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I dedicate this work to my family, who sacrificed so much for me so that I could complete my doctoral degree. I will forever be grateful to you.

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Abstract

Every year a significant portion of the college population is considered deficient in their mathematical skills and are deemed as needing some form of remediation before they can enroll in credit bearing courses. Traditional remediation, where students take their remedial courses as a series of prerequisites to their college mathematics gateway course, has proved to be unsuccessful (Bahr, 2008; Bailey, 2009; Bettinger & Long, 2009). The process of remediation is often too long with too many exit points so many students who need remediation never enroll let alone pass all the required gateway courses. Co-requisite remediation, where a student takes a gateway course along with a support course, serves the student with the dual purposes of supporting the student and significantly reducing the student's time spent in remediation. Co-requisite remediation in mathematics has been shown to decrease the number of remedial courses and essentially eliminates the exiting points of the leaky pipeline (CCA 2016; Jones 2015). Therefore, co-requisite remediation can be the new bridge, providing equity for students deemed not college ready.

This mixed-methods study examines the mathematics self-efficacy of co-requisite College Algebra students using the Mathematics Self-Efficacy Scale (MSES). Participants in the study whose mathematical self-efficacy increased, decreased, or remained the same, were interviewed to give their personal insights and perceptions of co-requisite College Algebra. Analysis of the quantitative data revealed co-requisite College Algebra students have a statistically significant difference in their mathematics self-efficacy when compared to their non-co-requisite peers. The data also showed that over the course of a semester co-requisite College Algebra students' mathematics self-efficacy does not significantly change. The qualitative data analysis revealed four main themes that emerged from the interviews of participants: community, multiple sources and multiple modes of instruction, support, and soft skills with sub-themes to support each major theme.

Keywords: remediation, co-requisite remediation, co-remediation, mathematics, self-efficacy, College Algebra

Chapter 1: Introduction

Each year in the United States millions of students arrive on college campuses ready to enroll in courses that will begin their journey to degree completion. It is estimated that in fall 2017 around 20.4 million students enrolled in a college or university in the nation (National Center for Educational Statistics (NCES), 2017). Individuals who wish to partake in this great American adventure often rely on a high stakes entrance exam such as the American College Test (ACT) or the Scholastic Assessment Test (SAT) to determine if the student is in fact college ready. Usually an arbitrary cut score, decided upon by the state or the individual institution, is the deciding factor for determining whether the student will take a college course for credit, such as English Composition or College Algebra, or will instead be placed into a remedial sequence of one to four classes in which no credit will be earned.

Remedial education allows students who meet the general college entrance requirements, yet are not considered college ready in one or more disciplines, to attend college. However, for the 40 to 60 percent of first-year college students who are in need of remediation in one or more subjects, remedial education has in most cases become the “bridge to nowhere” (Complete College American (CCA), 2012a; Jimenex, Sargrad, Morales & Thompson, 2016). Where remediation can be a bridge for underprepared college students to enroll in college, the bridge seems to be incomplete, missing planks, at crucial points in an individual’s college path. Only a small percent of students in need of remediation will ever enroll in, let alone complete, a college level course for credit, and only around seventeen percent will ever graduate (CCA, 2016). This is not a new phenomenon. The issue of college remediation and success of students enrolled in remediation has been a national issue for decades.

Traditional remediation funnels students into an often endless cycle of repeating courses, compounding debt, and not earning college credit. Even in the cases where students do manage to successfully pass one developmental course they often fail to enroll in the next course in the sequence (Bahr, 2008; Bailey, 2009; & George, 2012). This cycle is costly to the students, in both time and money without allowing them to earn college credit. Students placed into traditional mathematics remediation frameworks, where in some cases the student must complete up to three or four zero level mathematics courses, have only a slim chance of ever entering a college level credit bearing (gateway) mathematics course. Bailey, Jaggars, and Scott-Clayton (2013) see "the traditional system of assessment, placement, and developmental coursework as negative side effects (developmental coursework takes time and resources and may discourage students) which, when considering the developmental population as a whole, tend to balance out its positive effects" (p. 18).

Students placed into traditional remediation have an astonishing lower degree completion rate than their non-remediated peers. The National Conference of State Legislatures (NCSL) (2016) asserts that less than 50% of remedial students complete their remedial courses, and less than 25% earn a degree in eight years. They also found that 58% of students nationwide not needing remediation complete a four-year degree, while only 27% of students nationwide who do require mathematics remediation complete a four-year degree.

Complete College America (CCA), established in 2009, is a national nonprofit organization that commits to work with states to significantly increase the number of Americans with quality career certificates or college degrees and to close attainment gaps for traditionally underrepresented populations. In January 2016, CCA released a national report that stated 42%

of first-time freshmen in the United States enroll in remedial courses. Out of these students only 22% successfully complete at least one credit-bearing course within two academic years.

Students applying to colleges and universities across the nation are required to meet college admission requirements, some of which include an ACT or SAT score, high school GPA, and or class rank. Once students successfully jump through all the admission hoops they are often surprised to find out that in certain subjects, the most prevalent being mathematics, they are not college ready. Students not meeting the minimum ACT or SAT mathematics sub-score often proceed through a second test given at the institution. Students are often unprepared to take a mathematics test when they arrive to enroll at universities. Despite the opportunity to retest, students often enroll on the spot into remedial courses with attendant costs and delayed progress into gateway courses (Bahr, 2013; Bailey, 2009).

Institutions are continually looking for ways to improve student success and retention. In many states, remediation is not handled at four-year colleges. Instead, students who might need remediation must take care of that requirement at a community college. Colleges and universities have piloted and launched an assortment of remediation models over the past few years. In most cases results of these new models show the same poor pass and retention rates as the traditional model (Bahr, 2008; Bettinger & Long, 2009).

CCA (2016) asserts that a co-requisite model, where students are concurrently enrolled in a remedial help/support course as well as a gateway course, is successful and beneficial. They further show that when co-remediation was implemented in community colleges in Georgia, Indiana, Tennessee, West Virginia, and Colorado the pass rate for the mathematics gateway course was between 61%-64% in both one and two semester sequences. This is an astonishing increase in the national average of remedial students who pass a gateway course within two years, which is around 22%. The number of students showing success in the co-requisite model is impressive, but few studies have been conducted to find the factors that are responsible for student success.

Remediation

Remedial education is defined in this study as support or extra coursework taken by college students who are not considered college ready in one or more disciplines. Remedial education has many different names such as; remediation, developmental, college readiness, or support. Traditional remediation happens as a pre-requisite of skills, for no college credit, that a student must proficiently pass prior to that student being able to take a credit bearing course. Students deemed unprepared for college-level courses by high stakes tests such as the ACT, SAT, or institutional placement exams become candidates for remedial education. Remedial education is a continual controversial topic in higher education.

The fundamental principle of remediation is equity of opportunity, to give underprepared students the chance at a college degree by giving these students extra support in academic areas in which they have deficiencies (Attewell, Lavin, Domina, & Levy, 2006; Bahr, 2008; Bettinger & Long, 2005). Although remediation has opened the door and increased the college attending population, it has done little to improve student success, especially in mathematics. Students' success rates in developmental mathematics have become a "national crisis in American higher education" (Carfarella, 2014, p. 36). Students who begin their college career in remediation are less likely to graduate. Even when a student, who began in remediation, obtains a degree it often takes up to 50% longer than a peer who did not need remediation (Bailey, 2009, George, 2012; Jones, 2015).

Currently, college remediation functions in two somewhat contradictory ways. It first acts as a second chance policy for students deemed not college ready; and secondly, as gatekeeper to degree completion. This is especially true when a student is enrolled in remedial mathematics (Attewell et al., 2006, p. 916). It is a highly desirable goal to assist every college student to achieve college-level mathematics competency. However, most analyses show that while remedial mathematics does not hurt students it does not help them either (Bahr, 2013; Bailey, 2009).

Co-Requisite Remediation

Co-requisite remediation is when the student can immediately enroll in a college-level course while at the same time completing his or her remediation requirement. In this way students receive their remediation as a co-requisite not a pre-requisite. Research has shown when unprepared students are enrolled in a college-level course while receiving support in a co-requisite model their pass rates are comparable to their non-remedial peers (CCA, 2016).

Co-remediation serves the dual purposes of supporting students and significantly reducing the students' time spent in remediation. Because students are completing their remediation requirement and receiving college credit at the same time, the leaky pipeline of remedial mathematics is greatly reduced. Remedial mathematics education is not the only discipline to try the idea of co-requisite remediation. While co-requisite is still a new reform in remedial mathematics, co-requisite models for remediation in English have been successfully implemented for several years (CCA, 2016). Even though co-remediation in mathematics is a new domain, early research suggests a student with an ACT score as low as 13 in the mathematics portion of the test, can be successful in a college-level course when remediation is offered as a co-requisite (CCA, 2016).

Mathematics Self-Efficacy

A student's belief in his or her own knowledge, understanding, and confidence contributes significantly to his performance in a class. Bandura (1997) claimed an individual's perception or beliefs of his or her performance actually influences his accomplishments, and that one's self-efficacy determines how he feels, thinks, self-motivates, and behaves. One's own self-efficacy determines how likely she is to engage in challenging activities and learning experiences, and influences the amount of stress and anxiety she experiences (Jameson, & Fusco, 2014; Pajares & Miller, 1994; Street, Malmberg, & Stylianides, 2017).

Mathematics self-efficacy is not merely a belief in the mathematics skills the individual possesses, but rather in what he or she is capable of completing with those skills. There have been several studies that show a positive relationship between students' self-efficacy and performance, especially when specific positive encouragement and feedback is provided (McMullan, Jones, & Lea, 2012; Street et al., 2017). When students have higher levels of self-efficacy they are more willing to approach difficult problems as a challenge that can be accomplished verses an impossible insurmountable task (Bandura, 1997; Williams & Williams, 2010). Self-efficacy tends to have a positive correlation with one's performance, so raising a student's mathematics self-efficacy should help him or her become more successful. However, more research is needed to determine ways to raise the mathematics self-efficacy of remedial mathematics students when enrolled in co-requisite models.

Definitions of Key Terms

College-Ready: Students who meet a minimum requirement on a high stakes test. For example, in Oklahoma a student must score a minimum of a 19 on the mathematics portion of the ACT, or an equivalent score on an entrance test at the university.

Co-Requisite Remediation: The co-requisite remediation model is designed for students to enroll directly into their gateway course while also enrolling into a support course where they receive academic support alongside their credit bearing course.

Gateway Course: A credit bearing college course that is a typical course for college freshmen, needed for most majors. For example, College Algebra is a gateway course.

Mathematics Self-Efficacy: An individual's belief that he or she will be able to accomplish a specific mathematics task.

Remediation: Remedial education refers to classes taken on a college campus that are below college-level and are non-credit bearing. Other synonymous labels include; developmental education, skills courses, or college preparation courses.

Traditional Remediation: Traditional remediation is a sequence of pre-requisite courses where all the needed lacking skills are taught before the student enters a gateway course.

Significance of the Study

The problem of traditional remediation is a major issue in post-secondary education. Jones (2015) claimed that "of the 1.7 million students condemned to remediation each year, only about one in ten will graduate" (p. 26). While the issue is not isolated to mathematics, remedial mathematics is often the reason students do not complete their college degree. Attewell et al., (2006) found that mathematics is the most common remedial subject and that only 30% of all developmental mathematics students pass their entire remedial sequence.

CCA asserts that for every ten students who begin a three-course remediation sequence in mathematics only one student ever successfully completes a gateway course (2012a). There is an obvious leaky pipeline of developmental students. Even for the few who successfully complete a remedial course, many never even enroll in the next course in the sequence (Bahr, 2008; Bailey, 2009; Bettinger & Long, 2009).

Co-requisite remediation in mathematics has been shown to decrease the number of remedial courses and essentially eliminates the exiting points of the leaky pipeline (CCA 2016; Jones 2015). Therefore, co-requisite remediation can be the new bridge, providing equity for students deemed not college ready. CCA (2016) has clearly demonstrated that when co-requisite mathematics remediation is implemented in community colleges success rates dramatically increase. Thus, it is vitally important to understand how co-requisite remediation can be successful and explicate the features of successful models, so other colleges and universities can implement co-requisite models to help decrease the inequity of those students deemed not college ready.

Purpose of the Study

Although CCA supports co-remediation and many states have piloted some form of co-remediation over the past five years, there is still a significant gap in the literature explaining the success of co-remediation. Even though national data shows that co-remediation is incredibly successful when compared to traditional remediation, little research has been conducted investigating students' mathematics self-efficacy and perceptions when enrolled in co-requisite remediation at four-year universities. Since many public universities across the nation are implementing co-requisite remediation in mathematics there is a need for more research to understand remedial students' mathematics self-efficacy and perceptions when enrolled in co-requisite remediation. It is vital to understand what promotes and fosters students' mathematics self-efficacy and perceptions to develop better co-requisite programs for ultimate student success.

The purpose of this study is to explore developmental mathematics students' mathematics self-efficacy and perceptions when enrolled in a co-requisite course at a four-year university. This mixed methods study will investigate the mathematics self-efficacy and perceptions of college students enrolled in a co-requisite mathematics course at a four-year university in the Southern Midwest United States by addressing the following questions:

1. Do students' mathematics self-efficacy, when enrolled in a co-requisite mathematics course, differ from their peers who are enrolled in the same non-co-requisite, non-remedial gateway course?
2. Does the mathematics self-efficacy of students who are enrolled in co-requisite courses change?
3. What are the perceptions of students who are enrolled in co-requisite mathematics courses, regardless of their change in mathematics self-efficacy?

This study aims to fill in the gaps in the current literature that addresses mathematics co-requisite remediation. In Chapter 2, a brief history of education along with the reform in mathematics education specifically focusing on college remediation will be discussed in detail. The current literature pertaining to mathematics remediation in college, including many controversial issues tied to remediation, will be highlighted. Chapter 3 will describe in detail the theoretical framework, rationale, methods, and ethical considerations of this research study. Chapter 4 will closely examine students' mathematics self-efficacy and perceptions of their co-requisite mathematics class highlighting common themes among the students regardless of whether their self-efficacy increases, decreases or remains the same. Finally, Chapter 5 will present a discussion of the findings and of this study, their implications, and how they relate to the current literature on co-requisite remediation.

Chapter 2: Literature Review

For over a century public education has been tasked with the responsibility to prepare the nation's students for success in life and college. Multiple reform efforts in every discipline have taken place over the last one hundred years, all in hopes of increasing student learning and more adequately preparing students for college. Since the years of the cognitive revolution, educators have gained a better understanding of how individuals learn. Yet, creating curriculum that will help develop students who can problem solve, make connections, and develop reasoning has proved to be a difficult task (Schoenfeld, 2016).

At the turn of the twentieth century, high school was primarily set aside for the elite who planned to continue their education in college. In 1900, only 11.4% of 14 to 17 year old students nationwide attended high school in the United States, with only 6.3% graduating with a high school diploma (James & Tyack, 1983). By 1920, high schools saw an almost triple increase in their student population. During this same time period college admission requirements increased and arithmetic was replaced in high school with rigorous courses of algebra, geometry, and physics, and students were held to a high standard for learning the material (Schoenfeld, 2004; Stanic & Kilpatrick, 1992).

These efforts to prepare an ever increasing high school population with pre-requisites for college backfired. Instead of creating an opportunity for all students, the change in curriculum only helped better prepare those in an already elite status who could pass the courses. The lower-achieving students had little to no success in the new mathematics courses of algebra and geometry, even though they remained an "enduring feature of the 20th century mathematics curriculum" (Stanic & Kilpatrick, 1992, p. 409). Over the next one-hundred years the population of students in public education drastically increased as well as changed. Major social changes including urbanization, industrialization, immigration, the Great Depression, and America's involvement in World War I and World War II significantly changed the high school population and left everyone questioning the best way to prepare students for the future (Stanic, 1986).

With colleges demanding higher courses of mathematics as pre-requisites for admittance, a greater more diverse student population lacking in mathematical skills, and different educational interest groups having their own beliefs on mathematics education, there was little consistency in high school mathematics. The National Council of Teachers of Mathematics (NCTM) was developed in 1920, and was founded with the primary purpose to help stabilize and provide more consistency in high school mathematics.

From 1900 to World War II "broadly speaking the mathematic curriculum remained unchanged, whereas the student body facing it was much more diverse and ill prepared than heretofore" (Schoenfeld, 2004, p. 256). The onset of World War II bought the unpreparedness of our nations high school mathematics students into new light. "During World War II, both educators and the public recognized that more technical and mathematical skills were needed to push forward the developing technological age" (Herrera & Owens, 2001, p. 84). The military had to develop their own courses to help close the gap in mathematics between what their soldiers could do and what they needed to do (Schoenfeld, 2004). After the war, the debate over the curriculum intensified dramatically. "Mathematicians perceived a gap between the scholarly discipline of mathematics, especially as it was being taught in universities, and mathematics as it was taught in school" (Stanic & Kilpatrick, 1992, p. 411).

Although mathematics educators had been concerned about the growing crisis in mathematics education since the 1930s, it was not until the mid-1950s that mathematics education became the focus of national concern (Stanic, 1986). In 1955, the College Entrance

Examination Board (CEEB) appointed a Commission on Mathematics, consisting of university mathematicians, high school teachers, and college mathematics educators, to consider how their examinations should reflect the changes in the mathematics curriculum over the last 50 years (Herrera & Owens, 2001, p. 85). Even though colleges claimed the student population was unprepared, and the military during World War II supported this claim by creating its own mathematics courses to help bridge the gap of its enlisted population, little reform in mathematics education happened.

The launching of the Soviet Union satellite, Sputnik in October 1957, created the perception in the public that the United States was behind in mathematics and science and that curriculum reform needed to happen immediately. The National Science Foundation (NSF) supported a modern curriculum for mathematics and science education. In this new mathematics curriculum topics were added such as: set theory, modular arithmetic, and symbolic logic and together they became known as the "New Math" (Schoenfeld, 2004; Stanic & Kilpatrick, 1992).

The New Math movement faced several battles before it ever got started. One issue reformers ran into rather early "was that schools appeared to be preparing too few students to study advanced mathematics in college, and people were worried that the nation would suffer a serious shortage of mathematically trained personnel" (Stanic & Kilpatrick, 1992). Over the next several decades, reform movements began but were fairly short lived as there was no consistency between states or even school districts within the same state. During this time, some high schools students were only required to take one or two years of mathematics and depending upon their intent to go to college they might take different courses than their peers (Schoenfeld, 2004). There was a clear need for consistency across all grades in the nation.

In the fall of 1989 NCTM released the *Curriculum and Evaluation Standards for School Mathematics* (1989)*,* known best as the *Standards.* The *Standards* seemed to be the apparatus that mathematical reformers had been waiting for. "The 1989 NCTM Standards supports our national goals, first by recommending a curriculum that is both broad and rigorous and, second, by suggesting teaching and learning strategies that enable more students to become proficient" (Martinez & Martinez, 1998, p. 747). The *Standards* however, were not a national curriculum and the interpretation of the *Standards* differed from state to state. Many states followed the lead of California to develop their own state standards that mirrored the NCTM's *Standards* (Herrera & Owens, 2001).

Unfortunately, the standards movement did not solve the national crisis of poor mathematics performance as many had hoped. In 2000, the NCTM released the updated *Principles and Standards for School Mathematics,* (2000) in efforts to improve mathematics education. New legislation of the new century such as No Child Left Behind in 2001, and Race to the Top in 2009, as well as national programs to increase STEM fields have done little to better prepare students for college. It is estimated that 1.7 million students nationwide are considered underprepared for college mathematics, and of the 1.7 million, less than ten percent will ever obtain a college degree (Jones, 2015). The nation is still in a crisis where mathematics is concerned. Of the millions of students that are admitted every year in the United States to colleges and universities, more than half of them find themselves deemed not college ready in one or more subjects (Attewell et al., 2006; Bahr, 2008; Bailey, 2009; Bettinger & Long, 2005). Individuals who wish to enroll in college level courses often must rely upon a high stakes entrance exam such as the ACT or SAT to identify if they are in fact college ready.

Remedial education opens the door and allows for students who meet the general college entrance requirements, yet are not considered college ready in one or more disciplines, to have the chance to attend college. Remediation is by itself one word but the meaning of remediation and everything it entails is not easily described or defined. While remediation has some positive aspects, such as allowing students who are not college ready an opportunity to obtain a degree, there are many negative aspects, including financial cost, extended time, psychological effects, and high attrition rates (Bahr, 2008; Bailey, Jeong, & Cho, 2010).

Remediation in College

Remedial education is defined in this study as courses taken by college students where no college credit is earned upon successful completion of the course. Remedial education has many different names such as; remediation, developmental, college readiness, or support. Developmental or remedial education continues to be a controversial topic in higher education; hanging in the balance between offering support for students who are not quite prepared for college level courses and doing nothing, thus eliminating a large part of the population from attending college.

