeks throughout the summer. Students aged 17 years and younger were not allowed to participate since parental consent was required.

Several types of students were included in this study. First-time-in-college (FTIC) students who were admitted to Alamo Community College District in either Summer 2016 or Fall 2016, and who were placed into one of three levels of developmental mathematics based on placement testing (Basic Mathematics, Elementary Algebra, or Intermediate Algebra), were required to participate in the math refresher course. Additionally, students who were previously enrolled in either of the two lowest levels of developmental mathematics (Basic Mathematics or Elementary Algebra) in Spring 2016 within the Alamo Community College District, were targeted with advertising and encouraged to register for the math refresher course. As such, the participants of the study included some FTIC students and some non-FTIC students. No student was chosen or excluded from the study based on their major. The math refresher course was free of cost for all students who participated, eliminating financial status bias.

Students were asked to report their age, ethnicity, and sex identities as part of the Entry Survey (demographics survey). There were 270 students who agreed to participate in the study. However, due to error during the data collection process, only 249 records were able to be used in analyses. Table 1, below, shows the frequency of the age groups of the participants. Table 2 shows the gender make-up of the students and Table 3 shows the ethnicity of the participants.

Table 1

Number of Participants by Age

Age	Frequency (n)	%
18-21	205	83
22-27	14	6
>27	27	11
Total	246	100

Errors during the data collection process included one of two cases: either students left three or more questions blank in the MSES, or they completed the pretest, but not the posttest. The majority of the participants, 83%, fell in the 18-21 age group, indicating participation by many young students, and perhaps ones that recently graduated from high school. The percentage of students between 22 and 27 was only 6%, while the percentage of older students, those over 27, was 11%. The age groups boundaries were chosen in order to distinguish the newly graduated high school students from the adult students; whereas the highest age group was chosen to identify the students who were older than the mean age group for community college students. Nationally, in fall 2014, undergraduate college students under the age of 21 made up 39.7% of the population, 22- to 24-year-old students made up 19.7%, students between 25 and 29 made up 14.9%, and students over the age of 30 made up 25.6% of the population (National Center for Education Statistics [NCES], 2015).

Table 2

Number of Participants by Sex

Sex	Frequency (n)	%
Female	158	64
Male	88	36
Total	246	100

The majority of participants were female at 64%, while the percentage of male students was 36%. These percentages are somewhat in agreement with national gender statistics. According to the National Center for Education Statistic, in fall 2015, 56% of undergraduate college students were female, while 44% were male (NCES, 2017).

Table 3

Number of Participants by Ethnicity

Ethnicity	Frequency (n)	%
White	13	13
Black	8	3
Hispanic	175	71
Other	31	13
Total	246	100

The majority of students that participated in the math refresher courses were Hispanic, at 71%, a fact not surprising since the majority of residents in this geographical area are Hispanic. The percentage of students who identified as White was 13%, and the percentage who identified as Black was 3%. The percentage of students who fell into the Other category was 13%. This Other category consists of students who identified as

Asian, Native American, Pacific Islander, or mixed race. These statistics differ slightly from the ethnicity statistics for all students attending the Alamo Colleges. According to the Alamo Colleges web page, Hispanics make up 61.2% of the student population, Whites make up 25.4%, and African Americans make up 7.9%. The category of Other makes up 6% of the student population (Alamo Colleges, 2015). Neither the ethnicity rates for the Refresher course nor the rates for Alamo Colleges is in agreement with the national rates. In Fall of 2015, 55% of US college students were White, 18% were Hispanic, 14% were Black, and 7% fell into the Other category (NCES, 2017).

Setting

The study was conducted within the Alamo Community College District in San Antonio, Texas, which consists of five independent colleges. Participants included students participating in a mathematics refresher course. The math refresher course advertising brochure stated that the “session may help students bypass one or more levels of developmental math, accelerating completion of their developmental requirements” (Alamo Colleges, n.d.). The program had been offered at all five colleges in the district for several years and had undergone some minor changes since its inception. The district began implementation of the program in 2009 and was pleased with the success of the program. Therefore, district administrators mandated that FTIC students participate in the program.

Math Refresher Course

The program was designed for students to attend class for 4 hours a day on Monday, Tuesday, and Wednesday, and to take the alternate assessment test on Thursday. Sessions were offered by various full-time and part-time faculty members employed by

the community college district and were facilitated in a computer laboratory classroom on each of the college campuses. For First-time-in-college (FTIC) students, the Texas State Initiative assessment (TSIA) was considered their initial assessment score and was administered to them before the math refresher course began. For students who were enrolled in a developmental level mathematics course in the spring of 2016 (non-FTIC students), either the TSIA, SAT, ACT, THEA (Texas Higher Education Assessment), or Accuplacer placement test scores was considered to be their initial assessment score.

Students then began their math refresher program, utilizing the McGraw-Hill product, ALEKS (Assessment and Learning in Knowledge Spaces) to complete the mathematics review portion of the program. ALEKS is an internet-based program that uses artificial intelligence to create a unique mathematics remediation program for each user. ALEKS uses adaptive questioning to accurately determine what a student knows and does not know in a course. ALEKS then instructs the student on the topics she is most ready to learn and reassess the student periodically to ensure that learning has occurred (McGraw-Hill, 2019). To begin, students underwent an initial assessment in ALEKS and were prescribed a set of skills, called their personal pie. Once the student completes the pie, they have undergone a full review of their prescribed personal mathematic concepts.

Faculty at the various campuses in the district choose to implement the program differently to accommodate students' differing schedules. On some campuses, faculty for the math refresher course required students to be on campus for the full 4 hours per day. On other campuses, faculty gave students the option to leave campus and work at home (since ALEKS is internet-based). While all students were advised to complete their full

personal review (or their pie) before taking the alternative placement test (in ALEKS) on the last day of the refresher, they were not required to do so. As such, some students in the program completed their pie and others did not.

As part of my study, I designed three additional activities for students' completion that were intended to increase their self-efficacy for mathematics. Some students volunteered to be in this group, the EI group. Students who participated in my study but who did not complete the additional activities were in the TI group.

Traditional Intervention Activities

The students in the traditional intervention (TI) group had the opportunity to meet face-to-face with the instructor for 4 days. During this time, students reviewed mathematics topics based on their pie, or computer-generated prescribed material. They were able to ask the instructor questions, and work at their own pace. The students completed as much of their prescribed material as possible; some students did not finish all material prescribed to them. On the last day of the session, students took an alternative assessment to determine their new course placement. Although students could meet with their instructors every day of the session, some students opted to work independently away from campus and returned only to take the alternative assessment. It is important to note that the primary source of SE designed into this setting is mastery experience. When students practice on and are successful with the problems that they encounter in the ALEKS program, they are creating mastery experiences for themselves.

Enhanced Intervention Activities

Students in the enhanced intervention (EI) group participated in the same way as those in the TI group, but these students also complete an extra series of short, daily

activities designed to address self-efficacy through the three other sources: vicarious learning experiences, verbal persuasion, and physiological state. The additional activities completed by the EI group were printed in packets that students took with them and worked on throughout the week. In this way, this group of students had the opportunity to increase their SE for accomplishing mathematics more so than those students who participated in the TI group. This provides the distinction between the TI and EI groups.

The additional activities completed by students in the EI group included: (a) reading about math anxiety and how to reduce it, followed by answering a series of short questions; (b) answering a series of questions asking about their success so far in the program, followed by responses from the researcher emphasizing that their effort has contributed to their success; and (c) reading about taking Cornell notes, viewing a video of a math lesson on Khan Academy, and submitting notes taken while viewing the lesson. The first activity promoted gains in SE through considering the student's physiological state. In other words, if the student's anxiety level is lowered, he or she can potentially have higher gains in SE. Answering the questions ensured that the student had read and thought about the assignment. The second activity promoted gains in SE through verbal persuasion. I designed the questions in this activity to allow students to use self-discovery of their accomplishments and self-talk to praise themselves for their hard work. Since students worked alone during the math refresher course, this was the only way that verbal persuasion could be included in the enhanced activities. None of the questions referred to inherent talent or intelligence because according to SCT, responses to students addressing effort add to gains in SE while responses to ability do not. Finally, the third activity addressed vicarious learning, or more specifically, modeling. By viewing the

video of a mathematics problem being worked correctly, the students would hopefully be able to emulate the work when they attempted that type of problem on their own.