Critics of remedial education argue that students get bogged down by multiple remedial courses leading to failure and eventually dropout (Bailey, 2009; Cafarella, 2014; Rosenbaum, 2011). However, proponents of developmental education feel that remedial courses are essential for under-prepared students to be able to enroll in college, improve certain skills, and eventually complete a degree (Attewell et al., 2006; Bahr, 2010). Students deemed unprepared for college-level courses by high stakes tests such as the ACT, SAT, or institutional placement exams become candidates for remedial education. Colleges, and especially community colleges, are charged with teaching students college-level courses in English and mathematics, even though most open access college students are underprepared when they arrive (Bailey, 2009, p. 11).

The fundamental principle of remediation is equity of opportunity, to give underprepared students the chance of a college degree by giving these students extra support in academic areas in which they have deficiencies (Attewell et al., 2006; Bahr, 2008; Bettinger & Long, 2005). Although remediation has opened the door and increased the college going population, it has done little to improve student success, especially in mathematics. Students' success rates in developmental mathematics have become a "national crisis in American higher education" (Carfarella, 2014, p. 36).

Hagedorn, Siadat, Fogel, Nora and Pascarella (1999) found that students enrolled in college level mathematics have a clear advantage over students who enroll in remedial courses at the same institution including: better instructors, better advisement and placement support, more collaboration with peers, and more encouragement to stay in college; while, students who begin their college career in remediation are less likely to graduate. Even when a student who began in remediation does obtain a degree it often takes up to 50% longer than a peer who did not need remediation (Bailey, 2009, George, 2012; Jones, 2015).

Currently college remediation functions as two roles. It first acts as a second chance policy for students deemed not college ready; and secondly, as gatekeeper to degree completion. This is particularly true when a student is enrolled in remedial mathematics (Attewell et al., 2006, p. 916). It is a highly desirable goal to assist every college student to achieve college-level mathematics competency. However, most analyses show that while remedial mathematics does not hurt students it does not help them either (Bahr, 2013; Bailey, 2009).

History of Remediation in the United States

The idea of college remediation is not a novel concept brought to life in the last decade. College remediation can be tracked back to the early colonial days. In the 17th century, Harvard College provided tutors for those considered underprepared in Greek and Latin, and by the 18th century land-grant colleges had established preparatory programs for students who were weak in reading, writing, and arithmetic (Phipps, 1998). In the early 1900's over half of the students enrolled in Harvard, Yale, Princeton and Columbia took some sort of remedial course. Then from the 1960's to 1980's in response to open admissions policies and the Civil Rights Act of 1964, thousands of underprepared students entered colleges around the nation and created an influx in the student population needing some sort of remediation (Bettinger & Long, 2005; Brothen & Wambach, 2012; Phipps, 1998).

Although remediation has been an aspect of higher education for centuries, the 1990's brought remediation into the spotlight as an extremely controversial and debated topic that is still under the scrutiny of the nation today. The Board of Trustees of the City University of New York (CUNY) voted in May 1998, with support from then mayor of New York, Rudy Giuliani, to eliminate remediation at all the senior CUNY colleges beginning January 2000, this aligned with their goal of raising the academic standards in the senior colleges by eliminating unprepared students (Moses, 1999; Phipps, 1998; Trombley, 1998). This bold move from CUNY sparked the move of most states to "reform" remediation by removing traditional remedial courses from four-year universities and placing the remediation weight on the shoulders of community colleges. States from California to Massachusetts began discussing the cost and success of remedial or developmental programs, as well as the quality of academic excellence for several years prior to CUNY's new mandate (Astin, 1998, Trombley, Doyle, & Davis, 1998). This movement in the 1990's for four-year colleges and universities to either reduce the number of remedial courses, and/or reduce the number of students in these courses, led to problems for all institutions. "This movement to reduce remedial courses in colleges continues despite the fact that nearly every community college, four-year college, and university in the United States admits students who are not ready for the level of academic work expected of them" (Brothen & Wambach, 2012).

In response to the movement, of the late 1990's, proponents for student's rights began to speak out against four-year colleges and universities who were significantly reducing the number of remedial courses offered, reducing the number of remedial students admitted, or who were eliminating all remediation from their institutions. Astin (1998) called out prestigious flagship universities such as Harvard and Berkley to become leaders in positive ways to educate and not exclude underprepared students. However, with colleges such as CUNY phasing out remediation, the state of remedial education seemed to be going in the opposite direction. It was felt by proponents for students' rights that the education of the remedial student was the most important educational problem in America and that providing effective remedial education would do more to alleviate our most serious social and economic problems than almost any other action (Astin, 1998; Phipps, 1998, Trombley, 1998).

By limiting or removing remedial education from four-year institutions a hierarchical public system was created. In this system the least-well-prepared students are consigned to either community colleges or relatively non-selective public colleges; and when more selective colleges do admit underprepared students they often place them into classes that are taught by part-time outside instructors (Astin, 1998, p. 12). Some four-year institutions will admit students who meet the overall minimum requirement for the institution even though the student is deemed underprepared in one or more disciplines even if the admitting institution does not offer remediation. This frequently places the student in an awkward predicament. The admitting institution will often have an agreement with a local community college and the student will take classes from both the four-year university as well as from the community college. This can send a negative message to both the student and the community college that the class in question the student must take to be deemed "college ready" is not important enough to be offered at the university level.

Most researchers agree that the previous state of remedial education was not successful due to the high attrition rate and the lack of students completing their degrees. "A snapshot of the present situation of remedial mathematics college students lead us to believe that remediation in its present form is not successful" (Hagedorn et al., 1999). However, the suggestion for remedial education to be removed from four-year institutions was not considered as a solution to the problem of remediation.

Moses (1999) asserts "remediation and developmental education programs should be an integral part of the infrastructure of most higher education institutions, rather than the marginal, hidden, and peripheral programs that many of them are" (p. 23). Astin (1998) agrees with Moses "in our relentless and largely unconscious preoccupation with being smart, we forget that our institutions' primary mission is to develop students' intellectual capacities, not merely to select and certify those students whose intellectual talents are already developed by the time they reach us" (p. 12). Suggestions were made to create better, more efficient programs to help successfully and quickly remediate students, not to remove remediation that would essentially make college only an unachievable dream.

The ideas about how to best remediate our nation's students has been the hot topic of debate over the last 20 years, with many different programs claiming radical changes in success rates tried at many institutions across the nation. The first discussion of a form of co-remediation came from Boylan, (1999) when he suggested that the pairing of a remedial course with a college-level course would provide students support, enhance learning, and reduce the amount of time spent in remediation while enabling underprepared students to earn credit in college courses. Over the course of the next few years, the idea of integrating developmental education with college-level mathematics became more common, with a few pilot programs popping up at different institutions sporadically (Brothen & Wambach, 2012).

Since most four-year institutions were no longer responsible for the burden of remediation, the consistency of remediation became even more unstable. Some states such as Colorado have a statewide mandate by the Governors Board that remediation can only take place in two-year colleges or tech-schools for students with more than "limited academic deficiencies" (Fain, 2014). But in other states such as Oklahoma and Texas, the decision regarding whether or not to offer remedial courses in four-year universities is up to the individual institutions. Within the last seven years there has been a nationwide move to offer remedial courses as a co-requisite model for best success practices and optimal student success (CCA, 2016).

Placement into Remediation

Students applying for colleges and universities across the nation are required to meet college admission requirements, some of which include ACT or SAT score, high school GPA, and or class rank. Once students successfully jump through all the hoops of admissions they are often surprised to find out that in certain subjects, the most prevalent being mathematics, they are not college ready. The student's future is then immediately dependent upon a single high stakes test, or a secondary high stakes university placement exam. There are no clear-cut decisions that can be made about what is the best way to place students into courses. However, efforts to create valid and reliable placement, not only a test score, should be a top priority (Brothen & Wambach, 2012; Boylan, 1999).

Most research agrees that a single test score can provide information, but it should not be the sole criterion relied upon for placement, just a tool in the placement process (Boylan 1999; Brothen & Wambach, 2012; Saxon & Morante, 2014). Often universities have a "hard cut score" for their individual institution. Students scoring below this cut score are sent to remedial courses and students scoring above the cut score are sent on to college-level courses; this makes placing students a no thought process (Bettinger & Long, 2005). However, the cut score line determining if a student is college ready or not, varies from state to state and often from institution to institution within the same state, making this tool for placement unreliable across the nation. "Most remedial students turn out to be simply those who have the lowest scores on some sort of normative measurement but where the line is drawn is completely arbitrary" (Astin, 1998, p.12).

Attention and care must be given to correctly place students into the level of remediation that is most appropriate and requires the least amount of time possible, often being a college-level course with a certain level of support (Saxon & Morante, 2014). The starting point for success in any developmental program, especially developmental mathematics, must include attention to the best fit within the remediation spectrum for the individual student. Although it may take more time and resources to have advising professionals visiting with each student and looking at an array of information such as: high school courses taken, GPA, cognitive and affective characteristics of the student, and their standardized placement score, this process is crucial in determining the best placement of the student for his or her own personal success (Boylan, 1999; Saxon, Martirosyan, Wentworth & Boylan, 2005; Saxon & Morante, 2014, "Transforming Developmental," 2014).

Benefits of Remediation

When a student successfully completes remediation, studies have shown that his or her college outcome is very similar to his or her non-remediated peers (Attewell et al. 2006; Bahr, 2008, 2010; Bettinger & Long 2005, 2009; Lavin, Alba & Silberstein, 1981; Parmer & Cutler, 2007). Lavin et al. (1981) found students who passed at least one of their remedial courses were more likely to stay in college, and graduate than otherwise similar students who did not take remedial coursework. Likewise, Bettinger and Long (2009) and Attewell et al. (2006) found students in four-year colleges who completed their remedial courses, were more likely to complete a bachelor's degree than otherwise equivalent students who did not need remediation. Bahr's (2008, 2010) studies showed that students who successfully proceeded through the remedial sequence eliminated skill deficiencies and experienced educational outcomes that were effectively equivalent to those students not requiring remediation.

A similar study found no negative effects from students who took a remedial class and successfully completed it when compared to students who did not need remediation and "in fact, mathematics remediation appears to improve some student's outcomes" (Bettinger & Long, 2005, p. 24). Another study found that students who successfully completed the developmental sequence were only one question away on an assessment of pre-knowledge skills when compared to students who did not need remediation, and both groups of students answered similarly on the survey at the beginning of the pre-knowledge skills test about concept difficulty, and the level at which students believe they have understanding about these difficult concepts (Parmer & Cutler, 2007).

Where all these studies show remediation can be extremely beneficial, the key to the previous studies findings is that students “successfully” complete remediation. When students persist and complete their remediation courses their success in college increases. “However, the majority of remedial mathematic students do not remediate successfully, and the outcomes of these students are not favorable” (Bahr, 2008, p. 421). The reason students are not successful in remedial courses or persistent to complete the entire remedial sequence is unknown. It has been suggested that remediation might send a negative signal to some students and cause them to never even enroll in college, and others who do enroll may feel defeated and never complete the sequence of remediation.

However, even though colleges will lose some students by continuing to offer remediation, they will help other students who never had a chance at college due to being unprepared. This is especially true in remedial mathematics (Bettinger & Long, 2005). Students with severe deficiencies are less likely to successfully complete their remediation sequence. The more remediation students require, the longer their sequence and the more likely it is that they will drop out or simply not enroll in the next course (Attewell et al., 2006; Bahr, 2010; Bailey 2009).

Cost of Remediation

The positive benefits of remedial education are often diminished by the overwhelming cost to the student. Students beginning their college career in a sequence of remedial mathematics courses that offer no credit, are burdened by the extra financial cost and time to degree completion (Bailey, 2009; Bailey et al., 2010). Estimates place the national direct cost of public postsecondary remedial programs around 2.3 billion dollars annually (Jones, 2015; NCSL, 2016); an extreme increase over the estimated cost in the mid 1990's of one billion (Phipps, 1998). Collegiate institutions are constantly looking for ways to reduce the cost and time associated with remediation.

Whether the cost is a financial one that burdens the student, the institution, or the state another significant cost to the student is time. Many courses at universities have the pre-requisite of English Composition or College Algebra. Before students can even enroll in a multitude of courses they must successfully prove they are college ready by completing one or more remedial courses.

Because of the cost and the philosophical ideas of some critics of remediation who believe remedial courses should not be taught at four-year intuitions, remediation has been traditionally moved to the community college level where it remains under scrutiny (Bettinger & Long, 2005). Most legislators and policy makers accept and support the need for tutoring, instructional labs, individualized learning programs, and learning centers in colleges and universities. Most criticisms are not directed at student support but rather are directed at the lowest end of the continuum – to actual remedial courses that isolate students and prevents them from gaining college credit thus impeding their progress towards a degree (Boylan, 1999; Hoyt & Sorenson, 2001; Phipps, 1998).

Where critics view the cost of remediation as astronomical, proponents argue, "even if remedial education were terminated at every college and university in the county, it is unlikely that the money would be put to better use" (Phipps, 1998, p.13). For the students who are unable to succeed in college without remediation, a year spent taking remedial courses may represent a sound investment in time, money, and future earnings in income, when the alternative is never entering, let alone never completing college (Boylan, 1999; Phipps, 1998, Silva & White, 2013).

Where future earnings and opportunity of obtaining a college degree are important, advocates of the benefits of remediation insist the cost of remedial education is a cost-effective investment when compared to the alternatives. Underprepared students who are not in remedial courses are more likely to drop out of college. This can cause an increase in unemployment, welfare, and incarceration as studies have shown that these costs are directly associated with the limited education an individual possesses (Bettinger & Long, 2009; Bettinger, Boatman, & Long, 2013: Phipps, 1998). Austin (1998) states,

> If we fail to develop more effective means of educating 'remedial' students, we will find it difficult to make much headway in resolving some of our most pressing social and economic problems: unemployment, crime, welfare, healthcare, racial tensions, the maldistribution of wealth, and citizen disengagement from the political process (p. 12).

Although the cost of remediation can be seen as significant by some individuals, the decision to eliminate remediation would have detrimental effects on society. However, every effort should still be made to make the remedial process as effective as possible.

Social Justice and Remediation

In the NCTM's Principles and Standards for School Mathematics (2000) the first principle is equity. In order for excellence to occur in mathematics education NCTM states that all students deserve strong support. McKinney and Frazier (2008) explain NCTM's equity principle as the "core belief that all students, regardless of gender, socioeconomic level, or special needs are capable of learning mathematics and should be provided with the necessary resources, support, and assistance to accommodate their learning differences" (p. 205).

All students have the right to learn meaningful mathematics and should not be discriminated against because of race, sex, or socioeconomic status. Nolan (2009) states often, “mathematics serves as a gatekeeper and filter, circulating signs of its status and power to mathematics students at all levels” (p. 208). Urbina- Lilback, (2016) asserts that a goal of all mathematic teachers should be to increase mathematical access for all students, and to develop lifelong mathematic learners by teaching students to question the status-quo and to become critical thinkers.

Often the students who are placed into remedial courses are students who did not receive a quality preK – 12 grade education. “Many first generation, low income students attend inner-city schools with low levels of funding, crowded classrooms, inadequate course offerings and underprepared teachers. As these students make their transition to college they take along with them these disadvantaged factors” (Yue, Rico, Vang, & Giuffrida, 2018). 69% of students receiving Pell grants, 70% of Black, non-Hispanic, and 63% of Hispanic students at two-year institutions are placed in remediation compared to only 53% of white non-Hispanic students (CCA, 2016). In four-year public institutions the percentages are lower but still alarming. Yue et al. (2018) found that overall, in two-and four-year colleges, low-income students were almost four times more likely to not persist past their first year, and Caucasian students were seven times more likely to graduate than their underrepresented minority peers.

Disadvantaged students often have multiple factors that impede their overall success in college. Unfortunately, students placed into remedial mathematics are disproportionately minority and first generation. They often lack the necessary academic skills required for college success and they often commute to campus which leads to a lack of engagement with the campus community (Bonham & Boylan, 2011; Yue et al. 2018). The barriers that are faced by students who are considered disadvantaged only increase the already sustainable gap in prior knowledge and degree attainment. “Knowledge of any type, but specifically mathematical knowledge, is a powerful vehicle for social access and social mobility, hence the lack of access to mathematics is a barrier – a barrier that leaves people socially and economically disenfranchised” (Schoenfeld, 2004, p. 55).

Psychological Effects of Remediation

Students who find themselves labeled unprepared when they arrive at college are often surprised and discouraged. They are typically shocked when they learn they must take extra college courses for no credit, and that they must pass these courses before they can move on to college-level courses that count towards their degree. This label of unprepared, remedial, or developmental can cause students to question if they are in fact truly ready for college.

“Remedial student” and remedial education are basically social constructions that have negative connotations; they imply something is wrong with the student that needs to be remedied (Astin, 1998, p. 12). Schnee (2014) found the participants in her study expressed indignation, dismay, and concern for the impact remediation would have on their progression to a degree when they realized they were placed in developmental courses (p. 248).

One of the continual arguments for remediation is that students who are in need of certain skills are identified and grouped together so they are able to receive the necessary instruction for success. Even though in traditional remediation students are surrounded by peers with the same skills or lack thereof, students often feel isolated, embarrassed, or awkward (Cafarella, 2014), and the stigma associated with remediation negatively affects and discourages positive student outcomes (Bettinger & Long, 2009). “As a result of their placement into a developmental course, these students may experience a stigma associated with this placement, or other responses that may result in negative outcomes, particularly when compared with their college peers" (Boatman & Long, 2018, p. 35).

Not only do students placed into remediation have confidence issues, they usually also struggle with the skills necessary to be good and effective college students. Langley and Bart (2008) found students in lower performing groups typically do not have the confidence that they can successfully do the work expected of them in remedial mathematics courses. When compared to their non-remediated peers, remedial students struggle more with self-regulated learning strategies such as; taking notes, asking questions, participating in class discussions and having good study habits (Cafarella, 2014; Hagedorn, et al., 1999).

When working with students in remedial education instructors have a much bigger job than just teaching the material in the same old ways of lecture, memorization, and repetition. In all areas of remediation students face difficulty succeeding. This is especially true in remedial mathematics. Faculty working with remedial students should develop a rapport with students, making the learning process exciting while showing patience and understanding of students' mathematical difficulties in order to help break the cycle of inferiority, resistance, and prejudices toward the process of achievement (George, 2012; Hagedorn et. al., 1999).

An instructor should help empower students by challenging them to think and to be an active participant in their own education. Students should learn the process of thinking, making sense of a problem, and questioning themselves and others within the classroom through the process of productive struggle. Silva and White (2003) explain the idea of struggling effectively by allowing the student time to explore, investigate multiple methods, and articulate reasoning behind the approach they choose to use. This is much different than the students memorizing and following a restrictive algorithm given by the teacher. This builds confidence and success for the remedial student.

George (2012) found that remedial mathematics students in particular had the most success when they were motivated to learn the material either from their instructor or some sort of intrinsic motivation of wanting to complete and overcome their mathematics remediation. Once a student successfully completes the remediation process in a given subject area, his or her own academic disadvantage decreases and his or her own belief in what he or she is capable of increases. Thus, postsecondary remediation is highly efficacious for those students who are successful (Bahr, 2010).

Mathematics Self-Efficacy

A student's belief in his or her own knowledge, understanding, and confidence contributes significantly to his performance in a class. Bandura (1997) claimed an individual's perception or beliefs of his or her performance actually influences his accomplishments, and that one's self-efficacy determines how he feels, thinks, self-motivates, and behaves. One's own self-efficacy determines how likely she is to engage in challenging activities and learning experiences, and influences the amount of stress and anxiety she experiences (Jameson, & Fusco, 2014; Pajares & Miller, 1994; Street, Malmberg, & Stylianides, 2017).

Mathematics self-efficacy is not merely a belief in the mathematics skills the individual possesses, but rather in what he or she is capable of completing with those skills. There have been several studies that show a positive relationship between students' self-efficacy and performance, especially when specific positive encouragement and feedback is provided (McMullan, Jones, & Lea, 2012; Street et al., 2017). When students have higher levels of self-efficacy they are more willing to approach difficult problems as a challenge that can be accomplished verses an impossible insurmountable task (Bandura, 1997; Williams & Williams, 2010). Self-efficacy tends to have a positive correlation with one's performance, so raising a student's mathematics self-efficacy should help him or her become more successful.