Submitting the notes taken ensured that the student completed the activity.

Student Recruitment

I was able to recruit 279 students out of nearly 500 taking a math refresher course to participate in the study. However, recruitment of students for the EI group proved to be a more daunting ask. My plan was to designate alternate sessions of the refresher as EI and TI groups and to offer students the chance to win a \$20 Amazon gift card. The first session was a TI group, so the second was to be an EI group, and so on. After the second session, while recruiting for the EI group, it became clear that students did not want to complete the three additional activities for the mere chance of winning a gift card, so not many volunteered to participate in the study. I had to modify my recruitment technique in order to recruit a suitable number of students to participate in the EI group. With the next session, I then began offering a \$10 gift card to anyone who participated in the EI group. At the end of the session, when students presented the completed enhanced activities packet to me, they were then given the opportunity to choose their gift card. Gift cards choices included Starbucks, Amazon, Chili's, Sonic, Whataburger, Chick-fil-A, GameStop, and Google Play. This approach seemed to help encourage more students to participate.

Procedure

On the Monday of each session, I addressed the students only after the faculty member explained the math refresher course to them. I read a script to the participants on day one of each session, explaining my research and its importance. I then asked for

volunteers and offered gift cards to those who agreed to complete three extra assignments distributed in a packet of worksheets (for the EI group). Volunteers then signed the consent form, then completed both the Entry Survey (demographics survey) and the MSES (Math Self-Efficacy Scale) pretest before beginning work in the math refresher course.

I returned to the math refresher course session on Thursday to collect my final pieces of data. Students in the EI group who completed the extra activities submitted their work to me and afterwards, they chose their gift card. All participating students then completed the MSES posttest and an Exit Survey (opinion survey) consisting of the question: “What did you find most helpful about the math refresher course?” Only students who complete the MSES pretest and Entry Survey on Monday completed the MSES posttest and Exit Survey on Thursday.

Once I collected my data, students completed an alternative mathematics placement test using the ALEKS program. The ALEKS assessment score was used as their second assessment and determined each student’s new course placement. Students who arrived in class on Thursday took their alternative placement test in ALEKS. While some details may vary, I will adopt the definition of completion of the program to mean that the student took the alternative placement test.

Variables

The dependent variable in this study is SE. The participants’ mathematics self-efficacy (SE), was measured via the Mathematics Self-Efficacy Scale (MSES). Part I of the MSES measure addresses many different everyday math tasks (sample question: “How much confidence do you have that you could successfully: Add two large numbers

(e.g. $5379 + 62543$) in your head?” © MindGarden). Part II asks about students’ confidence levels in completing math related courses (Sample question: How much confidence do you have that you could complete the course with a final grade of “A” or “B” in: Basic College Math? © MindGarden). Students completed the MSES as a pretest and a posttest and SE was calculated as the difference between posttest and pretest. SE, then, is an interval variable with possible scores from 0 to 9 and it is defined as the students’ self-efficacy for accomplishing mathematics tasks.

The independent variables included Time, FG (FG vs. CG vs. Unknown), and Group (TI vs. EI). I defined a fourth variable, Degree of Participation, after having collected all the extra activities completed by the students in the EI group. I did so to be able to accurately report that not all students in the EI group completed all three extra activities. Some completed two, and some only completed one. The variables are:

- *Time* was measured at the categorical level. This categorical variable includes two levels, SEPre and SEPost.
- *FG (First-Generation status)* is categorical and refers to a student’s generational status. A first-generation (FG) college student is defined as one who does not have at least one parent who completed a bachelor’s degree or higher. Whereas, a continuous-generation (CG) college students is one who has at least one parent who completed a bachelor’s degree or higher. This variable consisted of three levels: FG, CG, and Unknown (a student who does not know their parents educational level).
- *Group* is a dichotomous variable and refers to the intervention group within which each student participated, either traditional intervention (TI) or enhanced

intervention (EI). The TI group consisted of students who took the math refresher course. The EI group consisted of students participating in the math refresher course and who agreed to complete three additional activities designed to provide more opportunities to gain math self-efficacy.

- *Degree of Participation* is a numerical variable. Frequently students in the EI group (who had committed to completing the three additional activities) submitted only one or two out of the three promised activities completed. I then created this new variable to distinguish, if necessary, between students who completed one, two, or all three of the enhanced activities. In my general analyses, I include students to be in the EI group as long as they completed at least one of the enhanced additional activities.

Measures

The primary measure for this study was the Mathematics Self-Efficacy Scale (MSES). Other data were reported through surveys. On the first day of each session, students completed an Entry Survey (or demographics survey) and the MSES. Students in the TI group did not complete any other surveys or assignments until the last day of the session. Students in the EI group completed and submitted the extra activities on the last day of the session. On the last day of each session, all participating students again completed the MSES along with the Exit Survey (or opinion survey).

Mathematics Self-Efficacy Scale

According to Bandura (1997), a self-efficacy scale should “measure people’s beliefs in their abilities to fulfill different levels of task demands within the psychological domain selected for study” (p. 44). The Mathematics Self-Efficacy Scale (MSES) does

exactly that by asking questions on confidence for accomplishing tasks of differing difficulty levels within the domain of mathematics. In this study, the MSES will be utilized to measure the students' self-efficacy for accomplishing math tasks. It is a multidimensional scale with correlated dimensions and it consists of two scales (Betz & Hackett, 1993).

Part One is *Everyday Math Tasks* and includes questions about students' beliefs about completing commonly used math tasks. This portion of the test includes eighteen questions. Students responded to questions using a 10-point Likert Scale. Response options are categorized into five categories: Not Confident At All (including a choice of 0), Very Little Confidence (including choices of 1, 2 or 3), Some Confidence (including choices 4 and 5), Much Confidence (including choices 6 and 7), and Complete Confidence (including choices 8 and 9).

Part Two is *Math Courses* and includes questions about students' beliefs about being successful in math courses and math-related courses (Betz & Hackett, 1993). This portion of the test includes sixteen questions. Students responded to questions using a 10-point Likert Scale. Response options were categorized into five categories: Not Confident At All (including a choice of 0), Very Little Confidence (including choices of 1, 2 or 3), Some Confidence (including choices 4 and 5), Much Confidence (including choices 6 and 7), and Complete Confidence (including choices 8 and 9).

The score obtained in the Everyday Math Tasks test and the score in the Math Courses test can be obtained and reported separately, but they can also be combined to produce one combined total score measuring mathematics self-efficacy. In this study, I utilized the combined score. The survey was administered as a pretest and as a posttest.

Validity of MSES. Betz and Hackett (1993) reported positive correlations between the MSES and other related mathematics scales such as math anxiety ($r = .56$), a medium positive correlation; confidence in doing math ($r = .66$), a medium-to-high positive correlation; perceived usefulness in math ($r = .47$), a medium positive correlation; and effectance motivation in math ($r = .46$), a medium positive correlation. These correlations with other related math scales provide evidence of concurrent test validity. In addition, Hall and Ponton (2005) found that there was a medium to high and positive correlation ($r = .580$) with ACT test scores for all students. However, the students enrolled in Calculus I had a medium and positive correlation between the MSES and the ACT ($r = .454$), while students in Intermediate Algebra had no significant correlation ($r = .052$).

Reliability of MSES. Betz and Hackett (1993) reported internal consistency reliability scores generated by the Spearman-Brown formula for the MSES. The coefficient alpha found was $\alpha = .96$ for the total scale in the first version of the MSES and the following alpha values: $\alpha = .92$ for the Tasks scale; $\alpha = .96$ for the Problems scale; and $\alpha = .92$ for the Math Courses scale. All these values of alpha indicate that a high internal reliability was found. In addition, in 1991, Lent, Lopez, and Bieschke utilized a slightly revised version of the MSES to fit local course offerings and reported a coefficient alpha of $\alpha = .92$, indicating high internal reliability, and a 2-week test-retest reliability of $\alpha = .94$, also indicating high reliability (Betz & Hackett, 1993; Lent et al., 1991).

Entry Survey (Demographics Survey)

In addition to SE measures, the students were asked to report their age, ethnicity, sex, and FG student status via a survey. These descriptive statistics served to give a complete portrait of the population of students sampled. The variables FG and Ethnicity were used in the first analysis, the two-way mixed ANOVA.

Exit Survey (Opinion Survey)

On the last day of the bridge program, the students were asked to complete an opinion survey. The survey solicited their opinions on what they felt was the most useful part of math refresher course. Responses were open ended.

IRB Application

The community college system in which the study was conducted did not have a centralized IRB approval process in place. A district level committee was formed to review my IRB request. After several months, I was granted permission to conduct my research at all five of the Alamo Colleges campuses.

I also applied for IRB approval from Texas State University. In the application to the Texas State University IRB committee, I included copies of the consent form, the Entry survey (demographics survey), the Exit survey (opinion survey), the Mathematics Self-Efficacy Scale—the primary measure used in the study (Betz & Hackett, 1993), and extra activities that I planned to use in the study. Also in the IRB application for Texas State University, I included the IRB approval letter from the community college district and a synopsis of the study. I then received approval from to the IRB Committee at Texas State University to conduct my study.

Background on Research Approach

The basis for this research design stems from a previous study conducted for my Comprehensive Exam. That study is considered to be the pilot study for the current study conducted for my dissertation. In the pilot, similar questions were examined in a math refresher course. Question 1 was: Are increases in self-efficacy (SE) for accomplishing math tasks influenced by time, first-time-in-college (FTIC) student status, or both? The sub-questions addressed for the first question were: (a) Is there a change in SE for accomplishing math tasks from SE pretest to SE posttest? (b) Does FTIC status influence SE for accomplishing math tasks? (c) Does the influence of FTIC status change students' SE for accomplishing math tasks when comparing SE pretest and SE posttest? Question 2 was: Is the success of students in the bridge program affected by SE posttest, FTIC student status, ethnicity, gender, age, and teacher?

An ANOVA was utilized to address the first question. Results showed that there was a statistically significant increase in SE for all students as measured from SE pretest to SE posttest, $F(1,108) = 63.47, p < .05$, and Cohen's $d = 0.44$, indicating a medium effect size. However, there was not a statistically significant result between FTIC and non-FTIC students and there was no significant interaction between SE and FTIC for changing students' SE. For Question 2, a binary logistic regression was used to see what factors affected student success. In this setting, success was defined as the event that the student was able to advance at least one math course level as a result of participating in the math refresher course. There were several results that were revealed from this analysis. Students who were in the oldest age category were more likely to be successful than students in the two younger categories. In addition, students who identified as an

ethnicity other than White, Hispanic, or African American were more likely to be successful in the bridge program. Finally, students who participated in the bridge program under the fourth instructor were more likely to be successful. Although these results were statistically significant, a greater or deeper explanation would be more beneficial to clearly understand the results.

The findings of the pilot study mentioned above left more questions to be answered. As a result of these findings, when I began planning for the current study, it seemed prudent to add a qualitative component to the second question. I felt that adding this qualitative question would be helpful in order to gain more understanding about which factors helped students to succeed or to advance course levels. The purpose of the qualitative question is to provide greater understanding of the quantitative results. Therefore, the pilot study gave rise to the current mixed methods design as it is primarily a quantitative study with a secondary qualitative part (Creswell & Clark, 2011). The research questions, hypotheses, and rationales are reiterated in the following section.

Research Questions

Question 1

Does self-efficacy (SE) for accomplishing mathematics tasks change over Time (from MSES pretest to MSES posttest) for students taking the math refresher course, and is the change moderated by Group (TI vs. EI), by first-generation student status (FG vs. CG vs. Unknown), or by both variables?

Hypothesis 1(a). Students participating in the math refresher course are hypothesized to experience a change in mathematics self-efficacy affected by Time (from pretest to posttest).

Hypotheses 1(b). FG students are hypothesized to have a greater change in SE from pretest to posttest as compared to CG students.

Hypothesis 1(c). Students in the EI (enhanced intervention) group are hypothesized to have a greater change in SE from pretest to posttest than those in the TI (traditional intervention) group.

Hypothesis 1(d). It is hypothesized that the interaction of Time and FG, Time and Group, or Time and FG and Group will affect SE.

Question 2

What are students' perceptions of the helpfulness of the math refresher course?

Hypothesis 2. For Question 2, there is no hypothesis. Students' open-ended responses were recorded. Afterwards, the focus was on categorizing the responses.

Data Analysis

The research questions were addressed through one quantitative analysis and one qualitative analysis. Data were collected for both the qualitative and quantitative portions simultaneously. The design is primarily quantitative with a qualitative aspect included. Preliminary analyses were conducted to examine the descriptive statistics of the data set. In addition, assumptions for each statistical analysis were conducted on the data set to ensure valid results. Results of the statistical analyses will be reported and integrated into the interpretation of the overall results, and any inconsistencies or contradictions will be noted and discussed in the next chapter (Creswell, 2014).

Analysis of Variance

A mixed ANOVA (Field, 2013) was used to explore the first question using the variable SE (self-efficacy) as the within-subjects variable and the variables Group (TI vs.

EI) and FG (FG vs. CG vs. Unknown) as the between-subjects factors. The question was divided into several sub-questions. They included: (a) Is there a change in SE for accomplishing math tasks over Time (from SEPre to SEPost)? (b) Does FG status influence SE for accomplishing math tasks? (c) Does the student's intervention group status influence SE for accomplishing math tasks? and (d) Are there any interaction effects (Group x Time, FG x Time, or Group x FG x Time) on SE?

Preliminary analyses involved testing the assumptions for the mixed design. The assumptions tested include homogeneity of variances and sphericity (Field, 2013). I used Levene's test to assess the homogeneity of variance assumption and Mauchly's test was used to assess the sphericity assumption. I also used the Greenhouse-Geiser correction a priori to test the study hypotheses because it corrects for violations in sphericity, if there are any, and makes no correction if no violations are detected. More information on testing the assumptions will be discussed in the next chapter. The primary analyses involved conducting the two-way mixed ANOVA. Afterwards, a Bonferroni adjustment was used as a post-hoc test because a significant interaction effect was found.

Content Analysis

The second research question was addressed using a content analysis. While content analysis is categorized as a qualitative method of research, historically, it has been very quantitative in nature (Merriam, 2009). Using content analysis, communication as a unit of measure is analyzed for "frequency and variety of messages, the number of times a phrase or speech pattern is used" (Merriam, 2009, p. 205). In this study, the content analysis provides a quantitative description of responses to a survey question. Responses were gathered on the last day of each session of the math refresher

course. Students were asked to answer one open-ended question: “What did you find most helpful about the bridge program?”

I began the content analysis after all responses were collected and the process utilized an inductive to deductive pattern of reasoning (Merriam, 2009). My first step was to code open responses to the questions asked of the participants by using pens with differing ink colors, beginning the inductive process. Once several responses were coded, I attempted to group the coded responses into larger categories. At some point in the process of reading new responses before coding, I began to try to fit the new responses into the existing categories, hence beginning the deductive process. This process led to the themes I reported in my analysis. The themes names were decided based on what students reported, on research in developmental mathematics, and on my experience in teaching developmental mathematics. Percentages of occurrence for each theme and sub-themes will be later presented with the other statistical analyses in an attempt to support the statistical findings and to provide triangulation (Creswell & Clark, 2011; Creswell, 2014). Results will be discussed in the next chapter.