Bandura (1977) claims there are four sources of self-efficacy beliefs: performance accomplishments, vicarious experiences, verbal persuasion, and emotional arousal. These four sources work together to affect one's self-efficacy. Performance outcomes is positive and negative experiences that influence the ability to perform a task. Vicarious experiences is developing self-efficacy based on watching another person perform a task and then comparing one's own competence to the other person's competence. Verbal persuasion is self-efficacy that is influenced by other's encouragement or discouragements in regards to a specific task. Emotional arousal is sensations within the body such as anxiety or enthusiasm that affect one's beliefs of efficacy (Bandura, 1977; Redmond, 2010). Self-efficacy is developed over time by many factors so therefore for one's self-efficacy to change there has to be a shift in the four sources that contribute to the individual's self-efficacy (Bandura, 1977; Bandura 1997; Pajares & Miller, 1994).

Dropout/Non-Persistent Students

Many students placed into remedial courses do not persist in college. This is especially true for those students placed into remedial mathematics. Persistence is defined as the number of terms in which a given student continually enrolls in courses. Persistence rates increase when the student is only required to take one remedial subject or only one remedial course in two different subjects. Boatman and Long (2018) found that students in need of remediation in reading or writing were more likely to persist than students needing mathematics remediation. They hypothesized that reading and writing skills are fundamental to all course work, where mathematics is critical for only certain majors. Therefore, students in need of mathematics remediation often do not value the importance of the courses, especially when several remedial mathematics courses are needed before they can take the one course required for their major (Boatman & Long, 2018).

Overall persistence rates are particularly dreadful for academically low mathematics students who require several levels of remediation before ever reaching a college credit bearing class (CCA, 2016). In the end, those who most need remediation are the least likely to remediate successfully, thus what was intended to reduce disparities compounds them with little or no success (Bahr 2010; Cafarella 2014).

For students with extremely weak mathematical skills the sequence of remedial courses can be long and daunting. Bailey (2009) found often the weakest students must enroll in and pass two to three pre-algebra courses before ever attempting to take College Algebra. The remedial sequence that academically low mathematics students must complete is often an "obstacle course" with many places for the student to exit while never obtaining a college mathematics credit (Bahr, 2008; Bailey et al., 2010; George, 2012; Hagedorn, et al., 1999).

Attewell et al. (2006) found that taking three or more remedial courses significantly lowered the graduation rate of students in four-year colleges. These findings support the earlier claim that, while remediation works for students who successfully complete the remediation sequence, many do not persist through all the developmental courses. The longer the sequence is for a student to endure the more unlikely the student is to successfully remediate. "Moreover, the major proportion of these students become frustrated with curriculums that include no true transferable college credit and therefore "drop out" of college without earning a degree or in many cases, transferable college credits" (Hagedorn, et al., 1999, p. 263).

Alternatives to the traditional remediation process are always being researched and discussed. However, Bettinger and Long (2009) make a fair point that the lower ability, less-prepared students are the ones who end up in remediation, and even in the absence of remediation this group of students is less likely to persist and complete a degree. Remediation can be a gateway to a college degree for some students who have such deficient skills that require a semester long course to catch them up and get them back on track.

However, remediation does not have to be strictly an obstacle of courses. It could be lab time, supplemental instruction, or additional support in a co-requisite course. Those individuals in charge of remedial education have a responsibility to insure the participation in semester long remedial courses is required only when absolutely necessary. If students can develop the skills essential for success without semester long remedial courses, then any time or money spent in remediation is too much (Boylan, 1999, p. 3).

Remediation in Mathematics

Where remediation in college is an issue in multiple disciplines it tends to be remedial mathematics education that becomes the gatekeeper to a student's college diploma. It has been said that, "a student's outcome in remedial mathematics may mean the difference between a full college education and everything such an education may portend" (George, 2012, p. 259) and "unfortunately, not only is the need for remedial coursework common in mathematics, it is also associated with poorer outcomes in college-level courses" (Parmer & Cutler, 2007, p. 38). In response to the low success rate and high attrition rate of sequenced remedial mathematics courses major reform efforts of remedial mathematics have been born within the last decade (CCA, 2016).

There have been several reform efforts over the past few years in remedial mathematics. Two main efforts have gained national popularity and support from government agencies. The first is the *Pathways Project,* supported by Complete College America, and the Dana Center. The second is co-requisite reform in mathematics supported by Complete College America. The *Pathways Project* focuses on multiple paths of remediation to receive credit in college-level courses.

For several years in many universities, students have been able to earn their college-level mathematics credit in other courses besides College Algebra. Many colleges have created courses such as General Mathematics or Mathematics Modeling to serve their students who do not need Calculus (Rocconi, Lambert, McCormick, & Sarraf, 2013; Tucker, 2013). Although the idea of different college-level courses has been around for years the idea of developing pathways of remediation is fairly new. Prior to the *Pathways Project* all students in need of remediation typically followed the same path, a path to prepare them for College Algebra (CCA, 2012b).

The new idea is to not bore the student with unnecessary semesters of mathematics that do not prepare them for their college-level courses ("Transforming Developmental," 2014). "Students find pre-college algebra skills to be redundant of their high school experience, and these skills serve little purpose in their college education other than fulfilling a course requirement" (Fox & West, 2001, p. 89). For students wanting to pursue a major that requires Calculus, they should proceed through remediation that will prepare them for College Algebra, the pre-requisite for Calculus.

Co-Requisite Remediation

Often remediation focuses on prior skills from previous years instead of focusing on specific skills needed for the mathematics course required for a student's major. Students in need of remediation are regularly placed into mathematics courses that are designed to re-teach arithmetic and algebraic skills beginning around a seventh-grade level. Before a student can even attempt a college level course they must first re-learn all the mathematics skills since middle school, even though not all of these skills are required for their college credit bearing course. In this way the idea of remediation acts as a roadblock but institutions should think of remediation as an on-ramp for credit bearing courses (Bettinger et al., 2013).

A recent major reform in remedial mathematics is the idea of co-requisite remediation. Co-requisite remediation is when the student is able to immediately enroll in a college-level course while at the same time completing their remediation requirement. In this way students receive their remediation as a co-requisite not a pre-requisite. Research has shown when unprepared students are enrolled in a college-level course while receiving support in a co-requisite model their pass rates are comparable to their non-remedial peers (CCA, 2016).

Co-remediation serves the purpose of supporting students while at the same time significantly reducing the students' time spent in remediation. Because students are completing their remediation requirement and receiving college credit at the same time, the leaky pipeline of remedial mathematics is greatly reduced. Remedial mathematics education is not the only discipline to try the idea of co-requisite remediation. While co-requisite is still a new reform in remedial mathematics, college English departments have successfully been implementing co-requisite remediation for several years. (CCA, 2016).

While some argue that co-remediation may work in English Composition as a support for students with weak writing skills, the amount of remedial mathematics needed is too great for a support course because mathematics is a more linear subject with topics building upon one another. However, "just in time" remediation has shown to be successful in gateway mathematics courses as well as higher mathematics courses such as calculus. For years upper level mathematics courses have successfully implemented supplemental instruction, or SI, secessions for struggling students to help boost their retention even though they were deemed college ready (Yue, et al., 2018). Even though co-remediation in mathematics is a new domain, early research suggests students with ACT scores as low as 13 in the mathematics portion of the test, can be successful in a college-level course when remediation is offered as a co-requisite support similar to supplemental instruction (CCA, 2016).

Conclusion

The research suggests that remedial education is effective when a student can complete the sequence of remediation. However, "comparatively few remedial mathematic students remediate successfully, and those students who do remediate successfully are disproportionately those who require the least assistance" (Bahr, 2008, p. 245). Traditional remediation as it is practiced in colleges today is ineffective in overcoming academic weaknesses, and does not allow for student success in college level courses (Bailey, 2009; Jones, 2015). Since remediation shows positive success for those who complete the sequence, it is important to realize students do need support to help them be successful. Remedial programs help maintain equity of opportunity by allowing academically weaker students the option of college and upward mobility in society. (Bahr, 2010, p. 200).

Due to the lack of success of students completing a lengthy remedial sequence, the objective of colleges should be to reduce the length of time spent in remediation prior to a student starting college level courses. This is an admirable goal; however, attention also needs to be placed on the attrition issue related to remedial mathematics. Accelerating the remedial process is a beginning but emphasis should be placed on the fact that more students fail to complete developmental sequences because they never enroll in the subsequent course (Bailey et al., 2010).

The National Council of State Legislatures (2016) claims students who test below college-ready can be successful in college level courses when extra academic support is available. One possibility is to let students enroll in their gateway courses but provide academic support as a co-requisite. "By providing remediation as a co-requisite—not a prerequisite sequence that sets students back—attrition is reduced, and long-term academic success becomes more likely" (Jones, 2015, p. 26). The best way to support students who are currently placed in remedial education is to put them directly into their gateway courses while providing them with appropriate academic support. Thus, the co-requisite model is successful in reducing the amount of time of remediation and the attrition of remedial students, because college credit may be obtained within a single semester.

In remedial mathematics courses students accumulate debt, spend time, money, and financial aid eligibility all while a full college education teeters on the student's success in finishing the remedial mathematics sequence (Bahr, 2008; Bailey, 2009; George, 2012). Developmental education carries significant financial, psychological, and opportunity costs for students. It is important when discussing reform efforts in remedial mathematics education that the amount of remedial work matters. One remedial course affects bachelor's degree outcomes some, but there are stronger consequences for students needing remediation in multiple disciplines or multiple levels within the same discipline (Adelman, 1998, p.11). Remedial programs, specifically remedial mathematics programs, should focus on developing programs that will bridge the gap in underprepared students entering college. After all, in the beginning, "it was hoped that remediation programs would be an academic bridge from poor high school preparation to college readiness — a grand idea inspired by our commitment to expand access to all who seek a college degree" (CCA, 2012a).

Chapter 3: Methods

The previous chapter provided a brief history of education along with the reform movements in mathematics education specifically focused on college remediation. The current literature pertaining to mathematics remediation in college highlighted the controversial issue of remediation being a life line to students who are not quite prepared for college level work verses a roadblock that keeps many students from completing their college degree.

Throughout the years many different models have been implemented in college level mathematics remediation. The students' time spent in remediation and the students' success in completing remediation seem to be the overall deciding factors of the students' success in obtaining their college degree (Adelman, 1998; Bahr, 2008; Bailey, 2009; George, 2012; Jones, 2015). A rather new reform in mathematics remediation is the idea of a co-requisite for remediation instead of the traditional remediation process. In traditional remediation students complete a remedial sequence of courses as a pre-requisite prior to ever taking a college level course for credit. In the co-requisite model students take their remediation as a support course while enrolled in the college level course, receiving just in time remediation when necessary.

The purpose of this study was to first explore remedial mathematics students' mathematics self-efficacy, when enrolled in a co-requisite course, to see if they differed from their non-remedial mathematical peers. Another goal of the study was to analyze whether or not the self-efficacy of remedial students who are enrolled in a co-requisite course changed over the course of the semester. Finally, this research study examined remedial students' perceptions of confidence and success when they were enrolled in a co-requisite mathematics course at a four-year university.

This mixed methods study investigated the mathematics self-efficacy and perceptions of college students enrolled in a co-requisite mathematics course by answering the following questions.

1. Do students' mathematics self-efficacy, when enrolled in a co-requisite mathematics course, differ from their peers who are enrolled in the same non-co-requisite, non-remedial gateway course?
2. Does the mathematics self-efficacy of students who are enrolled in co-requisite courses change?
3. What are the perceptions of students who are enrolled in co-requisite mathematics courses, regardless of their change in mathematics self-efficacy?

This mixed methods study answered the questions above by using two phases. In phase one a simple survey technique was employed. The surveys were first used to compare co-requisite College Algebra students' mathematics self-efficacy to non-co-requisite College Algebra students' mathematics self-efficacy. Then the survey was used to analyze if co-requisite College Algebra students' mathematics self-efficacy changed over the course of a semester. Phase two used a semi-structured interview technique to explore the perceptions of college students enrolled in a co-requisite College Algebra course.

Framework

In the world there exists an external reality that has both absolute and relative truths. The objectivist view of one absolute truth that can be tried and tested can be seen in many different places within the world. For example, if the two legs of a right triangle measure three and four units respectively then the hypotenuse must measure five units. This truth of the length of the hypotenuse can be verified by a measurement tool such as a ruler. The thoughts or feelings of the person completing the measurement has no bearing on the actual measurement; the length cannot be affected by what the individual carrying out the measurement thinks.

The worldview of objectivist thought takes the stand that regardless of what an individual does, feels, believes, or encounters, the external truths and reality of the world will not be affected. The truths exist out in the world and are there waiting for the learner to find them and it is this view of the world that is the basis for many quantitative studies. Often when implementing a quantitative methodology, a hypothesis about a certain group of individuals may be tested against the norm for the greater population of similar individuals. Or, in other words, the researcher is looking to see if the tested group show the same results or truths that are known by the world.

From the objectivist philosophy knowledge is obtained when an individual comes to know the one truth or reality that is out there waiting to be discovered. The process of discovery may be in different formats, but the truth exists free of the knower and is not constructed by the knower but is simply revealed to the individual. Once truth has been revealed, then the amount of knowledge the individual possesses can be tested by quantitative instruments such as: a survey or another standardized testing tool. Truth and knowledge are absolute and do not vary among individuals.

However, from the constructivist view, knowledge is not just waiting out there to be discovered. Knowledge is created by the learner with interaction from experience and other individuals (Merriam & Tisdell, 2016). Dewey (1903) believes that knowledge is created by the learner through true first-hand experiences, and cannot be acquired from the summaries and results of other people. Knowledge is constructed and reconstructed by the active learner; it is growing, evolving, and builds on prior meaningful experiences. Just as each individual is unique so is the knowledge they construct. "Knowledge is not an internalized representation of the real world that everyone views the same way. It is actively constructed, invented, created or discovered by learners" (Shiro, 2013, p. 141).

Although an external reality exists free of the learner this reality does not represent a truth. Reality is subjective and is constructed by the learner through exploration and experience (Davis, 2004). There is no one Truth, but many truths that are constructed by the individual learner. "Truth, or meaning, comes into existence in and out of our engagement with the realities in our world" (Crotty, 1998, p. 8). Truth is not considered objective; what is found to be a truth by one individual can vary by others or in some instances not be considered a truth at all.

From this constructivist viewpoint, truth and knowledge are not absolute and will vary in different individuals even in relation to the same phenomenon. Qualitative methodologies often look at the phenomenon of social interaction, scaffolding, and experience to help understand the multiple meanings and realities that individuals come to possess. Since the realities that individuals create are evolving and continually changing, the purpose of this research study differs from most quantitative approaches that aim to find an absolute truth. Qualitative research tools such as ill-structured interviews help to explain what affects and accounts for the attitudes, feelings, and beliefs of the individual or group. "Because human beings are the primary instrument of data collection and analysis in qualitative research, interpretations of reality are accessed directly through their observations and interviews" (Merriam & Tisdell, 2016).

Often in education, the questions posed by researchers are multi-layered and are concerned with both determining and understanding phenomenon. To help provide the answers for complex problems, the viewpoints of both objectivist and constructivist philosophies intersect to deepen and enrich the findings of the research study. The worldview of pragmatism helps to unite the objectivist, quantitative, and constructivist, qualitative, methodologies. Pragmatism as a theoretical framework focuses on the importance of the question being asked by the researcher rather than the method or methods the researcher will use (Creswell & Plano-Clark, 2011, p.41).

The questions posed in this study can only be thoroughly answered by intertwining objectivist and constructivist viewpoints and measures. Where it is true that the first and second question could be answered by only using a quantitative approach the third question could not. The third question posed would be difficult to be fully answered with quantitative data because the perceptions of the students need to be explored on a one-to-one basis. Similarly, increases or decreases in mathematics self-efficacy should not just be measured on the individual's ideas or feelings, but instead should be measured by an instrument to see if statistically significant changes can be shown. Because of the multi-layers of these questions a pragmatic approach is necessary.

In this research study the phenomenon of mathematics self-efficacy will be investigated to see how remedial mathematics students in a co-requisite model compare with their peers in a non-co-requisite, non-remedial model. The difference in students' mathematics self-efficacy in the two models is an objective truth. The students in the co-requisite model will either have a statistically different score on mathematics self-efficacy than their non-co-requisite peers or their will be no significant difference. The measured increase or decrease in students' mathematics self-efficacy will also be an objective truth. However, the students' explanations of beliefs about why their mathematics self-efficacy increased or decreased is not objective. Students construct their own meanings of mathematics self-efficacy. Two different students with the same experience in class can have very different ideas and perceptions about how the class affected them. Their constructed beliefs must be explained in their own words in order to gain a picture of what is happening. Since the nature of reality and knowledge is an evolving and changing system, the methods of discovery vary in different social constructs. This study aims to deepen the understanding of co-requisite remediation from the students' perspectives in relation to mathematics self-efficacy. The viewpoints and perspectives of the individuals studied may fill a gap in the current level of knowing or challenge current ideas about the remediation phenomenon (Schutz, Chambless, & DeCuir, 2004).

Rationale

For this research study I chose to use a mixed method design that essentially combines both quantitative and qualitative designs into one research project. By choosing a mixed method design I am able to get a wide breadth as well as a deep depth of information from the participants in the study. I feel my research questions, focused on students' perceptions and mathematics self-efficacy when enrolled in a co-requisite College Algebra course, can only be properly explained by using a mixed methods design. A mixed methods design is best suited for problems "in which one data source may be insufficient, results need to be explained, and or a theoretical stance needs to be employed" (Creswell & Plano-Clark, 2011, p.8).

The research questions posed in this study would be insufficiently answered using only quantitative methods, as vital information about the students perceptions of the co-requisite course would be missing. As stated earlier, the first question that compares the mathematics self-efficacy of the two groups of students could be easily and best answered using only a quantitative study. The reason for adding this question to this study was to provide context to the students' mathematics self-efficacy scores who are enrolled in a co-requisite course. The null hypotheses would be that there is no difference in students' mathematics self-efficacy between the two groups of students. To sufficiently address the problem of students being unsuccessful in remediation it is important to establish if students in remediation, specifically in this case co-remediation, have different perceptions of mathematics self-efficacy than that of their non-remedial peers. By using quantitative methods many students can be surveyed, thus providing a better picture of the phenomenon of the effect of remediation on students' mathematics self-efficacy.

The second and third questions posed would also be insufficiently answered using only quantitative or qualitative methods. For these questions only choosing qualitative methods would limit the response of the participants; thus, possibly only giving a portion of the picture of the phenomenon of co-requisite remediation. It is important to use the quantitative data to explain a general trend among a multitude of students. However, to fully answer question three, detailed specific information about students' perception of the co-requisite course must be explored. The reasons or explanations given by the students help to explain the general trends in the quantitative data findings and fill in gaps of missing details the quantitative data left out. The explanations given by students can be further researched to see if they could possibly lead to increasing mathematics self-efficacy to better support students in a co-requisite model.

The theoretical lens of pragmatism allows for the intertwining objectivist and constructivist viewpoints aforementioned. Using this lens often requires multiple level research with multiple different methods. This is the case in this study. To understand if students differ in their perceptions of mathematics self-efficacy, as well as understand what perceptions students have in the co-requisite mathematics course, both quantitative and qualitative methods give the best answer.

Research Design

The research questions posed in this study are best answered by using a mixed methods explanatory sequential design. As described by Creswell and Plano-Clark (2011), an explanatory sequential design begins with a quantitative phase followed by a qualitative phase. The qualitative phase is used to gain a better understanding of quantitative results and can only take place after all the quantitative data have been analyzed. The qualitative data illustrates the quantitative findings, "referred to as putting 'meat on the bones' of 'dry' quantitative findings" (Bryman, 2006, p.106).

In an explanatory sequential design, research study, individuals who participate in the qualitative phase are purposefully chosen from participants in the quantitative phase based on initial quantitative results. This study uses expansion as the primary mixing rationale. By mixing the results of the quantitative and qualitative data the breadth and range of the inquiry is extended (Green, Caracelli, & Graham, 1989). The mixing of this study took place at the methods level by purposively sampling from the quantitative results.

This study has a qualitative dominance phase with quantitative findings used to illustrate trends and outcomes and provide for purposeful sampling. The dominant phase of this study is qualitative and will be shown using the capital letters QUAL while the secondary phase of this study is quantitative and will be shown using the lower-case letters quan (Morse, 2003). This shorthand is used in Figure 1 to show the model of the sequential explanatory design used in this study.