Summary

This chapter included a discussion of the design of the study, the participants, the setting, the procedure, and the instruments used. A complete description of the research questions and sub-questions were reviewed, along with the rationale for each sub-question. Finally, a description of the methods by which the data were collected and analyzed was also discussed.

IV. RESULTS

The purpose of this study is to investigate changes in mathematics SE for students participating in a math refresher course, comparing students by first-generation (FG) status and intervention group. This chapter includes a discussion of (a) the analyses carried out for this study, beginning with a description of the students who participated in the study and the groups in which they participated, (b) the assumptions necessary to execute the statistical analyses, (c) the process of analysis, and (d) the results of the analysis.

Participants by Group

Upon beginning to collect data for the study, students were placed into one of the two Groups by class they attended. More precisely, each class was designated as either a TI (traditional intervention) group or as an EI (enhanced intervention) group. If the class was designated as an EI group, students were asked to complete the extra set of class activities designed to further elevate their self-efficacy enhancing experience. It quickly became obvious that not all students were interested in participating, even when gift cards were offered for their participation. Hence, by the third session, I began offering the gift cards for EI group participants in every session. Upon ending my data collection, I was not able to get an equal number of participants in the EI group and the TI group.

Table 4

Number of Participants by Group

Group	Frequency	%
TI	141	57
EI	105	43
Total	246	100

The majority of students, 57%, participated in the TI group. This group of students opted to complete the demographics survey, two administrations of the MSES survey, and the opinion survey. The percentage of students who participated in the EI group was 43%. These students agreed to complete the same surveys as in the TI group, but they also agreed to complete three additional activities aimed at increasing math self-efficacy.

Table 5

Degree of Participation in Enhanced Intervention Group by Number of Extra Activities Completed

Degree of Participation	Frequency (n)	%
1	15	14
2	34	33
3	56	53
Total	105	100

To be in the EI group, students agreed to complete three additional activities. However, many students only completed a portion of those additional assignments. If a student initially agreed to complete the activities, but did none, the student was then placed into the TI group. Students who completed one additional exercise made up 14% of the EI group. Students who completed two additional exercises made up 32 % of the EI group, and those who completed all three exercised made up 53% of the EI group. When considering this distribution within the context of all participants, the percentages are much smaller. The percentage of participants in the math refresher courses who completed only one additional exercise was 6%, the percentage who completed two exercises was 14%, and the percentage who completed all three was 23%.

Participants by First Generation Status

Students were asked to report the college education achievements of their parents in order to identify FG students. Many students were able to state this information on the Entry Survey (demographics survey) administered on day one of the math refresher, but some were not able to report on both parents. As such this variable consists of three levels: first generation students, continuing generation students, and students who don't know the education levels of their parents. The following table shows the makeup of each of the groups.

Table 6

Number of Participants by First Generation Status

Status	Frequency (n)	%
FG	145	59
CG	59	24
Unknown	42	17
Total	246	100

Assumptions

There are eight assumptions that must be tested before a mixed design ANOVA can be carried out (Field, 2013). The first assumption is that the dependent variable, in this case SE, must be a continuous variable. The description of the dependent variable in this study given previously stated that student responses for each question on the MSES test consisted of number choices from 0 to 9. Furthermore, the different levels of SE consisted of the SEPre and the SEPost, which were calculated as averages for each student. Hence, SEPre and SEPost scores were continuous scores between 0 and 9.

Secondly, the within-subjects factor must consist of at least two levels. This is the case for the present study as SE, the within-subjects variable, does indeed consist of two levels as two time points; they include SEPre and SEPost. Thirdly, the between-subjects factors must consist of at least two categorical independent groups. In this study there are two independent groups: FG and Group. The three levels FG include FG, CG, and Unknown, while the two levels of Group include EI and TI. Hence, the third assumption is met.

The fourth assumption is that there should be no outliers of the within-subjects factor or of the between-subjects factors. To check this assumption, box and whisker plots for both the SEPre and the SEPost scores were observed. Several scores fell above 1.5 standard deviations from the mean, but none fell above 3 standard deviations from the mean, indicating there were no outliers. The fifth assumption is that the dependent variable should be normally distributed for each cell of the design. Scores for the variable SE were normally distributed as reported by the Shapiro-Wilk's test ($p > .05$).

Table 7

Levene's Test for Homogeneity

	F	df_1	df_2	Sig.
SEPre	2.174	5	240	.058
SEPost	0.693	5	240	.629

The sixth assumption is that there must be homogeneity of variances. Levene's test checks for this. As can be seen in Table 7 above, the significance values for SEPre and SEPost are .058 and .629, respectively. Since neither is less than .05, then the interpretation is that the variances are homogeneous.

Table 8

Mauchly's Test of Sphericity

Within Subjects Effect	Mauchly's W	Approx. Chi- Square	df	Sig.	Epsilon		
					Greenhouse- Geisser	Huynh- Feldt	Lower- bound
SE	1.000	.000	0	.	1.000	1.000	1.000

The seventh assumption is sphericity (Field, 2013). Mauchly's Test checks for sphericity. However, since there are only two levels of the repeated measure, Mauchly's W has no significance level associated with it, and it suggests no violations in sphericity. The eighth assumption is that student responses must be independent, or not dependent upon other factors or interactions with other people. I did attempt to limit violations of this assumption by having students complete the intervention independently, as opposed to in groups. In this way, student responses are more likely to have been independent. Hence, with these explanations, all eight assumptions required to carry out the mixed design ANOVA have been met.

Process

The analysis I chose to execute was a two-way mixed ANOVA. The purpose of this analysis is to determine if there are any statistically significant main effects (Time, FG, or Group) or interaction effects (Time \times FG, Time \times Group, FG \times Time, or Time \times FG \times Group) on SE. I executed the ANOVA using Time as the within-subjects factor and with FG and Group as between-subjects factors. Results of the ANOVA revealed that there was significant main effect of Time on SE and a significant interaction

of effect of TimexFG on SE. Post-hoc tests were conducted using Bonferroni adjustments to probe the interaction.

Results

Question 1

Presented below are the descriptive statistics, including the means and standard deviations, of each group included in the mixed design ANOVA. The main effects and interaction effects will also be discussed.

Table 9

Descriptive Statistics for MSES Data

	Group	FG	Mean	SD	N
SEPre	TI	CG	4.5772	1.6320	33
		FG	4.5643	1.2521	83
		Unknown	4.1544	1.5335	25
		Total	4.4946	1.3983	141
	EI	CG	4.3517	1.5606	26
		FG	4.7549	1.3862	62
		Unknown	4.4843	1.9004	17
		Total	4.6113	1.5165	105
	Total	CG	4.4778	1.5912	59
		FG	4.6458	1.3099	145
		Unknown	4.2879	1.6771	42
		Total	4.5444	1.4481	246
SEPost	TI	CG	5.4891	1.4869	33
		FG	5.1669	1.3092	83

Table 9. Continued

	Unknown	4.7559	1.4470	25
	Total	5.1694	1.3866	141
EI	CG	5.5057	1.3926	26
	FG	5.4185	1.5846	62
	Unknown	5.1499	1.9517	17
	Total	5.3966	1.5932	105
	Total	5.4964	1.4338	59
	FG	5.2745	1.4336	145
	Unknown	4.9154	1.6585	42
	Total	5.2664	1.4795	246

The means of the MSES (SEPre and SEPost) tests for each group (First-Generation, Continuing-Generation, and Unknown) are shown above. All SEPost scores are higher than the SEPre scores and difference between the means of SEPost and SEPre is .7220.