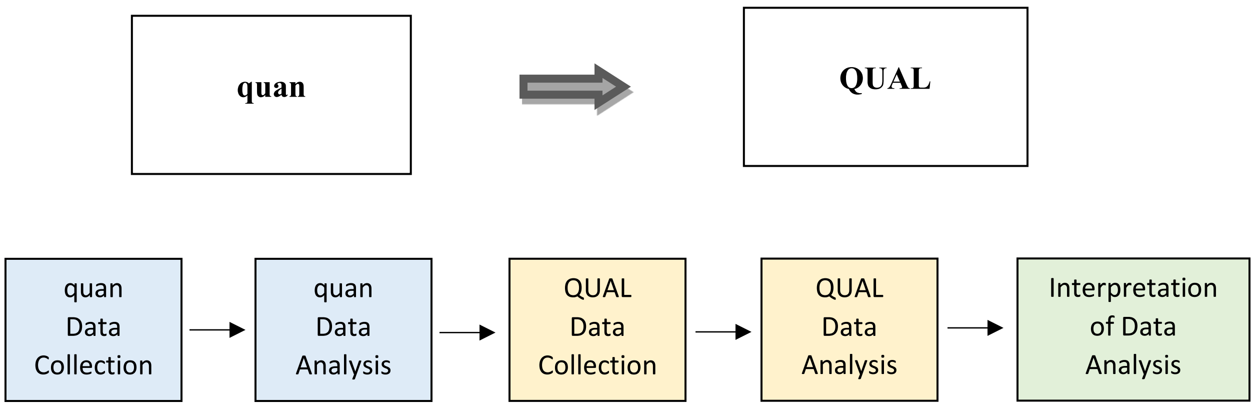

Figure 1. Model of Sequential Explanatory Design

The quantitative phase of this study involved two different parts. The goal of the first part was simply to answer the first research question: is mathematics self-efficacy different between the two groups of students, remedial (in a co-requisite model) and non-remedial? The second part of the quantitative phase was needed to answer the second question that addresses only the remedial co-requisite students. This two-part quantitative phase was slightly different from the typical sequential explanatory design given the data analysis from the second question was used to determine the participants in the qualitative data collection. Since there is no one best available mixed method research design for this study, flexibility and creativity was used (Subedi, 2016, p.575).

The entire quantitative phase of this study was simple survey design. Individual students were already placed into either a co-requisite course or a stand-alone gateway course at the beginning of the semester based on their placement scores. The qualitative phase of the study was a general semi-structured interview design. Individuals from the co-requisite courses were purposefully selected for interviews based off their survey results.

In this study participants were students enrolled at a regional four-year university in the Southern Midwest United States. The university where this study was conducted had 14,313 students enrolled during the spring 2018 term. 33.2% of the students were part-time, and around 70% of students commuted to school. In the spring 2018 term, 5,742 students took evening courses, the average age of all enrolled students was 24, and 40% of students were male and 60% were female. The ethnicity comparison for spring 2018 enrollment was 56.1% Caucasian, 10% were Hispanic, 9.2% African-American, 3.6% were American Indian, 3.5% were Asian, 6.4% were International, 11.1% were other races or not declared.

Participants in this study enrolled in the gateway course College Algebra in either a co-requisite or non-co-requisite course. These students were administered a self-efficacy survey during week one of the semester. It was not only important to see the differences in the two groups, but also to give the co-requisite remediation group a baseline score for mathematics self-efficacy. Then, students who were enrolled in a co-requisite remediation course were administered the survey again at week 13 of the 16-week semester. This was essential to gain a complete picture of the patterns of the changes in students' perceptions of mathematics self-efficacy while enrolled in a co-requisite course. Then from this wide breadth of sample size, select individuals whose mathematics self-efficacy increased, decreased, or remained the same were interviewed to gain a deeper understanding of their beliefs and changes of their mathematics self-efficacy. The breadth and depth answered by this study is only possible by implementing a mixed method design.

For this research study I designed and carried out the entire research project. During the quantitative phase I administered all the surveys, input all the survey data, and analyzed the survey results using statistical software. Throughout the qualitative phase I acted as a research instrument by interviewing, transcribing, and analyzing all qualitative data. I am currently a director of developmental mathematics and have background in teaching College Algebra both as a co-requisite and as a stand-alone course. In this research study, courses where I was the primary instructor in either College Algebra or the support course were not used.

Data Collection and Participants

Participants for Quantitative Data

The quantitative phase of this project utilized cluster sampling as describe by Teddlie and Yu (2007) where the researcher sampled a group that occurred naturally in the population. Students at the university were placed into either a non-co-requisite or a co-requisite College Algebra course at the beginning of the semester based off of their placements scores or their previous math course. The participants in this study were enrolled in a College Algebra course that met on campus and was not taught by the researcher. For the first part of the quantitative phase both non-co-requisite and co-requisite College Algebra students participated. For the second part of the quantitative phase only co-requisite College Algebra students who took both the pre and post survey were included as participants.

For the non-co-requisite College Algebra group the number of participants in the study was 119, with 62 males and 57 females, whose ages ranged from 18 to 45. The initial survey of the co-requisite College Algebra group had a total of 180 participants, with 61 males and 120 females, whose ages ranged from 18 to 45. The total number of participants in the first part of the quantitative phase was 299. The minimum total sample size for two-tailed hypothesis test using an effect size of 0.30 and a power level of 0.8 at the 0.05 probability level is 175 (Cohen, 1988). The total sample of 299 is well above this minimum recommendation for a sample size.

The second quantitative portion of the study only concerned the co-requisite College Algebra group. To be a participant in the second quantitative portion the student must have completed the first survey as well as the second survey. The total number of students in the co-requisite College Algebra group who completed both surveys was 113, with 41 males and 71 females. The minimum total sample size for a correlated two-tailed hypothesis test using an effect size of 0.30 and a power level of 0.8 at the 0.05 probability level is 87 (Cohen, 1988). The total sample size of 113 is still above the minimum recommendation of participants.

Quantitative Data Collection

The quantitative data for this study were collected by a simple survey technique. The first data were collected by a paper and pencil survey administered to students enrolled in College Algebra in either a co-requisite course or a non-co-requisite course at the university during the first week of class. Ultimately, six of the nine non-co-requisite College Algebra courses offered in the spring 2018 semester were surveyed. Of the three courses not surveyed one course was taught by the researcher and the other two courses the instructor of record chose not to allow their classes to participate. Students enrolled in a non-co-requisite College Algebra online course or a course that met off campus were also not administered the survey. Ten of 12 co-requisite College Algebra courses were surveyed. The two co-requisite College Algebra courses not surveyed were taught by the researcher. The students enrolled in the co-requisite course who participated in the first survey received the survey again during week 13 of the 16-week semester.

The survey instrument used was the Mathematics Self-Efficacy Scale (MSES) developed by Betz and Hackett in 1983. The MSES is a 34-item questionnaire composed of two subscales; mathematics tasks and mathematics courses (Hackett & Betz, 1989). The mathematics tasks portion is comprised of 18 different questions where students circle a number from zero to nine to indicate their confidence on completing the task. The students did not actually have to complete the task, just state their confidence on their ability to successfully complete the given question. The mathematics courses portion of the subscale asked students to circle a number from zero to nine to indicate how much confidence they have that they could complete the given course with a final grade of A or B. See Figure 2 for a breakdown of the confidence scale and Figure 3 for sample survey questions.

0	No Confidence at All
1, 2, 3	Very Little Confidence
4, 5	Some Confidence
6, 7	Much Confidence
8, 9	Complete Confidence

Figure 2. Ten Point Confidence Scale on MSES

Everyday Math Tasks:

How much confidence do you have that you could successfully:

Compute your car's gas mileage

Understand a graph accompanying an article

Math Courses:

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

Statistics

Accounting

Figure 3. Examples of Math Tasks and Math Courses on MSES Survey

Students were also asked to complete a demographics section on the survey. The demographics section was not a part of the original survey but was developed by me and approved by the Institutional Review Board. See Appendix A for the complete demographic section and a sample of the survey questions administered to students.

The developed MSES has been administered many times over the past thirty years with the internal validity and over all reliability maintaining a consistent Cronbach's coefficient alpha of around .95 for the entire scale with each subscale Cronbach's coefficient alpha of at least .90 (Betz & Hackett, 1983; Hackett & Betz, 1989: Kranzler & Pajares, 1997). This validity and reliability score is highly reliable considering the acceptable Cronbach's Alpha score is at or above $\alpha = .7$ to show reliability between items (Kline, 2005). For this research study the entire scale consisting of 34 questions was used.

To derive a student's total score on the MSES all the responses to the 34 questions are added together and then divided by the total responses 34. If a student failed to answer one to three questions then their total was divided by the total responses they answered 33, 32, or 31. If a student left more than three questions blank then their survey data was not included in the data set for the study. Overall three no-co-requisite College Algebra and two co-requisite College Algebra surveys were not used.

I administered every survey and, prior to handing out each survey, I read a recruitment script to the class to recruit participants for the research study. (See Appendix B for the script). If students chose to participate in the research study they were asked to sign a consent form, (see Appendix C) prior to completing the survey.

Participants for Qualitative Data

The qualitative phase of this study utilizes purposeful or qualitative sampling to achieve representativeness of those students whose overall mathematics self-efficacy score increased, decreased or stayed the same over the course of the semester (Teddlie & Yu, 2007). From the surveys, initially 26 students gave their permission to be contacted for an interview. Out of these 26 students, eight had an increase in their self-efficacy score on the MSES, 10 had a decrease in their self-efficacy score on the MSES, and eight had no change in their self-efficacy score on the MSES. A change in self-efficacy score on the MSES was set at a minimum of 0.5 points higher or lower than the original score. For the eight participants who did not have a change in their self-efficacy score, their pre-and-post-survey scores were within 0.5 points of each other.

Ten participants were selected from the initial interview pool of 26, five males and five females, to proceed with the qualitative semi-structured interviews. Four students selected, two male and two female, had mathematics self-efficacy scores that increased at least 0.5 points over the semester. Four students selected, two male and two female, had mathematics self-efficacy scores that decreased at least 0.5 points over the semester. Two students selected, one male and one female, had mathematics self-efficacy scores that did not change more than 0.5 points over the semester. Table 1 shows a breakdown of each student's pre-and post-survey score as well as the demographic information used.

Table 1

Qualitative Interview Participants

Participant	Gender	Age	Pre Score	Post Score	Difference Post-Pre
5	M	34	6.38	7.12	0.74
7	M	32	5.53	6.09	0.56
6	F	19	4.79	6.53	1.74
10	F	40	5.65	6.62	0.97
9	M	19	5.76	5.21	-0.55
8	M	19	5.24	2.94	-2.3
2	F	45	6.47	5.44	-1.03
3	F	19	6	4.74	-1.26
1	M	33	8.32	8.68	0.36
4	F	18	4.82	4.76	-0.06

The participants for the interviews were specifically selected to give a deeper understanding and meaning to the quantitative data. "Rather than being systematically selected instances of specific categories of attitudes and responses, here respondents embody and represent meaningful experience – structure links" (Crouch & McKenzie, 2006, p. 493). In order to gain a fuller explanation of students' perceptions of the co-requisite mathematics course it was important to interview students who's MSES scores increased, decreased, or remained the same. This helped increase the validity of the quantitative data by being able to explore possible factors for changes in student's scores on the MSES. As described by Crouch and McKenzie, (2006) interviews continued until saturation in each group was reached. As the interviews were being conducted the interview material and data were continually monitored. Since after the interviews of initial participants saturation was reached, the interviews for that group ceased.

Qualitative Data Collection

The qualitative data for this study were collected by conducting semi-structured interviews with purposefully selected participants identified from the quantitative results. Ten

15-20 minute interviews were conducted in a small conference style room in the library of the university where the study was taking place during weeks 14 to 16 of the 16-week semester. The interviews were one-on-one and face-to-face with me acting as the sole interviewer. Each interview began by gaining permission from the interviewee to record the session. Participants were asked to describe how their co-requisite mathematics course worked. From the participants response other questions were asked. Often a participant was asked to elaborate or explain a previous response. At the end of each interview each participant was asked if there was any other information they felt would be important or if they would like to add any other comments.

An advantage of semi-structured interviews is the ability to allow the interviewee to add elements to the data collection that may not be immediately available in the original questions posed by the interviewer. The initial outline of the semi-structured interview can be viewed in Appendix D sample questions can be seen in Figure 4.

1) Can you describe your experience in this course?

2) What was the best part of this class that you would like to see in other math classes?

3) Elaborate on your confidence in mathematics?

Figure 4. Sample Questions from the Semi-Structured Interview

Data Analysis

Quantitative Data Analysis

The quantitative research questions for this study focused first on the difference in mathematics self-efficacy between groups of students enrolled in College Algebra. Group one did not need remediation. Thus, they were enrolled in a typical stand-alone College Algebra course. Group two consisted of students in need of remediation, thus they were enrolled in a co-requisite support course along with their College Algebra course. The second quantitative question for this study focused on changes in students' mathematics self-efficacy over the course of the semester when enrolled in the co-requisite College Algebra course. Only the students in group two were used in the second quantitative portion of the study.

Students in both groups were administered the MSES during the first week of the semester and their scores were generated. Each individual student's overall score on the MSES is determined by taking the average of his or her responses. For each question, students select their response on a zero to nine-point scale with zero showing "no confidence at all" and nine showing "complete confidence". A student can score in a range of zero to nine on the MSES. Table 2 shows the minimum and maximum MESE scores for group 1, group 2 pre-survey, and group 2 post-survey.

Table 2

Minimum and Maximum MSES Scores for Group 1 and 2

Group	Minimum	Maximum
1	3.29	8.91
2 (Pre)	1.74	8.47
2 (Post)	1.85	8.68

The first purpose of the quantitative data analysis was to determine whether students in need of remediation in mathematics display the same mathematics self-efficacy as students not in need of remediation. The second purpose of the quantitative data analysis was to determine whether students enrolled in the co-requisite course have significant changes in their mathematics self-efficacy over the course of a semester. The quantitative data analysis aimed to answer question one and two. The third purpose of the quantitative data analysis was to help identify participants for the qualitative data collection.

Descriptive statistics were generated for the variable mathematics self-efficacy. Data analysis was performed by the researcher using SPSS software. For the first question an independent samples t-test was run using the variable of mathematics self-efficacy comparing group one, the students enrolled in non-co-requisite College Algebra, with group two, the students enrolled in co-requisite College Algebra using the survey responses at the beginning of the semester. The t-test revealed significance at the $p < 0.05$ level. Normality was also checked using the Kolmogorov-Smirnov and Shapiro-Wilk tests of normality as well as QQ plots and box plots. The researcher ran several variations of the data including group one to the initial and the post-surveys of only the students who completed both the pre-and-post-surveys in group two.

For the second question a correlated samples t-test of scores from group two, the co-requisite College Algebra group, was performed. The correlated samples t-test compared the difference in students' surveys scores between week one and week 13. To be included in question two students in the co-requisite College Algebra course had to complete both surveys, the first at week one and the second at week 13. The surveys were only administered during one class period each time. Students who were absent either day did not take the survey. For students who only completed one survey their data was omitted from the question two analysis. However, if students took the first survey during week one then they were still included in the question one analysis.

A second independent samples t-test was run comparing the initial survey of non-co-requisite College Algebra students with the initial survey of co-requisite College Algebra students who took both surveys. A third independent samples t-test was run comparing the initial survey of non-co-requisite College Algebra students with the second survey of co-requisite College Algebra students who took both surveys. I determined if the tests showed significance at the $p < 0.05$ level and checked for normality by using the Kolmogorov-Smirnov and Shapiro-Wilk tests of normality and the QQ plots and box plots.

Qualitative Data Analysis

The qualitative research question for this study, question number three, focused on the perceptions of students who were enrolled in a co-requisite mathematics course, regardless of whether they had an increase, a decrease, or no-change in their mathematics self-efficacy. The purpose of the qualitative data analysis was to gain understanding and explanation of the perceptions students have during their time in a co-requisite course. The qualitative data analysis was meant to enrich the understanding of the quantitative survey results for the overall group by filling in missing information that the survey could not show. Thus giving possible context for question one and question two.

The qualitative data were analyzed using a constant comparison method for data analysis. A qualitative data study is emergent in nature and the collection and analysis of data should be a simultaneous process, with the analysis becoming more intensive as the study progresses (Merriam & Tisdell, 2016, p. 195). Interview one was conducted and immediately transcribed verbatim into an Excel spreadsheet. The interview transcript was reviewed, and comments were made about the interview. I looked for commonalities or important information given by the interviewee. Next all the data were coded, and codes were given for different chunks of information within the interview. After this process, interview two was conducted and the process of transcription and coding used with interview one was repeated.

After interview two was transcribed and coded I compared interview one with interview two to see if any common themes emerged. This process of transcription, coding, and comparison continued for interviews three through ten. A data software program was not used to analyze the qualitative data, but an Excel document was used in lieu of a traditional transcribing notebook. The Excel document was split into four columns for each interview with the following headings; text, comments, coding, and themes. A second Excel spreadsheet was used to group the different themes together. Since qualitative data collection and analysis is an ongoing process that can extend indefinitely, the interviews concluded when saturation was met. Merriam and Tisdell (2016) describe saturation being complete when the "data collection produces no new information or insights into the phenomenon being studied" (p. 199).

Mixed Methods Data Analysis

Since this study was an explanatory sequential model, as described by Creswell and Plano-Clark (2011), the mixing of the analysis happened in three steps with the actual mixing of the findings occurring in step three. First, the quantitative data were collected and analyzed. Then purposeful sampling of the quantitative data was utilized to select participants for the qualitative phase whose overall MSES scores for mathematics self-efficacy increased, decreased, or maintained the same to achieve representativeness of all the students in the quantitative phase (Teddlie & Yu, 2007). Second, the qualitative data were collected and an analysis of the qualitative data was conducted to better understand the quantitative results. Third, both the quantitative and qualitative data were used together in the interpretive phase to help to fully answer the research questions posed for this study (Creswell and Plano-Clark, 2011, p. 221).

The mixed methods data analysis included sampling consideration as this was a sequential study with the quantitative results determining the sampling for the qualitative phase. Creswell and Plano-Clark (2011) described this data analysis method as connect mixed methods data analysis. Connect mixed methods data analysis can only be obtained by a mixed methods study that is sequential. In this case, the quantitative results determine the participants for the qualitative phase. The merging of these two data sets was used in a combined analysis where the quantitative data were analyzed quantitatively and the qualitative data were analyzed qualitatively. Then, the interactive strategy of merging was used so that the two sets of data were merged into a combined analysis (Creswell and Plano-Clark, 2011, p. 67). For the combined analysis the qualitative data were translated as quantitative results by using frequency counting of emerging themes. The frequency of these themes was then compared to the student's perceptions of mathematics self-efficacy to see if the themes could explain or predict perceptions of mathematics-self efficacy.

Trustworthiness

For the quantitative portion of this study, I used a representative sample of College Algebra students who were enrolled in a four-year institution who were either in a co-requisite or non-requisite course. The sample size for the groups being compared was well within the minimum recommendation of the effect size of 0.30 and a power level of 0.8 at the 0.05 probability level (Cohen, 1988). The survey instrument used had a highly reliable Cronbach's Alpha score of $\alpha = .95$ for the internal validity and overall reliability of the instrument (Kline, 2005, Kranzler & Pajares, 1997).

For the qualitative portion of this study, I maintained credibility within the study by using a form of triangulation. The method of triangulation that was applied was using multiple sources of data by interviewing groups of people with different perspectives (Merriam & Tisdell, 2016, p. 245). Students that showed an increase, decrease, or no change in their mathematics self-efficacy over the course of a semester were interviewed. This provided three different groups of students' data to compare in the findings of the qualitative data analysis. The researcher also had an adequate engagement in the data collection, and did not stop the interviews until the data and emergent findings felt saturated (Merriam, & Tisdell, 2016).

Ethical Considerations

The participants' identity in both the quantitative and qualitative part of the study were kept confidential. As students took the first survey they were assigned a random number know only by the researcher. Upon completion of the second interview the researcher coded each survey with the appropriate number that corresponded to the student and then the student's name was cut off the survey. For the interview, the interviewees were only identified by a number, rather than their name.

All survey documents and printed information of interviews were locked in a file cabinet in the researcher's office. Only the researcher had a key to the locked file cabinet, and when the researcher was not in the office, the office itself was also locked. All electronic files including the Excel documents for the qualitative data analysis was saved in a personal folder on the researcher's personal office computer. The computer must have a sign on and password that is strictly know by the researcher. Anytime the researcher was not at the computer the computer was locked and the office the computer was in was also locked.

Summary

This chapter began with a summary of the purpose of this study, followed by a detailed explanation of the theoretical framework and rational for this mixed methods research study. The chapter continued by describing the mixed methods explanatory sequential design of this study with a dominate QUAL phase. The research design, data collection, participants, and data analysis were explained. In the following chapter the findings of the data analysis will be fully described and then in chapter five the results of the study will be discussed with practical implications of the findings.

Chapter 4: Results and Analysis of Findings

In this chapter the results of this mixed methods study designed to investigate the mathematics self-efficacy and perceptions of college students enrolled in a co-requisite mathematics course will be discussed. The purpose of this study was to first explore remedial mathematic students' mathematics self-efficacy, when enrolled in a co-requisite course, to examine if and in what ways they differed from their non-remedial mathematical peers. Another goal of the study was to analyze whether or not the self-efficacy of remedial students who are enrolled in a co-requisite course change over the course of the semester. And finally, this research study examined remedial students' perceptions when they were enrolled in a co-requisite mathematics course at a four-year university.

The results of the data analysis will be discussed in three different parts. The first results will be the quantitative results answering the original research questions:

1. Do students' mathematics self-efficacy, when enrolled in a co-requisite mathematics course, differ from their peers who are enrolled in the same non-co-requisite, non-remedial gateway course?
2. Does the mathematics self-efficacy of students who are enrolled in co-requisite courses change?

The second results will be the qualitative results answering the original research question;

3. What are the perceptions of students who are enrolled in co-requisite mathematics courses, regardless of their change in mathematics self-efficacy?

The final results section will show the combined analysis of both the quantitative and qualitative data in this sequential explanatory designed mixed methods study.

Quantitative Data Results

The purpose of the quantitative phase of this study was to first determine whether students in need of remediation in mathematics possess the same mathematics self-efficacy as students not in need of remediation. The second purpose of the quantitative phase was to determine whether students enrolled in the co-requisite course have significant changes in their mathematics self-efficacy over the course of a semester. The entire quantitative phase of this study used the simple survey design and utilized cluster sampling explained by Teddlie and Yu (2007).

Individual students were already placed by self-enrollment into either a co-requisite course or stand-alone gateway College Algebra course at the beginning of the semester based on their placement scores. The quantitative data for this study were collected by a simple survey technique. The first data were collected by a paper and pencil survey administered to students enrolled in College Algebra in either a co-requisite course or a non-co-requisite course at a four-year university during the first week of class. Students enrolled in the co-requisite course who participated in the first survey received the survey again during week 13 of the 16-week semester.

The survey instrument used was the Mathematics Self-Efficacy Scale (MSES) developed Betz and Hackett in 1983. The MSES is a 34-item questionnaire composed of two subscales; mathematics tasks and mathematics courses. Students select their response on a zero to nine scale with zero showing “no confidence at all” and nine showing “complete confidence” (Hackett & Betz, 1989). Figure 5 shows the ten-point confidence scale used on the MSES.

0	No Confidence at All
1, 2, 3	Very Little Confidence
4, 5	Some Confidence
6, 7	Much Confidence
8, 9	Complete Confidence

Figure 5. Ten Point Confidence Scale on MSES

To derive a student's total score on the MSES all the responses to the 34 questions are added together and then divided by the total responses, 34. If a student failed to answer one to three questions then their total was divided by the total responses they answered 33, 32, or 31. If a student left more than three questions blank then their survey was not used. Overall three non-co-requisite College Algebra and two co-requisite College Algebra surveys were not used.

The individual paper pencil surveys were entered into an Excel spreadsheet. All identifiable information was removed and a random number was assigned to each survey. The data were then transferred into SPSS software. All the statistical data analysis in the quantitative phase of this study was performed by the researcher using SPSS software.

Difference in Mathematics Self-Efficacy between Groups

Non-co-requisite and co-requisite College Algebra students' surveys week one

The findings of this portion of the quantitative data analysis show non-co-requisite College Algebra students' mathematics self-efficacy is statistically significantly different than their co-requisite College Algebra peers. The participants were enrolled in either a non-co-requisite or co-requisite College Algebra course that met on campus and was not taught by the researcher. Non-co-requisite College Algebra students were assigned as group one and co-requisite College Algebra students were assigned as group two. The number of participants in the non-co-requisite College Algebra group was 119, with 62 participants being male and 57 being female, and the number of participants in the initial survey of co-requisite College Algebra group was 180, with 60 participants being male and 120 being female. In both groups the ages of participants ranged from 18 to 45. Figure 6 shows a breakdown of the ages of participants in groups one and two.

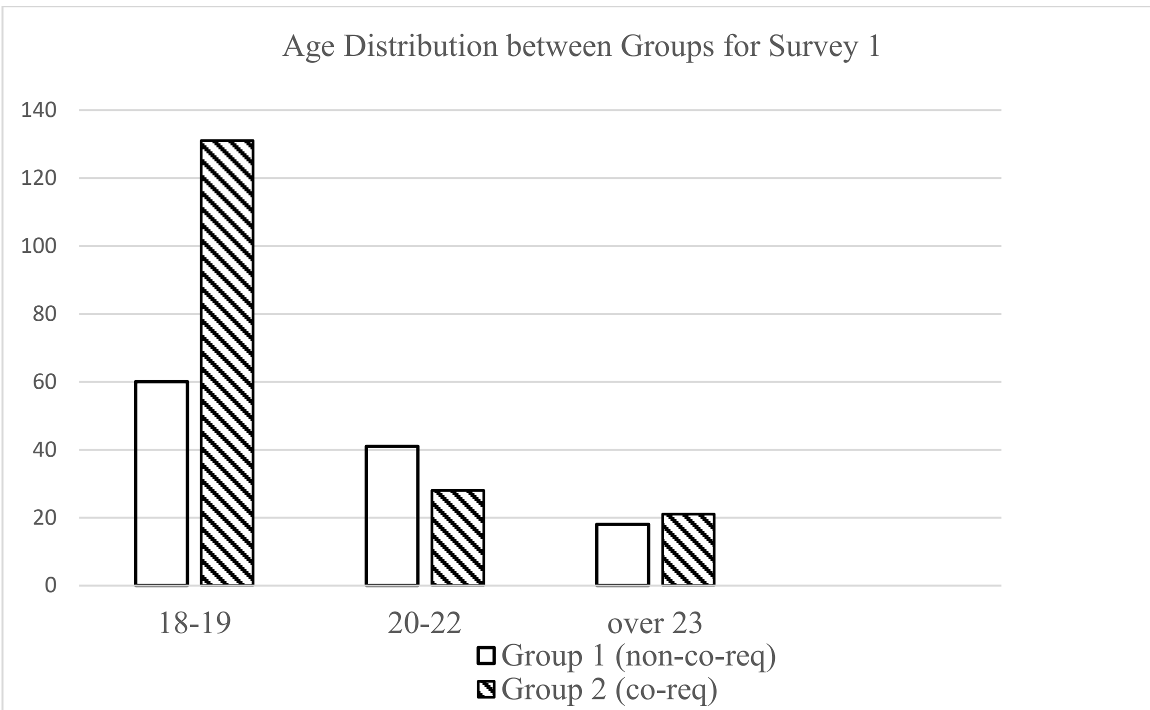

Figure 6. Age Distribution between Groups for Initial Survey

Descriptive statistics were generated for the variable mathematics self-efficacy between the two groups of students; group one, those enrolled in a non-co-requisite College Algebra course, and group two, all those enrolled in a co-requisite College Algebra course who took the first survey. Table 3 illustrates the descriptive statistics for groups 1 and 2.

Table 3

Descriptive Statistics for Initial MSES Scores for Groups 1 and 2

Group	N	Mean	Std. Deviation	Std. Error Mean
1 (non-co-req)	119	6.1864	1.38348	0.12682
2 (co-req)	180	5.4872	1.39221	0.10377

Both data sets were tested for normality. Group one showed normality in the Kolmogorov-Smirnov test with a p-value of $p = 0.079$ and normal looking Q-Q and box plots. Group one did not show normality in the Shapiro-Wilk test with a p-value of $p = 0.017$. Since the population was large and all other tests showed normality, normality of the data set of group one was assumed. Group two showed normality in the Kolmogorov-Smirnov test with a p-value of $p = 0.2$ and a normal looking Q-Q plot. Group two's box plot showed a few low outliers but nothing too extreme. Group two also did not show normality in the Shapiro-Wilk test with a p-value of $p = 0.009$. Again, since the population was large, and all the other tests showed normality, normality of the data set of group two was also assumed. Both group one and group two's means fall within a 95% confidence interval for their respected means (see Table 4).

Table 4

95% Confidence Interval of the Mean

Group	Mean	Std. Deviation	Lower Bound	Upper Bound
1 (non-co-req)	6.1864	1.38348	5.9352	6.4375
2 (co-req)	5.4872	1.39221	5.2824	5.692

Data analysis was then performed by running an independent samples t-test using the variable of mathematics self-efficacy comparing the two groups of students. The hypothesis was tested at the $\alpha = 0.05$ level of significance to determine if there was a significant difference between the means of group one and group two. For the independent samples t-test equal variances were not assumed. The null hypothesis assumed was that the means of the two groups were equal.

$$H_0 : \mu_1 = \mu_2$$

$$H_a : \mu_1 \neq \mu_2$$

Table 5

Independent Samples T-Test for Initial Survey Group 1 vs Group 2

t	df	Sig.	Mean Dif.	Std. Error Dif.	95% Confidence Int. of Difference Lower	95% Confidence Int. of Difference Upper
-4.267	253.874	0.000	-0.69914	0.16387	-1.02185	-0.37643

*sig = 0.000028

Table 5 shows the results of the independent samples t-test. The overall mean of students enrolled in a non-co-requisite College Algebra course was higher than the overall mean of students enrolled in a co-requisite College Algebra course. Using $\alpha = 0.05$ for a level of significance there is enough evidence to conclude that the mean self-efficacy score of students enrolled in a non-co-requisite College Algebra course is significantly different than the mean self-efficacy score of students enrolled in a co-requisite College Algebra course.

Non-co-requisite and persistent co-requisite College Algebra students' pre-survey

The findings of this portion of the quantitative data analysis show non-co-requisite College Algebra students' mathematics self-efficacy is statistically significantly different than their persistent co-requisite College Algebra peers pre-survey. During week 13 the MSES was administered again to only the co-requisite College Algebra students. From the beginning of the semester to week 13 when the survey was administered to the co-requisite College Algebra group, the number of participants in the co-requisite group changed. Although the means of the two groups of all the students who took the MSES survey during the first week of school showed a significant difference in their mathematics self-efficacy at the $p < 0.05$ level, a secondary t-test was performed, eliminating the co-requisite students who did not complete the second survey.

It was important to see if there was a significant difference between the non-co-requisite College Algebra group and just the students who persisted in the co-requisite College Algebra group. This helped to control for possible low self-efficacy scores from students who did not persist through the co-requisite College Algebra course. Statistical analysis of the non-co-requisite College Algebra group was then compared to the initial survey results from the co-requisite College Algebra group who participated in both the pre-and-post-surveys.

This reduced the number of participants in the co-requisite group to 112, but the non-co-requisite group's population remained at 119. Descriptive statistics were then generated for the variable of mathematics self-efficacy on the first survey between group one, non-co-requisite college algebra students, and group three, co-requisite college algebra students who took both the pre-and-post-survey (see Table 6).

Table 6

Descriptive Statistics for Initial MSES Scores for Group 1 and 3

Group	N	Mean	Std. Deviation	Std. Error Mean
1 (non-co-req)	119	6.1864	1.38348	0.12682
3 (co-req)	112	5.6673	1.32988	0.12566

Group one's data set did not change. Therefore, the normality of the data remained the same as in the previous analysis, where normality was assumed. Group three's data set was tested for normality. Group three showed normality with normal looking Q-Q and box plots. Group three did not show normality in the Kolmogorov-Smirnov test with a p-value of $p = 0.032$ and it also did not show normality in the Shapiro-Wilk test with a p-value of $p = 0.03$. Since the population was large and the other tests showed normality, normality of the data set of group three was assumed. Table 7 shows that both group one and group three's means fall within a 95% confidence interval for their respected means.

Table 7

95% Confidence Interval of the Mean

Group	Mean	Std. Deviation	Lower Bound	Upper Bound
1 (non-co-req)	6.1864	1.38348	5.9352	6.4375
3 (co-req)	5.6673	1.32988	5.4183	5.9163

Data analysis was then performed by running an independent samples t-test using the variable of mathematics self-efficacy comparing the two groups of students. The hypothesis was tested at the $\alpha = 0.05$ level of significance to determine if there was a significant difference between the means of group one and group three. For the independent samples t-test equal variances were not assumed. The null hypothesis assumed was that the means of the two groups were equal.

$$H_0 : \mu_1 = \mu_3$$

$$H_a : \mu_1 \neq \mu_3$$

Table 8

Independent Samples T-Test for Initial Survey Group 1 vs Group 3

					95% Confidence Int. of Difference	
t	df	Sig.	Mean Dif.	Std. Error Dif.	Lower	Upper
-2.907	228.895	0.004	-0.51908	0.17854	-0.87086	-0.16729

Table 8 shows the results of the independent samples t-test. The overall mean of group one, the non-co-requisite College Algebra students, was still higher than the overall mean of group three, the initial survey of co-requisite College Algebra students who completed both the pre-and-post-survey. Using $\alpha = 0.05$ for a level of significance there is enough evidence to conclude that the mean self-efficacy score of students enrolled in a non-co-requisite College Algebra course is significantly different than the mean self-efficacy score of students enrolled in a co-requisite College Algebra course who persist through the end of the semester. Although the student population for the co-requisite College Algebra group decreased by 61 students the two groups still showed significance in their mathematics self-efficacy at the $p < 0.05$ level.

Non-co-requisite and persistent co-requisite College Algebra students' post-survey

The findings of this portion of the quantitative data analysis show once again non-co-requisite College Algebra students' mathematics self-efficacy is statistically significantly different than their persistent co-requisite College Algebra peers post-survey. The initial surveys showed group one, the non-co-requisite College Algebra students, had a mean self-efficacy score higher than both group two, all initial co-requisite College Algebra students, and group three, initial co-requisite College Algebra students who complete both surveys. The mean of the non-co-requisite College Algebra students in group one was 6.1864 compared to group two 5.4872 and group three 5.6673. Since the results of the t-test showed a significant difference in the initial self-efficacy of non-co-requisite College Algebra students to co-requisite College Algebra students at the beginning of the semester, it was important to analyze whether there was still a significant difference in the co-requisite students' self-efficacy towards the end of the semester.

The non-co-requisite College Algebra students' initial survey results remained group one with no changes to the descriptive statistics or the normality tests. The co-requisite post MSES survey results administered at week 13 became group four. Table 9 shows the descriptive statistics for group 1 and 4.

Table 9

Descriptive Statistics for Initial MSES Scores for Group 1 and Post MSES Scores for Group 4

Group	N	Mean	Std. Deviation	Std. Error Mean
1 (non-co-req)	119	6.1864	1.38348	0.12682
4 (co-req)	112	5.7484	1.35445	0.12798

Group one's data set did not change. Therefore, the normality of the data remained the same as in the previous analysis, where normality was assumed. Group four's data set was tested for normality. Group four showed normality with normal looking Q-Q and box plots. It also showed normality in the Kolmogorov-Smirnov test with a p-value of $p = 0.2$ and the Shapiro-Wilk test with a p-value of $p = 0.781$. Since all tests showed normality, normality of the data set of group four was assumed. Both group one and group four's means fall within a 95% confidence interval for their respected means (see Table 10).

Table 10

95% Confidence Interval of the Mean

Group	Mean	Std. Deviation	Lower Bound	Upper Bound
1 (non-co-req)	6.1864	1.38348	5.9352	6.4375
4 (co-req)	5.7484	1.35445	5.4948	6.0020

Data analysis was then performed by running an independent samples t-test using the variable of mathematics self-efficacy comparing the two groups of students. The hypothesis was tested at the $\alpha = 0.05$ level of significance to determine if there was a significant difference between the means of group one and group four. For the independent samples t-test equal variances were not assumed. The null hypothesis assumed was that the means of the two groups were equal.

$$H_0 : \mu_1 = \mu_4$$

$$H_a : \mu_1 \neq \mu_4$$

Table 11

Independent Samples T-Test for Initial Survey Group 1 vs Group 4

					95% Confidence Int. of Difference	
t	df	Sig.	Mean Dif.	Std. Error Dif.	Lower	Upper
-2.431	228.640	0.016	-0.43793	0.18018	-0.79295	-0.08291

Table 11 shows the results of the independent samples t-test. The overall mean of group one, the non-co-requisite College Algebra students, was still higher than the overall mean of group four, the post-survey of co-requisite College Algebra students who completed both the pre-and-post-survey. Using $\alpha = 0.05$ for a level of significance there is enough evidence to conclude that the mean self-efficacy score of students enrolled in a non-co-requisite College Algebra course is significantly different than the mean self-efficacy score of students enrolled in a co-requisite College Algebra course who persist through the end of the semester. Although the student population for the co-requisite College Algebra group was surveyed in week 13 and the overall mean of the group increased from the initial survey of 5.4872 to the post survey 5.7484, students in non-co-requisite College Algebra still showed significance in their mathematics self-efficacy at the $p < 0.05$ level to co-requisite College Algebra students.

Difference in Mathematics Self-Efficacy in Co-Requisite College Algebra

Difference in pre-and-post-surveys for all co-requisite College Algebra students

The findings of this portion of the quantitative data analysis show students enrolled in co-requisite College Algebra have no statistically significant difference in their mathematics self-efficacy over a 13-week period of time. However, the post-surveys did show an increase in mathematics self-efficacy, just not at the significant level. For the second part of the quantitative phase, only data from the co-requisite College Algebra students who took both the pre-and-post-surveys were participants in the data analysis. The pre-survey was given to all students the first week of class. The post-survey was given during week 13 and was only given to students who took the pre-survey. The total number of participants for the co-requisite College Algebra portion who took both surveys was 112, 38 males and 74 females. The distribution of ages of the co-requisite College Algebra participants can be viewed in Figure 7.

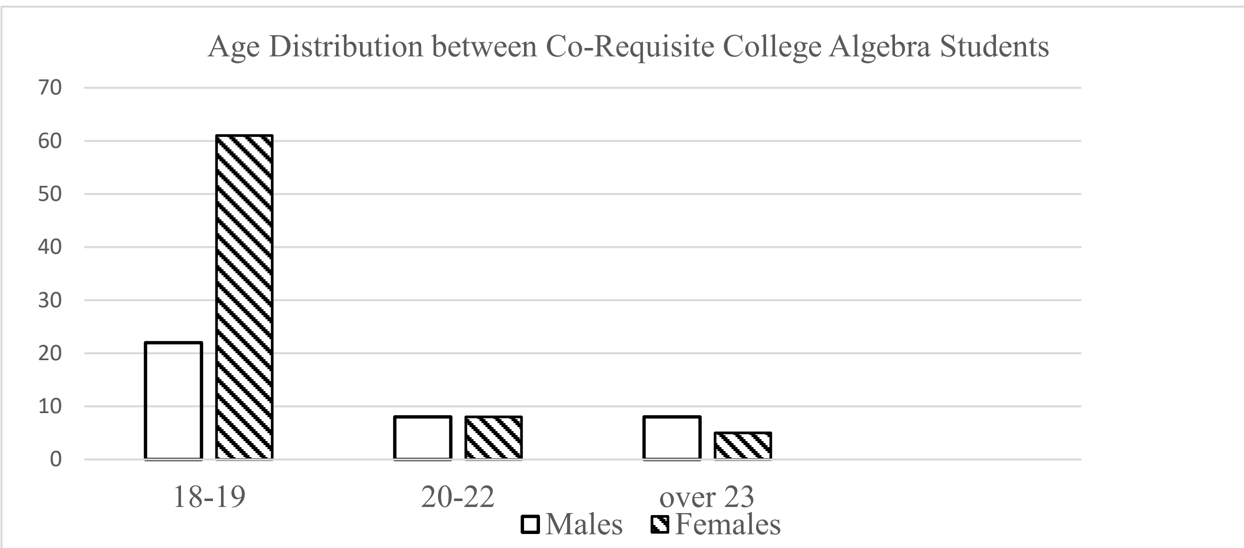

Figure 7. Age Distribution between Groups for Co-Requisite Initial Survey

Descriptive statistics were generated for the variable mathematics self-efficacy for the pre-survey scores, the post-survey scores, and the difference (post– pre)-survey scores (see Table 12).

Table 12

Descriptive Statistics for Pre, Post, and Difference

Group	N	Mean	Std. Deviation	Std. Error Mean
pre	112	5.66728	1.32988	0.12566
post	112	5.74842	1.35445	0.12798
difference	112	0.08115	1.05532	0.99719

All three data sets were tested for normality. The pre-and-post-group had already been tested for normality in part one of the quantitative data analysis. The pre-group showed normality with normal looking Q-Q and box plots but did not show normality in either the Kolmogorov-Smirnov test with a p-value of $p = 0.032$ or the Shapiro-Wilk test with a p-value of $p = 0.03$. Since the population was large and the other tests showed normality, normality of the data set of the pre-group was assumed. The post-group showed normality with normal looking Q-Q and box plots, as well as normality in the Kolmogorov-Smirnov test with a p-value of $p = 0.2$ and the Shapiro-Wilk test with a p-value of $p = 0.781$. Since all tests showed normality, normality of the data set of the post group was assumed. The difference group (post – pre-scores) showed normality in the Kolmogorov-Smirnov test with a p-value of $p = 0.2$ and the Shapiro-Wilk test with a p-value of $p = 0.714$. The Q-Q and box plots also looked normal and showed normality, so normality of the difference group was assumed. Table 13 shows that all three group's means fall within a 95% confidence interval for their respected means.