Table 10

Table of Main Effects

	<i>df</i>	F	Sig.
Time	1	107.103	.000**
FG	2	1.036	.356
Group	1	0.618	.433

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

Table 11

Table of Interaction Effects

	<i>df</i>	F	Sig.
TimexFG	2	3.493	.032*
TimexGroup	1	0.682	.410
FGxGroup	2	0.412	.663
TimexFGxGroup	2	0.178	.837

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

Main effects. Table 10 shows that there was a main effect of Time, $F(1,240) = 107.103, p < .05$, partial $\eta^2 = 0.31$. In other words, disregarding students' FG status and treatment group status, there was a significant difference in Time when comparing SEPre to SEPost. Moreover, 31% of the variance of SE is explained by Time. This was the only significant finding among the main effects and in addition, this was the outcome that was most anticipated with regard to this study.

Table 10 also shows that there was not a significant effect of FG, ($F(2,240) = 1.036, p > .05$). That is, disregarding Time and Group, the FG students' scores were the same as CG and Unknown students' scores. The last variable, Group, did not produce a significant effect either ($F(1,240) = .618, p > .05$). Hence, disregarding Time and FG, the scores of students in the TI group were the same as the scores of the students in the EI group.

Interaction effects. There was only one significant result among the interaction effects. Table 11 shows that there was as significant interaction effect between Time and FG, ($F(2,240) = 3.493, p < .05$, partial $\eta^2 = .03$). This finding indicates that the difference between SEPre and SEPost scores were dependent upon the students' FG

status. Combined these two variables, Time and FG, accounted for 3% of the variance in SE. Upon further review, after a Bonferroni adjustment, a pairwise comparison showed that for the FG, CG, and Unknown groups, all had a significant increase in SE from pretest to posttest, but CG students made stronger gains in self-efficacy over time than the other two groups. As can be seen below, CG students had a mean difference of 1.033 points on the MSES test scale.

Table 12

Pairwise Self-Efficacy Comparisons

FG	Time		Mean Difference	p
CG	1	2	-1.033	.000**
	2	1	1.033	.000**
FG	1	2	-.633	.000**
	2	1	.633	.000**
Unknown	1	2	-.634	.000**
	2	1	.634	.000**

Note. * indicates $p < .05$; ** indicates $p < .01$; Bonferroni adjustments were used.

All other interactions tested were found to be insignificant. The interaction between Time and Group was not statistically significant ($F(1,240) = .687, p > .05$), meaning that the difference between SEPre and SEPost scores were not dependent upon the students' intervention group status. The interaction between Time, FG, and Group was not statistically significant ($F(2,240) = .181, p > .05$), indicating that the difference between SEPre and SEPost scores were not dependent upon the students' FG status nor upon the students' treatment-group status. The interaction between FG and Group was

not statistically significant ($F(2,240) = .412, p > .05$), which indicates that differences in scores as compared by FG status were not dependent upon the students' intervention group status.

Follow-up test on Group. After consideration of the fact that a statistically significant main effect of Group significant was not found, I conducted a follow-up test to explore the difference between SE changes for students in the EI group who completed all three additional activities to those in the TI group who completed none of the additional activities. The rationale behind this additional test was that because there was no main or interaction effect pertaining to Group, I hypothesized that possibly there was no effect because the enhanced intervention was designed so that students would complete all three additional activities. If students had not completed all three, then they had not, in fact, participated as was expected to be in the EI group. Therefore, I excluded students from the analysis who completed only one or two activities and compared students who truly participated as being in the TI group (students who completed all three enhanced activities) to those who were in the EI group. To exclude those students who completed only one or two activities, I created a new variable called ActivityParts having two categorical levels (0 or 3).

I utilized a two-way mixed ANOVA to explore the mean differences with the between group variable being ActivityParts (either 0 or 3), FG (FG, CG, or Unknown), and the within variable being Time (SEPre and SEPost). In this analysis, I found no significant results. I then ran the ANOVA again, this time removing FG from the analysis. I again found no significant results. At this time, I concluded that the enhanced intervention truly had no significant effect on SE gains.

Question 2

For the second research question, a content analysis was performed. The objective was to attempt to extract more information about what the students found to be most helpful about the Math Refresher program. Participation was abundant; although there were 220 students who completed the opinion survey on the last day of the course, there were 380 total responses to the question on the survey, “What did you find most helpful about the math refresher course?” This rate of participation suggests that most students gave more than one answer for the question. A discussion of the responses given by the students is provided in each of the following sections.

ALEKS program. The aspect of the math refresher that the majority of students found to be most helpful was the ALEKS program, with a 49.5 % response rate. This is the online learning system that was utilized by all four colleges for the math refresher course. While there were many aspects of the program that were mentioned, I felt it was necessary to group them all under the umbrella of “ALEKS program.” Responses that fell into this category included:

- a) The explanations were very helpful.
- b) The steps the program showed were really helpful.
- c) The program gave multiple solutions for the same problem.
- d) The program gave good examples.
- e) The program was personalized for each student.
- f) The program forced me to master the content before moving on to another topic.
- g) I had multiple chances to get the problem correct.

The fact that many students felt that the ALKES program was the most beneficial part of the program is significant when considering the tenets of self-efficacy, specifically mastery experiences. The above statements are evidence that the ALEKS program allowed students to feel successful when reviewing math topics, thus increasing their self-efficacy for accomplishing mathematics tasks.

Mathematics Review. The next aspect of the refresher course that students found helpful had to do with the actual mathematics review. The percentage of responses that referenced the mathematics review was 23.9%. Some responses included:

- a) The program gave me a strong review of mathematics skills.
- b) The review helped me to strengthen my weaknesses.
- c) The review taught me concepts I had never learned before.
- d) I was able to learn specific content.

These responses also help students to create mastery experiences for themselves, and as such, they also relate to self-efficacy theory.

Confidence. Responses referring to confidence made up 9.7% of the students' answers to the question "What did you find most helpful about the math refresher course?" Some of the student responses ($n = 29$) indicated that the refresher course helped them to feel more confident. Even though the construct of self-confidence by definition encompasses a broader range of beliefs, this response is the closest students came to acknowledging that they gained self-efficacy for accomplishing mathematics tasks. The responses included:

- a) I feel more confident now.
- b) I liked the positive feedback that ALEKS gives.

- c) I now have a positive math attitude.
- d) I learned a lot.
- e) I thought I was bad at math, but I now know I'm not.
- f) I know I can get better at math.
- g) I can do it if I set my mind to it.
- h) I'm ready to take the alternative test.

Pace/Modality. The pace of the course and the modality of the course accounted for 8.4% of the responses. Several students responded that the online modality of the course was convenient for them because it gave them to opportunity to work on the refresher course from home or work. Related to modality, the pace was also mentioned because students felt they could work at their own pace. If they needed to spend more time on a particular topic, they had the ability to do so by working at home outside of class time. On the other hand, if they were able to work through a topic quickly, then they had the opportunity to move on to additional topics. Responses included:

- a) ALEKS was self-paced.
- b) I could work from home or work.
- c) I could work online.
- d) ALEKS provided a quick review.
- e) There was no set time for completing problems.

Instructor. A handful of students referred to the instructor as being the most helpful aspect of the Refresher course. Since the Refresher course is offered using an online learning management system, the instructor of record plays a smaller role in facilitating the review. Despite this fact, some of the instructors have personalities that

allow them to offer help to students more frequently than others do. Responses regarding the instructor as most helpful included 2.6% of the responses and included the following:

- a) The instructor was very helpful.
- b) I'm glad there was an instructor to help.
- c) The instructor presented alternative solutions.

Negative Comments. Some students gave negative comments concerning the refresher course. These made up 1.6% of all comments. Responses included a comment about the modality in which the refresher course was offered and a comment about the fact that technology was responsible for the teaching of the course. Some examples of such comments included:

- a) I prefer in-class instruction.
- b) I didn't like the technology aspect.
- c) I like to be shown how to work problems by another person.
- d) I was sad to know I needed to review so much.

In addition to the positive and negative responses listed above, there were a few responses that did not fall into any of the previously mentioned categories. As such, I categorized them as "Other." These responses made up the last 3.5% of all responses.

According to this qualitative evidence, most students felt that the ALEKS program was most helpful aspect of the math refresher course, with the mathematics review as second helpful aspect. Some students appreciated the self-paced nature of the course, and some felt the program boosted their confidence to do math. A few others liked the fact that a teacher was there to help them. Very few students had negative comments about the technology-based modality of the class.

Quantitative/Qualitative Ties

Many student qualitative responses corresponded to the sources of self-efficacy beliefs: mastery experiences, vicarious experiences, verbal persuasion, and physiological state (Bandura, 1997). Correspondences underscore the significant findings in Question 1 that students who participated in the program had a medium to large gain in self-efficacy after participating in the math refresher course.

For example, a majority of the responses referred to the ALEKS program and to the mathematics review. The majority of students felt that doing the practice problems in ALEKS was the most helpful part of the course. The structure of the program was such that students must master the skill (problem) before continuing to another skill. Therefore, these responses corresponded to mastery experiences, which are most effective for developing a strong sense of self-efficacy.

As part of the ALEKS program, the students had the opportunity to see an example of any problem in their review. They were also able to see an explanation for any problem they did not answer correctly. Examples and explanations can give students a model to follow when attempting a similar problem. Therefore, these responses can be mapped to vicarious experiences, the second most effective source of self-efficacy.

Several student responses corresponded to verbal persuasion, the third most effective source for developing strong self-efficacy. For example, a few students responded that they liked the positive feedback given by ALEKS. These responses are programmed into ALEKS, so that when students answers problems correctly, they get a message such as “Great job!”

The least effective source for increasing self-efficacy, according to Bandura (1997), is psychological state which also includes one's emotional state. While one of the enhanced intervention activities were designed to target this aspect to increase self-efficacy, students' responses did not corresponded to this source of the intervention. A few students did indicate, however, that they now have a positive attitude towards math. Others stated they feel more confident about math. Although the following responses did not directly correspond to any of the four sources, students who have a strong sense of self-efficacy may have a positive attitude toward math and feel more confident about math.

Summary

This chapter included a discussion of the two analyses that were utilized in this study: the mixed-methods ANOVA and the content analysis. A brief description of the students who participated was given next. Details of the EI group were given, explicitly how many students completed either 1, 2, or 3 of the extra activities. These details were included since results may have been affected the number of activities they completed. A brief description of the assumptions necessary to execute the statistical analysis, the process, and the results of the analyses were presented. Finally, a connection between the qualitative and quantitative findings was given. A discussion of the results will be given in the next chapter.

V. DISCUSSION

Because they begin college with fewer resources, first-generation (FG) students are more at-risk for not completing college than are continuing-generation (CG) college students (Stebbleton & Soria, 2012). In community colleges, where the majority of FG students attend college, developmental education is prominent, but findings on its effectiveness have not been consistently positive. In mathematics, a large number of students fail to finish their developmental education sequences, and hence, do not finish their college-level math courses. Recently, there have been several attempts to redesign and restructure developmental mathematics programs in hopes of greater student achievement in developmental mathematics, as well as college level mathematics (Bonham & Boylan, 2011). Research has provided evidence that bridge programs can help students to accelerate through development education. Bridge programs can be designed in different ways, but all programs have one common goal: to provide support to increase students' academic success (Hern, 2012; Hodara, 2013; Strayhorn, 2011).

For the past three decades, summer bridge programs have been a popular program offered by two- and four-year institutions to address students' underpreparedness for college courses. In fact, there is much institutional data that supports the efficacy of these programs for helping students to accelerate through developmental coursework, but there are not many studies that include experimental designs (Hodara, 2013; Strayhorn, 2011; Wathington, Pretlow, & Barnett, 2016). The math refresher course, for example, offered by Alamo Community Colleges has seen its share of success in helping advance students through developmental mathematics. Recently, the success rate of students (for advancing at least one developmental mathematics level) after the Math Refresher course

has been upwards of 60% among all five colleges in the district. I wanted to explore whether students were able to gain other positive non-academic outcomes, such as an increase in self-efficacy, as a result of completing the course, by using a quasi-experimental design. This chapter includes (a) a review of the study, (b) findings, (c) implications, (d) limitations of the study, and (d) recommendations for further research.

Review of the Study

The purpose of the study was to determine whether students experience a change in self-efficacy for accomplishing mathematics tasks as a result of participating in the summer bridge program. The Mathematics Self-Efficacy Scale was administered to students as a pretest and a posttest in order to measure the difference in math SE scores for completing mathematics tasks before and after participating in the program.

Statistical analyses were used to determine if there was an increase in self-efficacy for the participants due to solely participating in the program, due to group status (TI vs. EI), or due to first-generation (FG vs. CG vs. Unknown) status. Student perceptions regarding their success in the program were explored through a content analysis.

Findings

It was hypothesized that students participating in the math refresher course would experience a change in math self-efficacy from pretest to posttest. The results supported this hypothesis. In fact, it can be seen that not only was there a change in math self-efficacy from pretest to posttest, but the change was determined to be positive. This is a significant finding because the results of this study support the fact that students gain self-efficacy for mathematics tasks. Considering that the students also may have skipped

at least one level of developmental mathematics, they may have experienced two benefits from participating in the math refresher course.

It was also hypothesized that FG students would experience a greater change in self-efficacy than CG students when comparing pretest to posttest. The results did not support this hypothesis. When collecting demographics for this question, it was clear that many students did not know their generational status, and therefore a third group was formed, called the Unknown generation. There was no difference in math self-efficacy change for FG, CG, or Unknown generation students.

The next hypothesis stated that students in the EI group and in the TI group would experience a difference in self-efficacy change from pretest to posttest. Again, this hypothesis was not supported by the results. Hence, students who participated in the EI group did not have a greater change in math self-efficacy than did the students who participated in the TI group. Even when the second ANOVA was conducted specifically to further explore how students who completed all three EI activities compared to students in the TI group, there was no statistical significance in the SE as compared from pretest to posttest.

Lastly, it was hypothesized that the interaction of the variables Time, FG, and Group would affect SE. In other words, the interaction between FG status and intervention group would affect the change in math self-efficacy for students as compared from pretest to posttest. The results of the analysis did support the interaction of Time and FG. In fact, upon further investigation, I found that all generation groups had an increase in SE from pretest to posttest, but the CG group had a greater increase than did

the FG and the Unknown groups. The greater increase in SE by the CG group was, perhaps, what the post hoc analysis indicated as significant.

Results of the content analysis revealed that students felt they mostly benefitted from the ALEKS program and that the mathematics review itself was also helpful. Some students appreciated the self-paced nature of the course, while some felt the program boosted their confidence to do math. Others liked the fact that a teacher was there to help them. A few negative comments were made related to the internet-based modality.

These findings suggest that students were most impressed with the academic benefits of the course (ALEKS and the mathematics review). Fewer were impressed by the affective benefits (increasing positive attitudes about mathematics, boosting self-confidence). Even fewer students would have preferred a traditional setting, eliminating the technology aspect of the course altogether.

Implications

The results of this study provides an important contribution to future research on summer bridge programs, such as the math refresher course. One positive and important result of this study was that the math refresher course helped all students improve their SE from pretest to posttest. One possible explanation is that the math refresher course is extremely brief, with a duration of only 4 days. In this way, students only had time to concentrate on the review of mathematics, knowing that with just a few days of hard work, they may be able to skip an entire developmental math course. This could potentially be a very powerful motivator. For example, consider students who place into the lowest level of developmental math, and take more than a year to complete the developmental math sequence. The argument against DE is that many of these students

lose hope/interest and fail to complete the mathematics sequence, indicating a probable drop in mathematics SE. It could be that the briefness of this refresher is exactly what students want and/or need for an increase in mathematics SE.