Table 13

95% Confidence Interval of the Mean

Group	Mean	Std. Deviation	Lower Bound	Upper Bound
pre	5.66728	1.32988	5.4183	5.9163
post	5.74842	1.35445	5.4948	6.002
post-pre	0.08115	1.05532	-0.11645	0.2787

Data analysis was then performed by running a paired-samples t-test using the variable of mathematics self-efficacy comparing the pre-and-post-survey scores of co-requisite College Algebra students. The hypothesis was tested at the $\alpha = 0.05$ level of significance to determine if there was a significant difference between the pre-and-post-scores. The null hypothesis assumed was, there was no difference (d) between the pre-and-post-scores (see Table 14).

$$\mathrm{H}_0 : \mu_d = 0$$

$$\mathrm{H}_a : \mu_d \neq 0$$

Table 14

Paired-Samples Correlations

	N	Correlation	Sig
post - pre	112	0.691	0.000

Table 15

Paired-Samples T-Test for Pre-Post Co-Requisite College Algebra Students

Mean	Std. Dev.	Std. Error Mean	95% Confidence Int. of Difference Lower	95% Confidence Int. of Difference Upper	t	df	Sig. (2-tailed)
0.08115	1.0553	0.0997	-0.1164	0.2787	0.814	111	0.418

Table 15 shows the results of the paired-samples t-test. The overall mean of the post-survey was only slightly higher than the overall mean of the pre-survey. Using $\alpha = 0.05$ for a level of significance there is enough evidence to conclude that the true mean of the mathematics self-efficacy scores of students enrolled in co-requisite College Algebra did not change significantly from the pre-to-post-survey. Since the overall co-requisite College Algebra self-efficacy scores did not change from the pre-to-post-survey, other variations of the pre-to-post-survey were run to see if any specific groups of student's mathematics self-efficacy were significantly different from the beginning to the end of the semester.

Difference in pre-and-post-surveys for co-requisite College Algebra by gender

The findings of this portion of the quantitative data analysis show that by gender students enrolled in co-requisite College Algebra have no statistically significant difference in their mathematics self-efficacy over a 13-week period. All variations of the pre-and-post-survey were run using paired-samples t-test for the difference in (post – pre)-survey scores. The first variation was broken up by gender of the students. Descriptive statistics were run (see Table 16) and paired samples correlations for gender were run (see Table 17).

Table 16

Descriptive Statistics for Gender Pre, Post and Post - Pre

Group	N	Mean	Std. Deviation	Std. Error Mean
male pre	38	5.837	1.389	0.225
male post	38	5.738	1.539	0.250
male post-pre	38	-0.100	1.071	0.997
female pre	74	5.580	1.299	0.151
female post	74	5.754	1.260	0.147
female post-pre	74	0.174	1.042	0.121

Table 17

Paired-Samples Correlations for Gender

	N	Correlation	Sig
male post – pre	38	0.737	0.000
female post – pre	74	0.669	0.000

Table 18

Paired-Samples T-test for Post – Pre for Gender

				95% Confidence Int. of Difference				
	Mean	Std. Dev.	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
male	0.100	1.071	0.174	-0.452	0.252	-0.575	37	0.569
female	0.174	1.042	0.121	-0.067	0.416	1.437	73	0.155

Table 18 presents the results of the paired-samples t-test. The overall mean of the pre-survey for males was slightly higher than the overall mean of the post-survey for males. The overall mean of the pre-survey for females was slightly lower than the overall mean of the post-survey for females. However, using $\alpha = 0.05$ for a level of significance, both the male and female paired-samples t-test did not show significance between means.

The paired-samples t-test for gender did show several interesting insights about mathematics self-efficacy between genders. The 5.837 pre-survey mean score for males was higher than the 5.580 pre-survey mean score for females. Over the course of the semester, males' mathematics self-efficacy decreased from a pre-survey score of 5.837 to a post-survey score of 5.738. However, over the course of the semester, females' mathematics self-efficacy increased from a pre-survey score of 5.580 to a post-survey score of 5.754. The post-survey mean score for females of 5.754 ended up being slightly higher than the post-survey mean score for males of 5.738. So, over the course of a semester it seems that the mathematics self-efficacy of females enrolled in a co-requisite College Algebra course increased, while the mathematics self-efficacy for their male counterparts decreased.

Difference in pre-and-post-surveys for co-requisite College Algebra by age

The findings of this portion of the quantitative data analysis show that by age students enrolled in co-requisite College Algebra have no statistically significant difference in their mathematics self-efficacy over a 13 week period of time. The second variation of paired-samples t-test was run using the different age groups of students enrolled in co-requisite College Algebra. The age groups were broken down into the following intervals; 18-19, 20-22, and over 23. These intervals were chosen based on the following assumptions: the 18-19 age group represents traditional college freshmen, the 20-22 age group represents students who have been in college but are not in their freshmen year, and the over 23 group represents students coming back to college. Of course, these are simply representations, there could be some overlap as far as the classification of students. For example, a twenty-three year-old could possibly have been in college continuously but only be a part-time student, thus taking more than the traditional four to five years to graduate. Descriptive statistics were run (see Table 19) and paired samples correlations for age were run (see Table 20).

Table 19

Descriptive Statistics for Age Pre, Post, and Post – Pre

Group	N	Mean	Std. Deviation	Std. Error Mean
18-19 pre	83	5.489	1.296	0.146
18-19 post	83	5.567	1.326	0.142
18-19 post-pre	83	0.078	1.033	0.113
20-22 pre	16	5.871	1.396	0.349
20-22 post	16	6.101	1.458	0.365
20-22 post-pre	16	0.300	0.978	0.245
23+ pre	13	6.554	1.145	0.317
23+ post	13	6.471	1.159	0.322
23+ post-pre	13	-0.084	1.327	0.368

Table 20

Paired-Samples Correlations for Age

	N	Correlation	Sig
18-19 post - pre	38	0.690	0.000
20-22 post - pre	74	0.766	0.001
23+ post - pre	13	0.337	0.261

Table 21

Paired-Samples T-Test for Post – Pre for Gender

	Mean	Std. Dev.	Std. Error Mean	95% Confidence Int. of Difference Lower	Upper	t	df	Sig. (2-tailed)
18-19	0.078	1.033	0.113	-0.147	0.304	0.691	82	0.492
20-22	0.300	0.978	0.245	-0.291	0.751	0.940	15	0.362
23+	-0.084	1.327	0.368	-0.886	0.718	-0.227	12	0.824

Table 21 presents the results of the paired-samples t-test. The overall mean of the pre-survey for 18-19 year-olds and 20-22 year-olds was slightly lower than the overall the mean of the post-survey for each respective group. But, the overall the mean of the pre-survey for ages 23 and older was slightly higher than the overall mean of the post-survey for ages 23 and older. Using $\alpha = 0.05$ for a level of significance all different age groups; 18-19, 20-22, and over 23, paired-samples t-test did not show significance between means.

The paired-samples t-test for age groups did provide several interesting insights about mathematics self-efficacy between ages. The 20-22 year-old age group had the largest increase from a pre-survey mean score of 5.871 to a post-survey mean score of 6.101. However, this increase was still slight. Although, the mathematics self-efficacy did not significantly change over the course of the semester for any given age group, it seems that 18-22 year-olds enrolled in a co-requisite College Algebra course increased their mathematics self-efficacy, but those students over 23 in the same course decreased their mathematics self-efficacy.

Qualitative Data Results

The purpose of the qualitative phase of this study was to first gain understanding and explanation of the perceptions students have during their time in a co-requisite course. The second purpose of the qualitative data analysis was meant to enrich the understanding of the quantitative survey results for the overall group by filling in missing information that the survey could not show. Thus providing possible context for research question two.

The qualitative data analysis aims to answer question three which focused on the perceptions of students who were enrolled in a co-requisite mathematics course, regardless of whether they had an increase, a decrease, or no-change in their mathematics self-efficacy. Due to the results of the second part of the quantitative data analysis, which showed there were no significant changes in the mathematics self-efficacy of students enrolled in a co-requisite College Algebra course over a semester, I chose to interview participants whose overall mathematics self-efficacy increased, decreased or remained the same over the course of the semester.

The qualitative phase of this study utilized purposeful, or qualitative sampling, to achieve representativeness of those participants whose overall mathematics self-efficacy scores increased, decreased or remained the same over the course of the semester (Teddlie & Yu, 2007). From the surveys, initially 26 participants gave their permission to be contacted for an interview. Ten participants were selected from the initial interview pool of 26 (see table 22).

Table 22

Qualitative Interview Participants

Participant	Gender	Age	Pre Score	Post Score	Difference Post-Pre
5	M	34	6.38	7.12	0.74
7	M	32	5.53	6.09	0.56
6	F	19	4.79	6.53	1.74
10	F	40	5.65	6.62	0.97
9	M	19	5.76	5.21	-0.55
8	M	19	5.24	2.94	-2.3
2	F	45	6.47	5.44	-1.03
3	F	19	6	4.74	-1.26
1	M	33	8.32	8.68	0.36
4	F	18	4.82	4.76	-0.06

The Qualitative data for this study were collected by conducting semi-structured interviews with purposefully selected participants from the quantitative results. Qualitative participants were assigned a number one through ten. I conducted ten 15-20 minute interviews in a small conference style room in the library of the university where the study was taking place during weeks 14 to 16 of the 16-week semester. The interviews were one-on-one and face-to-face with me acting as the primary interviewer. Figure 8 shows a sample of the initial interview questions.

1) Can you describe your experience in this course?

2) What was the best part of this class that you would like to see in other math classes?

3) Elaborate on your confidence in mathematics?

Figure 8. Sample Questions from the Semi-Structured Interview

Emergent Themes from Interviews

The qualitative data analysis aimed at answering two questions. The first question was, "How do the perceptions of students enrolled in co-requisite mathematics help to explain the trends in mathematics self-efficacy of co-requisite mathematics students?" The quantitative data revealed there was a slight increase in the mathematics self-efficacy of co-requisite students over the 13-week period, however there was not a significant change. Since overall there was a slight increase in mathematics self-efficacy it was important to determine if any common themes emerged in the different groups of participants: those with increased, decreased, or no change in mathematics self-efficacy. The second question that the qualitative data analysis aimed to answer is, "Regardless of a student's change in self-efficacy what perceptions do they have of the class, and what helped them to feel successful in the class?" The overall descriptions from the participants about how the class worked provided better insight on what teaching practices worked best for success in co-requisite mathematics remediation.

Using these two overall driving questions, interviews of participants began. Inductive and deductive reasoning were used to read through transcripts to find common stands of information that could be placed into themes and then sub-themes. The following findings emerged: community, multiple representations of material, support, and soft skills.

Before addressing each theme and sub-themes it is important to understand the individual participants interviewed. In Figure 9 the interviewees are group by certain factors that their responses highlighted in some way.

Increase on the MSES	Decrease on the MSES	No-Change on the MSES
5, 6, 7, 10	2, 3, 8, 9	1, 4

Traditional Student	Non-Traditional Student
3, 4, 6, 8, 9	1, 2, 5, 7, 10

Male	Female
1, 5, 7, 8, 9	2, 3, 4, 6, 10

Business	Nursing	Engineering	Funeral Services	Undecided
2, 1, 5, 6	3, 4, 7	9	10	8

Class Met 5 Days a Week	Class Met Back-to-Back Two Nights a Week
3, 4, 6, 7, 8, 9, 10	1, 2, 5

Figure 9. Description of Interview Participants

Figure 9 presents which participants had an increase, decrease, or no change in their mathematics self-efficacy on the MSES pre-to-post-survey score. An increase or decrease in self-efficacy score on the MSES was set at a minimum of 0.5 points higher or lower than the original score. Participants were placed in the traditional category if they stated in their interview that this was their first year in college after high school. They were considered non-traditional if they were returning to college after any period. All participants interviewed were traditional college freshmen, or non-traditional students returning to college after several years. There were no participants interviewed that did not fit into one of these two categories. The participants were also asked to provide their declared major to help give insight on how many more math classes they may need before graduation. Of the ten participants interviewed, four were business majors needing many more mathematics classes including Business Calculus, three were nursing majors needing only one statistics class, one was an engineering major needing many more mathematics classes including Analytical Calculus, one was a funeral services major not needing any more mathematics, and one was undecided regarding a major.

At the university where this study took place the co-requisite College Algebra course is a three-hour credit bearing College Algebra course with a three-hour non-credit bearing support course and has two different structures of meeting times. The first requires students meet five days a week with two different instructors. On Tuesday and Thursday the students attend a 75-minute College Algebra course with one instructor. On Monday, Wednesday, and Friday the students attend a 50-minute support course with a different instructor. The second scheduling structure requires students meet only two nights per week with the support course immediately following the College Algebra course. On Tuesday and Thursday students meet in the evening for a 75-minute College Algebra course with one instructor followed by an additional 75-minute support course with a different instructor.

Each interview began with the initial question: “Can you describe your experience in this mathematics course?” From the initial response follow-up questions were asked about the participant’s instructors, homework, in class groups etc. Often participants were asked to elaborate on explaining one of their previous statements or responses. Analysis of interview data revealed four major themes: ***community, multiple sources and multiple modes of instruction, support,*** and ***soft skills*** with sub-themes to support each major theme. Figure 10 illustrates the themes and sub-themes derived from the interviews.

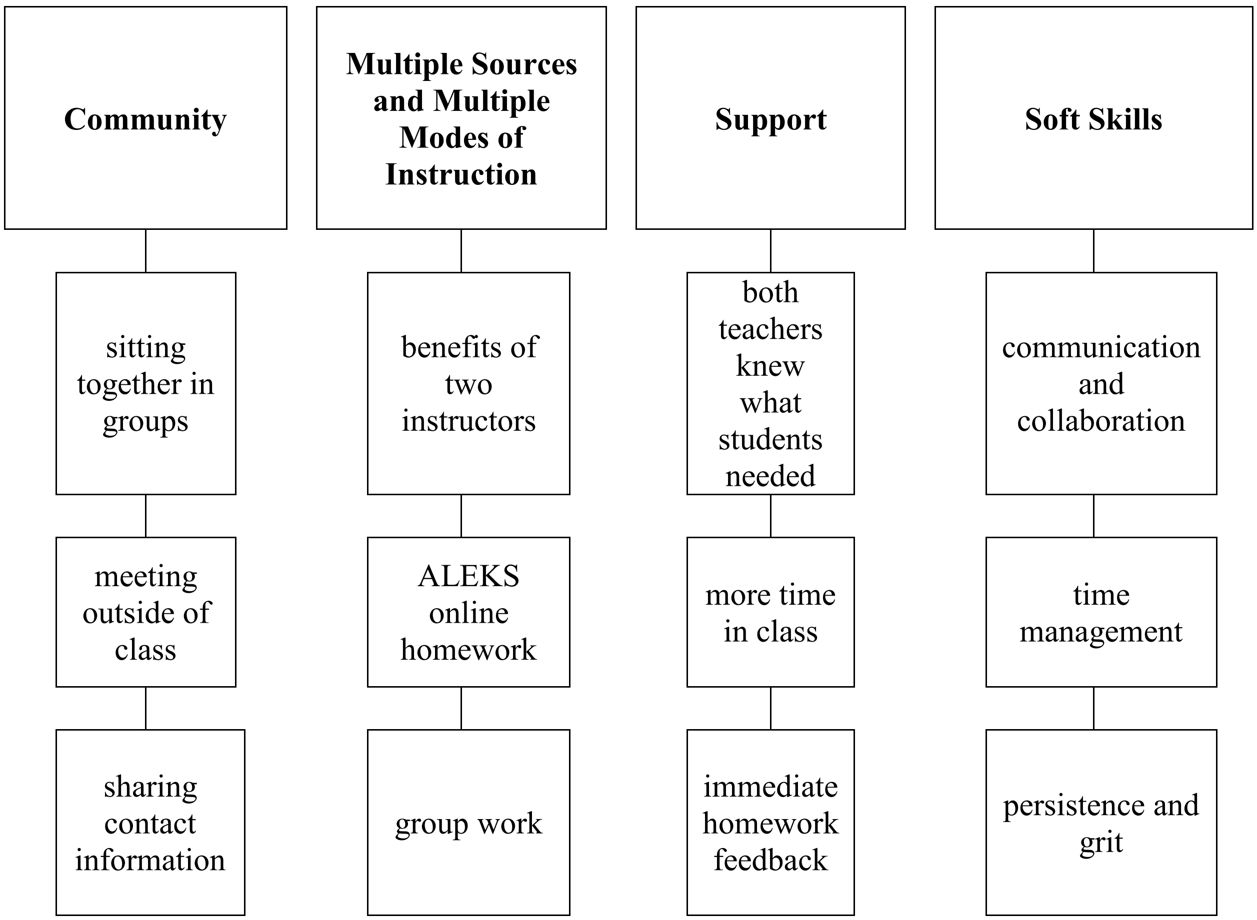

Figure 10. Themes and Sub-Themes of Qualitative Data

Community

The first finding that emerged in the qualitative data was the theme of community. All ten participants interviewed mentioned, in one form or another, the idea of a learning community. Wegner (2000) describes communities of learning as, "communities of practice that grow out of convergent interplay of competence and experience that involves mutual engagement: they offer an opportunity to negotiate competence through an experience of direct participation" (p. 229). Within the participants' interviews common themes emerged early about the idea of community. Participants described where they sat in class, who they regularly talked with and described meeting outside of class. From these descriptions three sub-themes developed under the theme of community: ***sitting together in groups, meeting outside of class,*** and ***sharing contact information***.

Sitting together in groups

Initially interview participants described both classroom settings. In their descriptions, comments were made about the seating arrangement, specifically how they sat with the same groups of people in both classrooms. All ten participants talked about the group of people they sat by every day. In all but one interview, the participants did not know anyone in the class before the first day. Participant 6 stated that, "I took this course with my friends, we did it all together and were there together every day, we all made it through as one." The participants described the individuals they sat with daily as "my group." Throughout the interviews, eight of the ten participants used the term "my group" on at least one occasion. When asked to clarify if the group they were talking about was a group assigned by the instructor, the interviewee would always describe the group as people sitting at their own table. Of the ten participants interviewed two participants who had a decrease in mathematics self-efficacy, one participant who had no change in mathematics self-efficacy, and two participants who had an increase in mathematics self-efficacy stated that their group worked together to solve problems and helped each other by explaining concepts not fully understood by all. Interview participant 7, who had an increase in mathematics self-efficacy stated, “I sat by the same people every day, but I usually worked alone, others at the table worked together and seemed to like it.”

After the initial description from the participants of sitting in groups I followed up with questions such as; “Did you ever meet with this group outside of class?” and “Did you interact through texting or any other sort of social media with anyone from the class?” Through these secondary questions the interview participant’s responses revealed interesting findings. In the following findings I will be discussing the interview participants by number. Interview participants 2, 3, 8, and 9 had decreases in their mathematics self-efficacy, participants 1 and 4 had no change in their mathematics self-efficacy, and participants 5, 6, 7, and 10 had increases in their mathematics self-efficacy.

Meeting outside of class

The participant’s responses from meeting outside of class were one of the following; never met outside of class, met right before class, or met outside of class different days or times. Participants 6 and 10 met multiple times other than class, especially before exams. They both stated they met at least once a week. Participant 6 knew the group she met with prior to being in the co-requisite course and described the group as her friends. Participant 10 did not know anyone in her group before being in the co-requisite course but described setting up regular meeting times and anyone in the group who was available would meet up at that time. She stated that sometimes only two people would show up but other times all five would be there, especially before the exams. Participants 1, 4, and 5 met right before class started. Participants

1 and 5 who had class back-to-back two nights a week described meeting with their group in the hallway an hour before each class started. Participant 5 stated, "I met up with the same few people before every class to discuss what we didn't understand and to try to help each other." Participant 4 who took the course five days a week met with her group before class began on quiz and exam days. Participants 2, 3, 8, 9, and 7 claimed they never met outside of class with anyone from the course. Participant 7 said, "I was not able to meet up with the others outside of class because I worked full time." Participant 7 knew that his group did meet regularly but he was not able to attend do to his work schedule. Participants 2, 3, 8 and 9, who all had decreases in their mathematics self-efficacy, never met outside of class and all four of them stated they were not aware of anyone from their class meeting outside of class.

Sharing contact information

The participant's responses about communicating outside of class fell into one of the following; exchanged contact information, exchanged contact information but never used it, did not exchange contact information. Participants 2, 4, 6, and 10 had contact information from other students in the class and used it to communicate with others on a regular basis. Participant 2 and 4 texted the same person regularly about questions from class. Participant 4 also claimed that in addition to texting the same person regularly, "my group also used Snapchat to help each other." Participant 6, who took the class with her friends said, "I did not contact anyone new from class but talked to my friends about class every day." Participant 10 said, "my instructor encouraged us to get each other's phone numbers the first day of class, we did and then we would text each other throughout the week." Participants 1, 7, and 9 exchanged contact information on the first day but never used it to contact anyone in the class. Participant 9 said, "I did my own thing out of class, but others communicated on group chats, I just didn't participate."

Participants 3, 5, and 8 never exchanged contact information from anyone in the course. Participants 3 and 8 had a decrease in their mathematics self-efficacy but participant number 5 had an increase in his mathematics self-efficacy. It is interesting that participants 2, 4, 6, and 10 communicated regularly with students outside of class were all female. However, participant number 3 claimed to never exchange contact information and was also female.

Summary of community theme

In all, each participant interviewed described being part of a community. For participants 7 and 9 they only fit into the sub-theme of sitting together in groups in both classes. However, each one stated he knew about other options such as meeting outside of class or students communicating through text or Snapchat, even though he chose not to be a part of anything happening outside of class. Of the four participants having an increase in their self-efficacy, (participants 5, 6, 7, and 10), participants 5, 6, and 10 were in at least two of the three sub-themes that can be seen below. Participant 7 worked a full-time job and claimed he knew about the different ways students were working together, but because of his work restriction he was not able to participate.

sitting together in class	**meeting outside of class**	**sharing contact information**
1, 2, 3, 4, 5, 6, 7, 8, 9, 10 specifically claimed group helped them learn in class 3, 4, 8, 5, 10	1, 4, 5, 6, 10	2, 4, 6, 10

Figure 11. Sub-Themes of the Community Theme

Multiple Sources and Multiple Modes of Instruction

The second finding that emerged in the qualitative data was the theme of multiple sources and multiple modes of instruction. All ten participants interviewed mentioned in one form or another the idea of learning from multiple sources in multiple ways. Multiple teaching strategies suggest that students learn best when presented material in different ways and can interact with mathematical topics in a multitude of ways (Sulaiman, Abdurahman, & Rahim, 2010; Modebelu & Ogbonna, 2014). During the interview, participants were first asked to describe how their co-requisite mathematics course worked. In each participant's description of the course they commented on having two different instructors, one for the College Algebra class and one for the support course. They also all commented on the online homework system called ALEKS. As a follow up to the first question, I asked, "How did you feel about having two different instructors?" and "Tell me more about the ALEKS homework system." From these descriptions common themes emerged supporting the idea of multiple sources and multiple modes of instruction. Several sub-themes emerged as participants described, multiple sources and multiple modes of instruction: ***the benefits of two instructors, the way the ALEKS online homework system worked,*** and ***how working in their groups helped them learn***.

Benefits of two instructors

Of the ten participants interviewed, nine participants specifically stated they liked having two different teachers. Two of the nine participants only stated they liked the two different teachers. One of them said, "my support teacher was easier to talk to." The other seven participants commented on the helpfulness of having two different explanations, or two different ways of showing the same problem. Participant number 9, who had a decrease in mathematics self-efficacy said, "I liked having two teachers, everyone learns differently and hearing the same thing a different way helped me." Participant number 1, who had no change in mathematics self-efficacy, stated, "I liked the different teaching styles and different explanations and multiple ways the material was taught by both teachers." Participant number 5, who had an increase in mathematics self-efficacy, commented that, "Many examples with two different explanations plus ALEKS was just great, the teachers not teaching exactly the same way really helped." The other participants had similar comments. It seemed that participants not only liked having different explanations but also many different problems to solve. Participant number 10 stated, "I liked hearing the material again the next day in a different way. It was never a repeat, just more application and practice."

ALEKS online homework

Each participant interviewed also positively described the ALEKS online homework program. ALEKS is an adaptive online mathematics learning program that determines what a student knows, what they do not know, and what they are most ready to learn. ALEKS only allows the student to work on topics they are ready to learn and have a 94% or better chance of getting correct. A student must answer three different questions correct in a row to receive credit for the topic. Out of the ten participants who described the ALEKS program six specifically talked about ALEKS showing a different way of learning a particular topic. Participant 7 commented, "ALEKS is a great program that shows you a reminder of what you did in class and lets you practice. It really helped strengthen what we learned and helped make it stick. It did a great job of refreshing my memory with the examples." Participant 9 said, "ALEKS does a good job explaining step-by-step then lets you practice, so if I missed the topic from both professors I at least got to see it again in ALEKS." The participants' comments about ALEKS either filling in the gaps or showing a new example of a mathematical topic reinforces the idea of multiple sources and multiple modes of instruction.

Group work

Another way multiple sources and multiple modes of instruction manifested itself during the interviews was through the participants description of working in groups. Where being in a group was highlighted in the community theme, this sub-theme focuses on the learning of the participant when working in a group. Seven of the ten interview participants specifically talked about the benefit of working with others in the class. Three participants mentioned that because they were in the support course they had time to work with others during class. Participant number 10 said, "the support course gave me more time, the teacher would have us work in groups during the support course on either problems or ALEKS. The people around me really helped me a lot." Participant number 2 stated, "I liked getting to go deeper in the support course because we had time. We would work together. The people at my table could show me a different way of doing a problem. It really helped." By being able to work with other students in groups the participants in the interviews described yet another way they were able to understand a topic.

Summary of multiple sources and multiple modes of instruction

All in all, participants interviewed highlighted in their opinion the importance of multiple representation of mathematical topics and material. Each participant commented on the importance of at least two sub-themes of learning a topic in more than one way. Every participant explained they felt it was a positive experience being able to learn a topic with multiple different explanations.

2 teachers, 2 different explanations	ALEKS online homework	group work
1, 2, 3, 4, 5, 7, 8, 9, 10	1, 5, 6, 7, 9, 10	2, 3, 4, 5, 6, 8, 10

Figure 12. Sub-Themes of Multiple Sources and Multiple Modes of Instruction

Support

The theme of support emerged as participants repeatedly described different forms of support that they felt the co-requisite College Algebra course offered. No one specific question was asked in relation to support within the course. However, though the participant's rich and candid interviews three sub-themes emerged to form the overall theme of support. The sub-themes for support are: ***both teachers having an understanding of what the students needed, more time in class,*** and ***immediate homework feedback.***

Teachers understanding of student's needs

All ten interview participants talked about the support course aspect of their co-requisite College Algebra class in great detail. A student not in need of remediation takes a three-hour College Algebra course for credit. However, a student in need of remediation takes a six-hour co-requisite College Algebra course but only receives credit for three-hours upon successful completion of the course. Participants described the mathematics course as one continuous course even though they had two different instructors and often met five days a week. Participants used the terms "Algebra Class" and "Support Class" regularly throughout their interviews.

Eight interview participants described needing the two courses and two instructors because they felt it took both to help them be successful. Four participants described the support course as a place to prepare the students for the College Algebra material. Participant 3 stated, “we pre-learn topics in the support course and that helps save time in the College Algebra course, so everyone was ready for the College Algebra stuff every day.” Three of the participants described the support course as being a place to apply the rote information they learned in the College Algebra course. Participant number 5 commented, “the College Algebra course was lecture only, the support course was the practical part, real life examples. The support teacher filtered down the information and helped make it easier to understand. She gave tips and tricks to help you remember.” Participants 4, 5, 6, 7, 8, and 9 described how they felt the instructors for both classes really took the time to know what each student needed extra time or help with. Participant 4 summarizes this idea by stating, “this is different than high school. If you didn’t get it in high school, you just didn’t and had to move on to the next thing. Here with the two classes the teachers knew what we needed more work on and just would make it happen.” Participant 5 echoed the previous statement by explaining, “the teachers really knew what we were struggling with the most and they always took the time to catch us up.” As much as there was a description of the instructors understanding the needs of the participants, there was just as much of a sense of the participants feeling they needed the extra time provided by the co-requisite course.

More class time

All ten participants interviewed discussed the amount of time they were in the co-requisite course and how they felt they needed this time to be successful. Nine of the ten participants specifically stated they felt they needed the extra support course for success. Participant number 6 stated they did not feel they needed the support course but they needed the time in the class, specifically “the support course helped me review and the teachers helped us with our homework. Going everyday helped me not get behind." Participants seemed to agree that the time provided in the support course was crucial to the success in the course by providing time to: review, work on homework, apply material, and reduce student stress.

Each participant highlighted different ways the extra time from the co-requisite course was a benefit to them. Participants 5, 6, 7, 8, and 9 commented they felt like the time available to review either topics for quizzes or exams was critical to their success in the co-requisite course. Participant number 8 said, "we reviewed for quizzes and exams. We had to practice the problems a lot. It was good for someone like me who struggles to be forced to do many problems." Participants 1, 3, 6, 7, and 10 explained that the extra time allowed in the co-requisite course helped them to be able to work on homework with support from either the instructor or their peers. Participant 6 shared, "I liked the ALEKS days the best out of all the stuff we did in class, because I could work on my homework and get help on the stuff I didn't understand instead of just listening to the teacher explain something I already know." Participants 1, 2, 4, and 9 described the extra time provided by the co-requisite course was a way for the hard topics of College Algebra to be applied in an everyday manner. Participant number 9 explained, "the College Algebra teacher would lecture but then the support teacher would go into depth and help you actually understand and process what you heard the day before. She would show us how to use the math." Eight of the ten participants used the word stress and explained how the co-requisite course helped to take some of the stress out of the College Algebra course. Participant 8 summed up many feelings when he stated, "I was not prepared for College Algebra because I did not have a math class my senior year. I was stressed about having six hours of math but the six hours wasn't harder it; was just to help me. The six hours actually made me successful and not stressed." The extra class time provided different positive experiences for different participants. However, the common sub-theme of extra time in class was one of the main supports participants viewed as helping them to be successful.

Immediate homework feedback

The last sub-theme for support was the immediate feedback the ALEKS online homework system provided. In the previous theme of multiple sources and multiple modes of instruction, the ALEKS program was described in detail. When students are working in the ALEKS program they immediately know if an answer they submit is correct or not. If a student enters a wrong answer the program shows them the correct answer and then sends the student through a review problem. There are deadlines set up in ALEKS but a student may work ahead if he desires. Out of the ten participants interviewed five explained they liked the immediate feedback ALEKS offered. Participant number 10 said, "I liked the immediate feedback in ALEKS, knowing if I was right or wrong not just working out many problems to only find out later they were all wrong." Five participants interviewed also talked about liking ALEKS because they could work at their own pace and specifically work ahead. Participant number 1 stated, "I liked being able to work ahead in the homework so I knew what I didn't understand and then I was able to ask better questions during class."

Soft Skills

The final theme that emerged from the interview data was the theme of soft skills. Soft skills are not the academic material students are taught but rather all the other skills necessary for success, such as time management, collaboration, communication skills, persistence and grit. Merz (2014) states "as a veteran math teacher, I'd argue that a student proficient in the soft skills but who struggles academically is better prepared for the next step than his or her straight-A peers who lack skills like self-management or grit" (p. 18). During their interviews the participants described the theme of soft skills as sub-themes of ***communication and collaboration, time management,*** and ***persistence and grit.***

Communication and collaboration

Some of these soft skills have already been highlighted within the other categories developed from the interview data. Communication and collaboration were discussed in the themes of community and multiple sources and multiple modes of instruction though the participants working together in groups either inside or outside of the classroom. Eight of the ten participants claimed they worked together either meeting face to face or though digital media though out the semester and claimed these communities of learning helped them be successful. Participant number 10 stated, "I feel that in order to be successful in my future classes, I need to really meet people and network."

Time management

Time management was discussed in the support theme under the sub-theme of more time in class. Five of the ten participants commented on having time to review for quizzes and exams; and five participants explained that the extra time spent in class allowed them to work on their homework. Participants conveyed an importance of studying and making time for homework to learn the material and be successful. Participant number 6 who is an accounting major and has to take Business Calculus next shared, "honestly I think I will do fine in my next math class. I know I have to go to every class and stay up with all my homework and study for every quiz and exam."

Persistence and grit

The sub-theme of persistence and grit emerged from the participants descriptions of how they felt at the beginning and end of the co-requisite course, as well as how they feel about their next mathematics course if applicable. Eight of the ten participants, 2, 3, 8, and 9 who had a decrease in mathematics self-efficacy, 4 who had no change in mathematics self-efficacy, and 5, 7, and 10 who had an increase in mathematics self-efficacy, stated they were scared or nervous at the beginning of the semester. Participant 8, who is an electrical engineering major and needs Trigonometry next stated, "at the beginning I was scared, I am not good at math and never will be. I am still nervous about Trig but I know I can do good if I just practice every day and get help as soon as I do not understand." Participant 8 was the only participant out of the eight, who claimed he was scared or nervous at the beginning of the course, and stated he was still nervous. He specifically said, "I am not good at math and never will be." The other seven participants made comments that they did not struggle as much at the end as in the beginning and that they feel good about their next mathematics classes. Participant number 3 who is a nursing major and needs Statistics for the Sciences next explained, "I don't feel like I struggle as much now as in the beginning. I am still a little apprehensive about statistics, but I should be okay because I have learned how to memorize formulas, how to study, and how to do extra problems when I need to." Participant number 5 who is an accounting major and has to take Business Calculus next said, "I know what to expect in math courses now. I am ready for my next class and look forward to more math classes now that I have the basics down. I have learned how to be a math student." Of the eight participants none of them stated the next class should be easy, but they collectively explained what it would take to have success in their next mathematics course. In all cases persistence and grit were highlighted in comments about going to class, studying, and doing all assigned homework. Three participants talked about meeting students in their new classes and working together. Two participants mentioned getting help in the class as soon as they needed it from either the instructor, a peer, or a tutor.

Summary of Mixed Methods Data Results

From part one of the quantitative data analysis the results of the independent samples t-test show the mean of group one, the non-co-requisite College Algebra students, was 6.1864 with a standard deviation of 1.38348 and the mean of group two, the co-requisite College Algebra students, was 5.4872 with a standard deviation of 1.39221. The "sig" value determined by the independent samples t-test was $p = 0.000028$ using $\alpha = 0.05$ for a level of significance, there is enough evidence to conclude that the mean self-efficacy score of students enrolled in a non-co-requisite College Algebra course is significantly different than the mean self-efficacy score of students enrolled in a co-requisite College Algebra course.

Knowing that the mean self-efficacy score of College Algebra students significantly differed from the mean self-efficacy score of co-requisite College Algebra students, I wanted to determine if over the course of a semester the mathematics self-efficacy of co-requisite College Algebra students changed. Part two of the quantitative data analysis results of the paired-samples t-test show the mean of the pre-survey was 5.66728 with a standard deviation of 1.32988 and the mean of the post-survey was 5.74842 with a standard deviation of 1.35445. The "sig 2-tailed" value determined by paired-samples t-test was $p = 0.418$ using $\alpha = 0.05$ for a level of significance, there is enough evidence to conclude that the true mean of the self-efficacy scores of students enrolled in co-requisite College Algebra did not change significantly from the pre-to-post-survey.

Although there was not a significant change in the co-requisite College Algebra student's mathematics self-efficacy over the course of 13 weeks, participants were still purposefully selected to be interviewed based off of the change in their mathematics self-efficacy scores. Four participants selected to be interviewed had a decrease in their mathematics self-efficacy, two had no change in their mathematics self-efficacy, and four had an increase in their mathematics self-efficacy. Participants were selected with purpose to grasp their perceptions of the co-requisite course so that common themes among the interview participants could be analyzed to see if any categories could be developed to help explain the phenomenon of co-requisite remediation.

From the qualitative data analysis four themes emerged: **community, multiple sources and multiple modes of instruction, support,** and **soft skills**. All ten interview participants added to each of the four categories. Sub-themes emerged that supported each theme. The sub-themes for **community** were: ***sitting together in groups, meeting outside of class,*** and ***sharing contact information***. The sub-themes for **multiple sources and multiple modes of instruction** were: ***benefits of two instructors, ALEKS online homework,*** and ***group work***. The sub-themes for **support** were: ***both teachers knew what students needed, more time in class,*** and ***immediate homework feedback***. The sub-themes for **soft skills** were ***communication and collaboration, time management,*** and ***persistence and grit***. Each sub-theme was developed by common threads of interview data from multiple participants regardless of whether their mathematics self-efficacy increased, decreased, or remained the same. Although, there was no significant change in the mean scores of mathematics self-efficacy of co-requisite College Algebra students over a 13-week period, the interview participants painted a clear picture of certain perceptions they had during the co-requisite College Algebra course. These perceptions became the themes that can be further researched to determine how to make co-requisite College Algebra students more successful. The implications and conclusions drawn from this mixed methods study will be further discussed in Chapter 5.

Chapter 5: Conclusions and Implications

Remedial education in college has been a highly controversial topic for years. In particular, remedial mathematics education seems to be at center of the controversy, as mathematics is the subject with the highest percentage of remedial students (Carafarella, 2014; Hagedorn et al., 1999). This ongoing conflict between whether remediation belongs in college, and if it does, what is the best way to successfully remediate students deemed not college ready in mathematics is a battle most colleges and universities face on a daily basis. If universities choose not to offer remediation then they automatically eliminate over half of the student population from attending college and obtaining a degree (Attewell et al., 2006; Bahr, 2008, 2010; Bailey, 2009, Jones, 2015). However, if universities offer a series of remedial courses that students must pass before they can ever take a college credit bearing course, they are only providing the less prepared college students a small percentage chance of ever reaching a course for credit or obtaining a degree (Bahr, 2013; Bailey, 2009; George 2012).

Studies have shown that when a student successfully remediates, his outcome in college is very similar to his non-remedial peers (Attewell et. al., 2006; Bahr, 2008, 2010; Bettinger & Long, 2005; Lavin et. al., 1981). Although, successful remediation creates similar results for student achievement most students do not successfully remediate (Bettinger & Long, 2009; Bonham & Boylan, 2011; Carafarella, 2014; CCA, 2012a, 2016; Jimenex et. al.; 2016). The literature review provided in Chapter 2 highlighted the many aspects involved in mathematics remediation and showed many factors including: cost, equity, psychological effects, and non-persistence that play a role in a student not remediating successfully.

Since "successful" remediation seems to be the key to providing an equitable education to underprepared students it is vital to determine or develop a remediation model that provides a more successful outcome to students in need of remediation. Co-requisite remediation is a fairly new reform movement in mathematics. In co-requisite remediation a student is able to immediately enroll in a college-level course while at the same time completing his or her remediation requirement. In this model the remedial portion of the class is not a pre-requisite taken before the credit bearing course, but instead, a co-requisite with just-in-time remediation and support for the underprepared student. Co-requisite remediation in mathematics is still a new domain. However, early studies have shown that students with an ACT score as low as 13 in the mathematics portion of the test can be successful in a college-level course when remediation is offered as a co-requisite (CCA, 2012b, 2016).

Although, the CCA supports co-requisite remediation, and several states have piloted some form of co-requisite remediation in the last few years showing initial positive results, little research has been conducted to find the reasons behind the success of co-requisite remediation. Thus it is vitally important to understand how co-requisite remediation can be successful and explicate the features of successful models. Other colleges and universities can then implement successful co-requisite models and help decrease the inequity of those students deemed not college ready. At the university where this study took place the pass rates for College Algebra for a student needing remediation increased from 22% taking the students three or more semesters to 54% in one semester when enrolled in the co-requisite College Algebra course.

Although, national data shows that co-remediation is incredibly successful when compared to traditional remediation, little research has been conducted investigating students' mathematics self-efficacy and perceptions when enrolled in co-requisite remediation at four-year universities. Since many public universities across the nation are implementing co-requisite remediation in mathematics there is a need for more research to understand remedial students' mathematics self-efficacy and perceptions when enrolled in co-requisite remediation. It is vital to understand what promotes and fosters students' mathematics self-efficacy and perceptions in order to develop better co-requisite programs for ultimate student success.

This study aimed to explore developmental mathematics students' mathematics self-efficacy and perceptions when enrolled in a co-requisite course at a four-year university. The following research questions helped guide this study:

1. Do students' mathematics self-efficacy, when enrolled in a co-requisite mathematics course, differ from their peers who are enrolled in the same non-co-requisite, non-remedial gateway course?
2. Does the mathematics self-efficacy of students who are enrolled in co-requisite courses change?
3. What are the perceptions of students who are enrolled in co-requisite mathematics courses, regardless of their change in mathematics self-efficacy?