Few studies have produced similar gains in SE after a comparable study to the current math refresher course. One example is the Skills Learning Support Program (SLSP), a 6-week summer bridge program provided to underprepared students in the northeast region of the U.S. As result of participation in this summer bridge program, students experienced a statistically significant increase in SE from pretest to posttest (Wibrowski et al., 2017). Another example is the program described by Strayhorn (2011) in which 5-week precollege summer bridge program designed to enhance underprepared students' college readiness through developmental coursework and facilitate their social adjustment to college life. After this summer bridge program, students also experienced a statistically significant increase in academic SE. Unfortunately, neither study revealed the effect size for the increases in SE. Additionally, these two studies differ from the present study in that the SE measurements did not target mathematics specifically. Hence, this study will contribute to the literature by positing that students can increase their mathematics SE by taking a short-term bridge program.

A second important outcome to address is that students in the FG and Unknown groups improved, but not as much as students in the CG group. Unfortunately, the scope of this study did not allow for any further analyses to possibly address the reason for this outcome. Hence, I can only offer speculation as to the reason why. One such explanation could be that according to Yosso (2005), CG students enter college with greater navigational capital than do FG students. For example, CG students may have

been more familiar with the expectations faculty had for them while participating in the math refresher course or less preoccupied with how they were going to get to campus to participate in the refresher. In this way, CG students may have been able to focus their concentration on only the mathematics review and not on other situational circumstances that may have drawn their attention away from the refresher. This may explain why CG students had a slightly higher increase in SE than did FG students.

Perhaps the mathematics refresher course could be redesigned in order to address FG students' needs. As is, the mathematics refresher course is relatively simple, addressing mainly mathematics concepts and possibly system navigation for all students. However, if the mathematics refresher course was combined with a component designed to address FG students' needs, they could become empowered, boosting their confidence, increasing their self-efficacy, and improving graduation rates. Such a component could be modeled by a difference-education intervention (Stephens et al., 2014), a lay theory intervention (Yeager et al., 2016), or a utility-value intervention (Harackiewicz et al., 2016), for example.

The third major finding to be addressed is: the enhanced intervention did not have a significant effect on gains in mathematics SE. One possible reason for this outcome is that the additional activities that I created with the intention of boosting students' mathematics SE were not effective. For example, the activity which was meant to improve SE by vicarious learning used modeling by having the students watching a video on the internet, or by modeling. Perhaps, the modeling activity was not effective because the students was not able to see a live-action form of modeling. Also, the activity to improve SE by verbal persuasion utilized self-talk, as opposed to feedback from others.

There is a possible second explanation for why the enhanced activities had no effect on students' SE. All students had a moderately large increase in SE after completing the mathematics refresher course. Hence, it may be unreasonable to expect another increase after the first large increase.

Delimitations

One of the delimitations of this study is the fact that the sample has a narrow focus. The students who participated included only students from three out of five campuses of one community college system. In order for the results to be more meaningful, a more useful sample would include students from other colleges, cities, or even states. In addition, a second limitation of the study is that since the summer bridge program was only 4 days in length, it was difficult to entice students to engage in the extra activities designed to increase math self-efficacy. Even though gift cards were offered, participation was lacking, and several students who agreed to participate in the extra activities completed only one out of the three.

Limitations

Several circumstances occurred in the study for which the researcher had no control and that may explain some of the results of the study. For example, participating students included only those from three out of five campuses of one community college system. In order for the results to be more meaningful, a more useful sample would include students from other colleges, cities, or even states. In addition, while students were strongly encouraged to complete identified topics (pie) needed for college readiness in mathematics based on their pre-assessment, they were not required to do so. Instead, facilitators encouraged them to work hard, but since no grade was assigned for the class,

many students may not have taken the refresher course seriously. Moreover, students were allowed to take an alternative assessment regardless of whether they completed the recommended review topics or not. Differences in posttest math self-efficacy scores may be attributed student effort and not necessarily by the design of the math refresher course.

The official description of the course stated that students would spend 16 hours over the course of four days (Monday through Thursday) working on the review; however, in practice this requirement was not adhered to. Based on instructor reports, some students went to class every day, while others did not. Since ALEKS (the program utilized in the math refresher course) is internet-based, it is possible that some of these students logged-in review hours from home while others may not have. Specifics regarding which students specifically did work from home was not available to be collected. Again, a student was considered to have completed that summer bridge program by simply taking the alternative assessment on day four of the course.

Although there was no true time limitation enforced for students as they completed the entry survey and the MSES survey, a few students may not have taken the time to fully consider the questions on the survey instrument. As part of the design of the study, students were asked to complete the two surveys on day one, before beginning work on the mathematics review portion of the bridge program. With this in mind, some students may have rushed to answer all required questions because they were eager to begin the math review or perhaps because they did not feel that the survey was of great importance to them. Hence, some students may have given responses that were not obtained in a mindful manner.

Not all students who opted to participate in the EI group completed all three additional exercises. Slightly more than half of the students (53.3%) in the EI group completed all three additional exercises, 32.4% completed two exercises, and 14.3% completed one. The fact that so many students in the EI group did not complete all three additional activities required to be in this group may be the reason that there was no significant difference between the SE scores of the EI group and the TI group. Another possibility for this lack of participation could be the length of the course. Because the mathematics refresher course was only four days in length, students might not been enticed to engage in the extra activities within such a short time period, even though gift cards were offered for participation. Students self-selected to participate in the EI group, but if students had been randomly placed into intervention groups, the outcome of the study may have been different. It is also possible that students in the EI group may not have had time to complete or understand the importance of completing all additional activities. Therefore, the data may have been skewed. Although, when a follow-up test was conducted comparing students who completed none of the activities to those who completed all three, there were still no significant findings. This, then, would indicate a possible limitation of the enhanced activities, i.e., possibly the activities were not strong enough to increase SE any further for the students who completed them.

The survey instrument, the MSES, utilizes a 9-point Likert scale. Even though there are nine choices, it is possible that students may not have been able to distinguish between a response of 5 or 6, for example, and therefore the results could have affected the study results. Lastly, the reliability of the content analysis is weak as I was the only researcher who completed the analysis. The same researcher conducted the analysis

several times before the final results were reached. To increase the reliability of the analysis, it is recommended to have several different people complete the analysis.

Recommendations for Future Research

This study could be enhanced if a number of details could be better controlled. For example, upon beginning work in ALEKS, every student had to complete an initial assessment. This assessment then generated the student's own pie, consisting of individualized topics that the students needed to review. This list of topics was determined by how well the student scored on the ALEKS initial assessment.

Throughout the course of the math refresher session, the students were not required to complete the topics that were recommended in order to complete the math refresher course. Even if a student did not finish his or her own personal review pie, the student could still complete the math refresher course by taking the alternative assessment only. This fact indicates that some students may have worked much harder than others; some may have completed the entire pie, while others may have only worked through part of their pie.

Tracking students beyond the summer session and into the next two years of their study, whether it be at the same community college or at the next level (university), would be greatly beneficial. Not only would the study be able to determine whether the students eventually completed the developmental math sequence and, subsequently, college level math, but it could also measure their mathematics self-efficacy level again to see if the gains (or losses) they experienced during the refresher have been maintained.

Although it is an uncommon occurrence, some students who participate in the refresher course at the community college may not take college algebra until they transfer

to a university. If this occurs, it is more difficult to track these students than it is to track those students who complete the developmental and college-level math sequence at the community college. Nevertheless, it is important to stay in contact with all students who do participate in these refresher courses if they do transfer before completing the sequence, as it would for more accurate data regarding student success and math refresher success.

The focus of this study is somewhat narrow, having measured only mathematics self-efficacy for each student. In the future, I would consider broadening the focus of the study to design a more complete and well-rounded one. Measuring other variables would contribute to the study and make it more robust. Some variables related to student learning and to motivation may include persistence, self-regulation, and accumulation of credits, and they would be beneficial to examine as part of a similar study.