Difference in Mathematics Self-Efficacy between Groups

The answer to the first research question is yes, there is a difference in students' mathematics self-efficacy when they are enrolled in a co-requisite course. Students' mathematics self-efficacy when enrolled in co-requisite mathematics courses, differs from their peers who are enrolled in the same non-co-requisite, non-remedial gateway courses. In this study non-co-requisite College Algebra students' mathematics self-efficacy was compared to co-requisite College Algebra students' mathematics self-efficacy during week one of the semester. When the t-test showed a statistically significant difference in mathematics self-efficacy in the two groups during week one, subsequent t-tests were conducted. The co-requisite group was given the MSES survey again during week 13. When eliminating the initial survey of co-requisite students who did not persist to week 13 of the semester, there was still a statistically significant difference between non-co-requisite and co-requisite College Algebra students. It was important to eliminate the students who did not persist to help control for possibly low self-efficacy scores within the population of non-persistent students. The non-co-requisite MSES scores from the beginning of the semester were also statistically significantly different than the co-requisite students post-survey scores at week 13. In all cases the non-co-requisite College Algebra group had a higher mathematics self-efficacy score than the co-requisite College Algebra group.

The findings of this study coincide with the findings of Hall and Ponton (2005). In Hall and Ponton's (2005) study they also used the MSES scale and looked to see if there were differences in mathematics self-efficacy of Intermediate Algebra (remedial) and Calculus I (non-remedial) students. They found a statistically significant difference ($p < 0.001$) between the two groups of students. In their study the non-remedial Calculus I students also displayed a higher mathematics self-efficacy than the remedial Intermediate Algebra students. A typical sequence of courses for students needing Calculus I follows a path similar to: remedial mathematics, College Algebra, Trigonometry/Pre-Calculus, and Calculus I.

This present study adds to the previous research by Hall and Ponton (2005) by looking at a closer set of student groups on the pathway to Calculus. Where Hall and Ponton (2005) compared students in remedial mathematics to at least three courses higher in the Calculus I sequence their results were the same as this study that compared remedial students to only one course higher than College Algebra students. Both the present study and the study conducted by Hall and Ponton (2005) suggest that remedial students display a lower mathematics self-efficacy than non-remedial students.

Likewise a study conducted by Baxter, Bates and Al-Bataineh (2016), using the MSES survey, found that there was a statistically significant difference ($p = 0.032$) in the mathematics self-efficacy of students placed into lower mathematics courses than Intermediate Algebra and those students placed directly into Intermediate Algebra. The present study along with the study by Hall and Ponton (2005) and Baxter, Bates and Al-Bataineh (2016) all confirm the same results; students placed into lower level courses display correspondingly lower mathematics self-efficacy. Bandura (1997) claimed, "perceived self-efficacy is not a measure of the skills one has but a belief about what one can do under different sets of conditions with whatever skills one possesses" (p. 37). It is more than likely accurate that students in lower mathematics classes possess lower mathematical skills than students placed into higher level mathematics classes. However, according to Bandura, self-efficacy is not determined by the skills one possesses, but by the belief of what can be accomplished given one's skill set. Even though the skill sets of students in different levels of mathematics classes may differ, the three studies discussed reveal that the students' beliefs about what they can accomplish mathematically differ significantly depending on the level of mathematics courses in which they are placed.

Difference in Mathematics Self-Efficacy in Co-Requisite College Algebra

The answer to the second research question is no, the mathematics self-efficacy of students who are enrolled in a co-requisite course does not statistically change over the course of a semester. Students' mathematics self-efficacy, when enrolled in a co-requisite College Algebra course, does not significantly change over the course of 13 weeks. In this study, co-requisite College Algebra students' MSES scores, during week one, were compared to their MSES scores, during week-13. Overall, there was a slight increase in the mean of the post survey given at week-13 compared to the pre-survey during week-one, however the increase was not significant.

When the co-requisite group's paired samples t-tests showed no statistically significant difference in mathematics self-efficacy from week one to 13 subsequent paired samples t-tests were conducted. Even though there was no statistically significant difference in the mathematics self-efficacy of the entire group of co-requisite College Algebra students over 13 weeks, it was important to see if any variations of the entire group showed significant differences in mathematics self-efficacy over the 13 weeks. Paired samples t-tests were also conducted in the co-requisite College Algebra group for the variations of gender and age. In the variations of gender and age there were no statistical differences in the mathematics self-efficacy of co-requisite students over 13 weeks.

The findings of this study are similar to research conducted by Hagerty, Smith and Goodwin (2010). Hagerty et al. (2010) found that the mathematics self-efficacy of college students had no significant increase in measure over the course of a semester. The present study differs from Hagerty et al. (2010), in the level of mathematics the students were enrolled in and also the instrument used to measure mathematics self-efficacy. In the study by Hagerty et al. (2010) the researchers used a self-developed mathematics self-efficacy measure and the participants of the study were upper course mathematics students. Both studies had similar findings that the mathematics self-efficacy of college students does not significantly change over the course of a semester.

The similar findings of the mathematics self-efficacy of students not significantly changing over the course of the semester in the present study and the study conducted by Hagerty et al. (2010) may be explained by Bandura's theory that many outside factors influence self-efficacy (Bandura, 1993, 1997). Bandura (1993) claimed that self-efficacy is a part of a cycle of past performance, personal goals, analytic strategies, and new performance. If self-efficacy is a part of a complete cycle and past performance plays a direct role on self-efficacy, then it may be possible that the older a person is, the more past performances (either good or bad) she has. It is possible that one semester of success in a college level mathematics course may not be enough to completely change an individual's self-efficacy. Bandura (1993) claimed that one way to potentially increase an individual's self-efficacy was through the instructors' beliefs in the students ability, instructional treatment, and persistence. Self-efficacy is developed over time, so changes in one's self-efficacy may take longer than a semester.

Perception of Students Enrolled in a Co-Requisite College Algebra Course

Although, the results of the second question revealed there was not a significant difference in the mathematics self-efficacy of co-requisite college algebra students over the course of a semester, other research studies show that co-requisite remediation is successful (CCA, 2016; Kashyap & Mathew, 2017). Since the purpose of the study was to determine why co-requisite remediation is successful, the perceptions of all students enrolled in co-requisite College Algebra, regardless whether their mathematics self-efficacy increased, decreased, or remained the same, helps to paint a vivid description of possible factors that are responsible for co-requisite success. From the qualitative data analysis four themes emerged: **community, multiple sources and multiple modes of instruction, support,** and **soft skills**. Within each of these themes sub-themes emerged.

The themes and sub-themes from the interview data revealed some of Bandura's four sources of self-efficacy. For example, verbal persuasion can be seen in the themes of community and support in the way group members and the instructor encouraged students. Vicarious experiences can also be seen in the community and multiple sources and multiple modes of instruction themes by group members watching their fellow peers have success problem solving during homework, group work, or seeing their peers overall success on quizzes and exams. Performance outcomes can be highlighted in the support theme under the sub-theme immediate homework feedback. With immediate feedback, students can build positive experiences from their successes. The soft skills sub-theme of persistence and grit, student described in the beginning of the semester they were scared and nervous and feared failure but at the end, they were confident of their success in the current course as well as future courses. This finding highlights the emotional arousal source of self-efficacy by creating in the individual excitement of success (Bandura, 1977).

Interviews of all ten participants revealed one strong sub-theme was the idea of a learning community. Participants described sitting together in groups in the ***community*** theme; they described working in groups in the ***multiple sources and multiple modes of instruction theme***; and they described communication and collaboration in the ***soft skills*** theme. In some colleges learning communities are intentionally developed by the institution where similar students are grouped together in more than one class (Schnee, 2014). Several studies show that learning communities increase student success especially for students enrolled in lower level courses (Boatman & Long, 2010; Freeman, Alston, & Winborne, 2008; Schnee, 2014). In the university where this study took place students in co-requisite College Algebra were automatically placed into two courses together, as they were in cohorts. The learning community participants described seemed to be more intense than just being in more than one course together. Participants describe fostering a community relationship with "their group members." Multiple times in each interview the participants used the words "my group." When follow-up questions were asked the "groups" seemed naturally occurring within the classes not created by the instructor. Participants developed groups on their own, and expressed learning and growing from being with their groups.

Another strong sub-theme that arched between themes was the ALEKS online homework system. Again all ten participants made comments about ALEKS during their interviews. Participants described ALEKS' examples in the ***multiple sources and multiple modes of instruction*** theme; they described immediate homework feedback in the ***support*** theme; and they described ALEKS helping with time management in the ***soft skills*** theme. Computer assisted instruction in college level mathematics courses is gaining popularity. Several studies have shown that implementing a mathematics computer program along with other methods such as lecture or lab time has positive results in students' achievement (Craig et al., 2013; Modebelu & Ogbonna, 2013; Spradlin & Ackerman, 2010; Taylor, 2008). ALEKS online homework was used in each of the co-requisite College Algebra courses at the university where this study took place. Participants described liking the many different aspects of the online program. They commented that they appreciated being able to see a different way to work out mathematics problems and they liked the fact they could work ahead. Several participants stated that they appreciated knowing immediately if they were right or wrong. In today's society where so much of one's everyday life depend on technology, the participants seemed to appreciate a technology driven homework piece within the co-requisite course.

Implications

With the nation being in crisis where remedial mathematics is concerned, this study may provide valuable information to be used in the future in similar settings. In this study it is clear that remedial students have lower mathematics self-efficacy then their non-remedial peers. Just as important, the mathematics self-efficacy of remedial students does not change over the course of one semester. Knowing these two critical facts, educators of remedial mathematics must look for different ways to influence and improve mathematics self-efficacy of their students. One potential way to help increase mathematics self-efficacy of students in remedial courses is for the students to experience success in their mathematics class and persist in their degree completion (Attwell et al., 2006; Bandura, 1997; Bettinger & Long, 2005; Jameson, & Fusco, 2014).

For years, traditional remediation has had dreadful pass rates and has done little to help students be successful despite different models and implementations (Bahr, 2008; Bailey, 2009; Bailey et al., 2010; Boatman & Long, 2018; George, 2012; Hagedorn, et al., 1999). Co-requisite mathematics remediation has proven to have more student success than traditional remediation and students earn college mathematics credit for the course (CCA, 2012b, 2016; Kashyap & Mathew, 2017). Since traditional remediation has very few successful students and since co-requisite remediation has more successful students, it is important to consider what is causing co-requisite remediation to have success.

The qualitative findings of this study may inform co-requisite models to help foster more student success. Four main themes evolved from the interview data: **community, multiple sources and multiple modes of instruction, support,** and **soft skills**. Future directors and educators of remedial mathematic programs who are implementing co-requisite models should be aware and try to foster community, use multiple sources and multiple modes of instruction, support, and soft skills within their programs.

Although the qualitative portion of this study looked at the perceptions of participants with increased, decreased, and no change in their mathematics self-efficacy, the developed themes were expressed by all participants. All participants interviewed, except one, regardless of their MSES scores, claimed that they felt successful in their co-requisite course and felt they would be successful in their next mathematics courses. One participant claimed he knew he was going to fail the course, but stated it was because he did not go to class regularly and did not show up for a test. Although he claimed he was going to fail, he said he was confident he could pass the course the following semester if he would just attend every class. He still described the same themes as the other nine participants.

In this study, the qualitative participants were all in different courses with a variety of instructors. Some students attended a co-requisite model that met five days a week. Others attended a model that met back-to-back two nights a week. Each participant had two different instructors and used the ALEKS online homework system. From there, the structure of the class each participant was in was different. Although the structures of the courses were different, the themes that developed from participants were the same.

The theme of **community** appeared to happen on its own. Some participants met outside of class; some shared contact information; and all discussed sitting with their groups in class. Knowing that developing a sense of community for the students is important will help instructors of co-requisite remediation to foster the idea of community beginning the first week of class. Possibly the connectedness a student feels when part of a group could be prompted by an instructor suggesting students meet each other on the first day of class and share contact information with several students sitting nearby.

The theme of **multiple sources and multiple modes of instruction** emerged from each interview participant. Since every participant in this study had two instructors they automatically received different modes of instruction. Some co-requisite models have the same instructor teaching both the credit bearing and support courses. The results of this study reveal that participants feel there is a benefit from seeing the same material presented in different ways.

Directors and instructors of co-requisite mathematic models should be aware of the positive effect multiple sources and multiple modes of instruction may have on co-requisite students. In some cases it may not be feasible for different instructors to teach both courses. If the courses cannot be taught by different instructors it is important for a single instructor to be able to show the mathematics content in different ways, and also, to incorporate other sources such as group work or a homework program that provides an alternate method of learning the material.

Interview participants described the amount of **support** the co-requisite courses provided. Participants commented on feeling that both instructors knew exactly what the students needed. Whether it be more time, more review, or simply seeing the information again, participants expressed that they would not have been successful without the support course. For instructors in a co-requisite model it is vitally important to know exactly where your students are in their understanding, and to communicate with the other instructor of the course. The participants in this study were in class face-to-face with an instructor six hours per week. The amount of in class time doubled from a traditional College Algebra course. This extra time allowed students to receive just-in-time remediation, and also to apply the mathematical concepts they were learning. The additional in class time helped support the participants in many ways.

The final theme that emerged from the qualitative data was the theme of **soft skills**. Soft skills are often defined not as the academic material students are taught but rather all the other skills necessary for success in college such as; time management, collaboration, communication skills, persistence and grit. The results of this study suggest that it would be beneficial for directors and educators of co-requisite students to not only focus on the mathematics students need to learn but also help the students develop betters skills for success in college. Perhaps co-requisite programs should automatically build into the course the explicit development of soft skills students need to be academically successful. Instructors of students in co-requisite models should help foster communication and collaboration within the classroom. Instructors should help their students with time management, study skills, and with building up their own persistence and grit.

This study was focused on co-requisite remedial programs, but highlighted many factors that could be generalized to any remedial program. The finding of the study, that remedial students have lower mathematics self-efficacy than their non-remedial peers is likely to be true at other universities in other states. The finding that remedial educators should look for ways to increase mathematics self-efficacy and success in remedial courses could be generalized to all remedial programs. The specific themes and sub-themes generated from the qualitative interviews is somewhat more restricted to the setting of this particular study. However, the general themes of community, multiple sources and multiple modes of instruction, support, and soft skills could be implemented in many different aspects in a way that is conducive to the particular set up of the co-requisite model at any university.

Limitations

This study was only conducted at one university in only one semester. In the quantitative part of the study, only students in the co-requisite College Algebra group receive the MSES surveys again at week 13 of the semester. There was no change in the co-requisite College Algebra students MSES scores, but it would have been useful to compare the co-requisite College Algebra group's MSES scores to the non-co-requisite College Algebra group at week 13. Another limitation of this study is that pass rates of the co-requisite College Algebra students were not given nor analyzed. An analysis of whether a student had an increase, decrease, or no change in their mathematics self-efficacy, should be compared with the final grade in the course to see if any correlation could be derived from success and an increase in mathematics self-efficacy.

The greatest limitation of this study was the limited time and number of interview participants. Although saturation was met with ten interviews in the co-requisite College Algebra group, it would have been beneficial to also interview participants in the non-co-requisite College Algebra group. Then themes between the two groups could have been compared for differences and commonalities. Within the interview data, commonalities, and themes were solely based on the perceptions of the individual researcher. With additional time and resources, such as a secondary researcher, the validity and reliability of this study would be strengthened and the results would be more generalizable.

Recommendations for Future Studies

Due to the limitations of this current study, future research is necessary to better understand the success of co-remediation courses. While this study may add to previous research, there is still so much to learn about co-requisite mathematics remediation. More research is needed to compare co-requisite and non-co-requisite College Algebra students' perceptions of success and also their MSES scores over a longer period of time. Likewise, more research could be conducted to see if there are correlations between students' grades in co-requisite courses and their mathematics self-efficacy. Furthermore, it would be informative to have the co-requisite students take the MSES again after they received their final grade in the course to see if their final grade affected their self-efficacy compared to weeks one and 13.

Given more time and resources, a study with the same aims of this current study could be conducted on a larger scale adding to the validity and reliability of this present study. Implications of a large scale study could enlighten educators of co-requisite remediation on best teaching practices for student success. In addition to conducting a larger study, a longitudinal study that extends this present research study could add valuable information on if students who are also successful in co-requisite remediation are successful in their next mathematics course. This may also have implications on co-requisite remediation students’ graduation rates when compared to traditional remedial students’ graduation rates.

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Appendix A: Sample MSES Survey Questions and Demographic Questions

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

Section I - Demographics

1. How many mathematics classes did you take in high school? No Response _____________

2. What was the highest mathematics course you took in high school? No Response _____________________

3. What was your average grade in your mathematics classes in high school? No Response __________

4. What was your score on the math section of the ACT? No Response _______________

5. Is this the first time you have taken College Algebra? No Response Yes No

Section II – Mathematics Self-Efficacy Scale SAMPLE

How much confidence do you have that you could successfully:

1. Add two large numbers in your head

2. Determine the amount of sales tax on a clothing purchase

3. Figure out how much material to buy in order to make curtains

Section II – Mathematics Courses Scale SAMPLE

How much confidence do you have that you could make a final grade of A or B in these courses:

1. Basic College Math

2. Economics

3. Statistics

Appendix B: Recruitment Script

Hello,

My name is Alana McAnally and I am inviting you to participate in research about the self-efficacy of college algebra students. If you agree to participate you will fill out one to two surveys. If you wish to provide your contact information you may be contacted for a 30-45 min interview about your experiences in your mathematics classes this semester.

You do not have to participate in any part of the study. Even if you choose to participate now, you may stop participating at any time and for any reason.

If you have any questions I would be happy to answer them, or you can feel free to contact me at any time at 405-974-5715 or by email amcanally@uco.edu.

If you are choosing to participate in the study I will bring you a consent form to read and sign and then you will take a 10-15 min survey. If you do not wish to participate at this time you may leave the class for the day.

Thank you for your time

Alana McAnally

Appendix C: Research Consent Forms

Non-Co-Requisite College Algebra Consent Form

Consent to Participate in Research at the University of Oklahoma

You are invited to participate in research about **the self-efficacy of college algebra students at the University of Central Oklahoma.**

If you agree to participate, you will **complete the Mathematics Self-Efficacy Scale survey.**

There are no risks or benefits in participating.

Your participation is voluntary and your responses will be: **anonymous**

Even if you choose to participate now, you may stop participating at any time and for any reason. Your data may be used in future research studies, unless you contact me to withdraw your data.

If you have questions about this research, please contact:

Alana McAnally, at 405-974-5715 or via email at Alana.r.mcanally_1@ou.edu or my faculty advisor Dr. Stacy Reeder, at 405-325-1498 or via email at reeer@ou.edu.

You can also contact the University of Oklahoma – Norman Campus Institutional Review Board at 405-325-8110 or irb@ou.edu with questions, concerns or complaints about your rights as a research participant, or if you don't want to talk to the researcher.

Are you 18 years of age or older? ___ Yes ___ No (If no- cannot participate)

I agree to participate in this research. You will be given a copy of this document for your records. By providing information to the researcher(s), I am agreeing to participate in this research.

_______________________________ _______________

Signature of Participant Date

_______________________________ _______________

Signature of Researcher Obtaining Consent Date

Co-Requisite College Algebra Consent Form

Consent to Participate in Research at the University of Oklahoma

You are invited to participate in research about **the self-efficacy of college algebra students at the University of Central Oklahoma.**

If you agree to participate, you will **complete the Mathematics Self-Efficacy Scale survey two different times during the semester. You may also participate in an interview if you choose to do so and you are selected based off of your survey answers.**

There are no risks or benefits.

Your participation is voluntary and your responses will be: **confidential**

Even if you choose to participate now, you may stop participating at any time and for any reason. Your data may be used in future research studies, unless you contact me to withdraw your data.

If you have questions about this research, please contact:

Alana McAnally, at 405-974-5715 or via email at Alana.r.mcanally_1@ou.edu or my faculty advisor Dr. Stacy Reeder, at 405-325-1498 or via email at reeer@ou.edu.

You can also contact the University of Oklahoma – Norman Campus Institutional Review Board at 405-325-8110 or irb@ou.edu with questions, concerns or complaints about your rights as a research participant, or if you don't want to talk to the researcher.

Are you 18 years of age or older? ___ Yes ___ No (If no- cannot participate)

I agree to participate in this research. You will be given a copy of this document for your records. By providing information to the researcher(s), I am agreeing to participate in this research.

____________________________________ __________________

Signature of Participant Date

____________________________________ __________________

Signature of Researcher Obtaining Consent Date

Appendix D: Outline of Semi-Structured Interview Questions

1) Can you describe your experience in this course?

a) Did you work with other students more or less in this class than in other math classes?

b) Did you do more in class work than in other classes?

c) What was the teaching style in your class… mostly lecture, group work, individual work?

2) Did you feel you were a part of a group within the class?

a) Did you sit with your group or the same people? In both classes?

b) How did you would with your group…. On campus, off campus, on homework, to study for quizzes and exams?

3) How did you feel about having two different instructors?

4) Do you feel that you needed the support course in order to be successful in college algebra?

a) Do you feel this class will help you be successful in your next math class?

5) What was the best part of this course that you would like to see in other math classes?

6) What was the worst part of this course that you would like to see changed?

7) What are some things you think I should know?