Conclusion

This study was an attempt to investigate if students gained benefits, other than advancing course levels, as a result of participating in the mathematics refresher course offered by Alamo Colleges. This study is also a response to the call for educators to find ways to expand the number of students who are successful in developmental education and who complete college-level math courses. My focus was to determine if this intervention would help first-generation students specifically, to be more successful, as they are a group of students that have been identified to be highly at-risk for failure. While results supported student gains in mathematics self-efficacy for all participating students, gains specifically for first-generation students were not detected. We must continue to create and study interventions to assist at-risk groups of students (such as

first-generation students) to persist and complete degrees, and we must consider both academic and non-academic benefits for the students in designing these interventions. For in developmental mathematics, the need to assist students has been and will be ever present.

APPENDIX SECTION

APPENDIX A

Entry Survey for Math Refresher Participants

What is your age? _____

What is your birthday (Month/Day/Year)? _____

What is your sex? (choose one)

- a) Female
- b) Male

What is your ethnicity? (choose one)

- a) White (non-Hispanic)
- b) Black (non-Hispanic)
- c) Hispanic
- d) Asian
- e) Mixed race (for example, part Hispanic and part White)
- f) Other

What is the education level of your **mother**? (choose one)

- a) No college
- b) Some college
- c) Bachelor's degree
- d) Higher than a Bachelor's degree
- e) Don't know

What is the education level of your **father**? (choose one)

- a) No college
- b) Some college
- c) Bachelor's degree
- d) Higher than a Bachelor's degree
- e) Don't know

APPENDIX B

Exit Survey for Math Refresher Participants

What did you find most helpful about the Math Refresher course?

APPENDIX C

Consent Form

You are being asked to be part of a research project. I'm trying to learn more about the benefits of participating in the Math Refresher programs. If you agree to be part of this research, I will ask you to complete four surveys within the 4-day Math Refresher course period. One consists of 34 questions and will be offered on Monday and on Thursday. The second consists of 6 questions and will also be offered on Monday. The third includes one question and will be offered on Thursday. It should take you about 30 minutes to finish the surveys on each day.

If you agree to participate, you may also be asked to complete three additional activities per day that will take no more than 45 minutes to complete. These activities and instructions will be given to you on Monday and you will submit them on Thursday. The research is being conducted by Cristella Rivera Diaz, a doctoral student in Developmental Education at Texas State University, cd1398@txstate.edu or cdiaz@alamo.edu.

There is a low to medium risk to you since I will collect student names, which is a piece of your personal information. However, none of the questions are of a personal nature. They ask only about your beliefs for completing mathematics tasks.

You may leave unanswered questions and you can withdraw from the study at any time. Doing so will not affect your performance in this Math Refresher course. Your

participation is voluntary, and refusal to participate will involve no penalty or loss of benefits to which you are otherwise entitled.

It is possible that you may benefit from an increase in math self-efficacy by participating in this study. In addition, the study may help students better prepare for college level math and avoid developmental mathematics, and as such, it may benefit society as a whole.

You may receive a gift for participating in the study. I will gift 5 Amazon gift cards by drawing for those who participate. If you are a winner, you will receive your gift on Thursday, the last day of the Refresher course.

Two of the surveys will be completed twice and I will need to compare the results of each. Therefore, I will record your name on the surveys and other study records, but only I will have access to the data. Names will not be revealed in the results of the study. I will keep the surveys in a locked file cabinet at Texas State University or at the Alamo Colleges for three years and then I will destroy the surveys. Only I, Cristella Rivera Diaz, will have access to the surveys.

This project 2015M7264 was approved by the Texas State IRB on 12-8-15. Pertinent questions or concerns about the research, research participants' rights, and/or research-related injuries to participants should be directed to the IRB chair, Dr. Jon Lasser (512-245-3413 - lasser@txstate.edu) and to Becky Northcut, Director, Research Integrity & Compliance (512-245-2314 - bnorthcut@txstate.edu).

A summary of the findings will be provided to participants upon completion of the study, if requested. To access results of the study, contact me, Cristella Rivera

Diaz at cd1398@txstate.edu or at cdiaz@alamo.edu. I will keep a copy of this consent form and you will receive a copy to keep as well.

Thanks for your participation!!

Printed Name _____

Signature _____

Researcher _____

Date _____

APPENDIX D

Enhanced Activities Information

These enhanced activities are an extension of the Math Self-efficacy study. They will give you the opportunity to gain training and skills in addition to the Math Refresher course you will be taking this week.

There are three additional activities to be completed in the evenings of Monday, Tuesday, and Wednesday of this week. The descriptions of the activities are below as well as their estimated times to complete.

1. On Monday night you will complete Activity 1 (about 30 minutes)

This activity will allow you to read about math anxiety and how to reduce it. After reading, you will answer a few questions regarding the reading and what you learned.

2. On Tuesday night you will complete Activity 2 (about 30 minutes)

This activity requires you to think about the work you have completed in the Math Refresher so far, and to answer a few questions regarding that work.

3. On Wednesday night you will complete Activity 3 (about 45 minutes)

This activity will requires you to read about taking Cornell notes. You will then choose a math topic found in Khan Academy and view the topic while taking notes. You will be asked to answer a few questions afterwards.

On Thursday, you will submit the completed activities to me. I feel that these activities are will be extremely helpful to you as you begin your college courses at Alamo Colleges!!

Please send me an email at cdiaz@alamo.edu or cd1398@txstate.edu if you have additional questions as you are completing these assignments.

Thank you so much for your participation!!!

Cristella Rivera Diaz

APPENDIX E

Enhanced Activity 1

Please read the following information article on math anxiety and how to reduce it:

[http://www.weber.edu/wsuiimages/vetsupwardbound/StudySkills/overcomemathanxiety.p](http://www.weber.edu/wsuiimages/vetsupwardbound/StudySkills/overcomemathanxiety.pdf)

[df](http://www.weber.edu/wsuiimages/vetsupwardbound/StudySkills/overcomemathanxiety.pdf)

This information is a supplement to a video to which I do not have access, but it has great information! I believe you will greatly benefit from the webpage alone. When you have complete the reading, please answer the following question.

- 1) What, if anything, did you learn from this information?

APPENDIX F

Enhanced Activity 2

Please answer the following based on the Math Refresher course work you did today, and answer as honestly as possible.

- 1) What was your greatest accomplishment in the Math Refresher course today? Ex: “I learned how to add fractions.”

- 2) Describe how you felt when you realized your accomplishment. Ex: “I felt very proud of myself!”

- 3) What activities do you attribute to this accomplishment? Ex: “Even though I don’t like fractions, I spent a lot of time reviewing and working problems.”

- 4) What will you work on tomorrow? Ex: “Tomorrow I will work on solving equations with fractions.”

APPENDIX G

Enhanced Activity 3

Please read the following information on how to take Cornell notes:

http://lsc.cornell.edu/wp-content/uploads/2015/10/Cornell-Note_Taking-System.pdf

1) What, if anything, did you learn about taking notes?

Now, visit Khan Academy at www.khanacademy.org, and view a tutorial on solving a math problem of your choice. Using Cornell notes format, take notes on the lesson you choose to view. Use the back side of this page to take notes and bring them to Math Refresher course on Thursday.

Cornell Notes Page: (entire blank page)

APPENDIX H

Letter of Permission from MIND GARDEN.COM

For use by Crisbella Diaz only. Received from Mind Garden, Inc. on June 12, 2016



To Whom It May Concern,

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

Mathematics Self-Efficacy Scale

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

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

Sample Items:

How much confidence do you have that you could successfully:

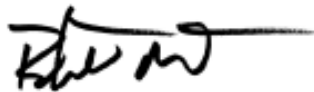
Add two large numbers (e.g., $5379 + 62543$) in your head.

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

Basic College Math

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Sincerely,



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

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