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A Scaffolded Corequisite Curriculum for College Algebra Students: Effects on Achievement and Motivation

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A SCAFFOLDED COREQUISITE CURRICULUM FOR COLLEGE ALGEBRA STUDENTS: EFFECTS ON ACHIEVEMENT AND MOTIVATION

by

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ABSTRACT

This study chronicles the implementation of a scaffolded corequisite College Algebra curriculum at a Southeast community college and the corresponding effects on student motivation and achievement. The scaffolded curriculum incorporates academic-related skills, academic support, and student motivation to promote success in the gateway college math course. The corequisite model allows students to bypass a prerequisite course and enroll directly in the college-level coursework, with remedial content from the prerequisite course delivered concurrently through supplemental learning sessions or labs. In fall 2023, data were collected from five College Algebra courses, including student demographic data, from two evaluative instruments administered at the beginning and end of the semester. The results showed that traditional and corequisite students demonstrated statistically significant increases in their basic algebra skills and motivation metrics, with no significant differences between the two groups. Results from the corequisite treatment group identified motivational subfactors of persistence and anxiety as statistically significant predictors of improved mathematics motivation, suggesting that students gain motivation by reducing anxiety and are more willing to persist in mathematics within the corequisite cohort. Multiple linear regressions were conducted to identify significant predictors of pre- and post-assessment scores, with Senate Bill 1720 exemption status, course type, and final course letter grade emerging as important predictors.

ACKNOWLEDGMENTS

I was uncertain what to expect when deciding to pursue an EdD in Curriculum and Instruction. I remember attending my first doctoral course feeling overwhelmed, as the topics of research and methodology were outside of my area of expertise. However, I decided to trust myself, my professors, and my family and friends, who kept encouraging me, and I continued forward one semester at a time. Now, nearly six years later, I am prepared to defend my dissertation. The professors in my program and concentration area (Instructional Design and Technology) provided me with the knowledge and tools necessary to research complex problems and stay current in the field of education and technology. These skills have taught me to look at research, education, and life in general from multiple lenses. As a result, I am a more well-rounded person, and I am very thankful to my professors for taking me on this rewarding journey.

On a more personal note, I want to thank my family and friends for their ongoing support and encouragement. When I felt overwhelmed, they were always there to lift my spirits. I also want to thank Dr. Boote and Dr. Gunter for playing instrumental roles in my journey. Dr. Boote was my professor for nearly half of my core courses, so I learned so much from him regarding research and methodology. He was instrumental in guiding me through the research and data analysis required for this dissertation. Dr. Gunter was my advisor and professor for many concentration courses. She provided me with the instructional design and technology skills necessary to build the corequisite course—the foundation of my dissertation—and ensured I met all the milestones that made this dissertation possible. I express my deepest gratitude to all the incredible faculty, family, and friends who supported me on this incredible adventure!

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LIST OF ACRONYMS

ALP	Accelerated Learning Programs
ANOVA	Analysis of variance
CANE	Commitment and Necessary Effort
FTIC	First time in college
IAS	Intermediate Algebra Skills
JIT	Just in time
JCC	Juniper Community College
LMS	Learning Management System
LSC	Learning Support Center
MANOVA	Multivariate analysis of variance
MLR	Multiple Linear Regression
MML	MyMathLab
NCES	National Center for Education Statistics
SB1720	Florida State Senate Bill 1720
SDT	Self-determination theory
ZPD	Zone of proximal development

CHAPTER ONE: INTRODUCTION

Introduction

Higher education represents a gateway to achievement for many high school graduates and adults seeking opportunities for success. Two-year community or state colleges often serve as an entry point for students pursuing job training or trade skills or transferring to a four-year college or university. According to the National Center for Education Statistics (NCES), two-year colleges represent over one-third of all students pursuing higher education, with nearly two-thirds of all graduates attending a two-year college at some point (Irwin et al., 2023). Unfortunately, fewer than half of community college students successfully complete a degree (Irwin et al., 2023). Due to the open-access nature of these colleges, enrollment often includes students with diverse backgrounds and varied skill levels—many of whom are underprepared for college-level coursework. Such students often represent first-generation students, students with low-income backgrounds, underrepresented minorities, and/or English as a Second Language (ESL) students (Boylan & Trawick, 2015; Irwin et al., 2023). To accommodate skills gaps, colleges enroll students in remedial or developmental programs. Nearly 50% of first-year college students and 70% of first-year community college students enroll in at least one developmental course (Barringer-Brown & Lynch, 2022; Chambers, 2020). While such programs aim to prepare students for college-level work, requiring completion of additional courses or learning services often lengthens students' time to complete a degree and allows for additional "exit points" in which students may withdraw from school. Research indicates this is particularly true for college students enrolled in developmental mathematics (Bailey et al., 2010; Kosiewicz & Ngo, 2020; Xu & Dadgar, 2016).

Background

Developmental mathematics often serves as an obstacle to success for many college students (Kosiewicz & Ngo, 2020). Underprepared students may need to complete up to three developmental math courses before enrolling in their first college-level (gateway) math course. According to Complete College America (2021), only 10% of students who enroll in three developmental math courses complete a gateway math course within two years. In addition, 74% of students taking a developmental course during their first year of college are more likely to drop out of college than their "college-ready" counterparts (Schak et al., 2017). As such, national initiatives of colleges across the United States have focused on alternative methods of remediation that deviate from the traditional prerequisite course sequence (Jaggers & Biggerstaff, 2018; Rutschow & Mayer, 2018). One increasingly popular approach is the corequisite model—an accelerated remediation approach that recent research touts as an effective alternative to traditional developmental coursework (Childers et al., 2021; Logue et al., 2019; Petillo & Anuszkiewicz, 2023; Waschull 2018; Wenner, 2011). The corequisite model allows students to bypass a prerequisite course and enroll directly in the gateway college math course. The remedial content from the prerequisite course is delivered concurrently with the college-level coursework through supplemental learning sessions or labs. The skills and content from the remedial corequisite sessions are delivered "just in time" (JIT) for students to apply the knowledge in the upcoming college-level lesson. This dissertation chronicles the implementation of a corequisite College Algebra course at Juniper Community College (JCC) and the corresponding effects on student motivation and achievement.

Organizational Context

Juniper Community College (JCC) is a Southeastern public two-year college and is part of the state college system. There are approximately 65,000 credit-seeking students enrolled across multiple campuses, according to the 2022-2023 institutional research report. This enrollment stated in the reports includes students in credit-bearing courses where 17.2% are African American, 4.9% are Asian, 27.1% of the students are Caucasian, 40.8% are Hispanic, and 10% identify as multi-racial, another race or did not report a race. Females represent 58.3% of the student body, while males comprise 38.3% of enrollment.

Nearly half of JCC students pursue an Associate of Science (AS) degree as a gateway for transferring to a four-year college or university. Per college rules, these students must complete a minimum of six credit hours of college-level mathematics. College Algebra serves as the most common gateway to mathematics at JCC. To enroll in College Algebra, students must meet minimum course prerequisites. Otherwise, students must first complete Intermediate Algebra (or start in a lower developmental course) before gaining eligibility to enroll in College Algebra. Figure 1 provides the sequence of mathematics courses offered at JCC from the developmental sequence through College Algebra.

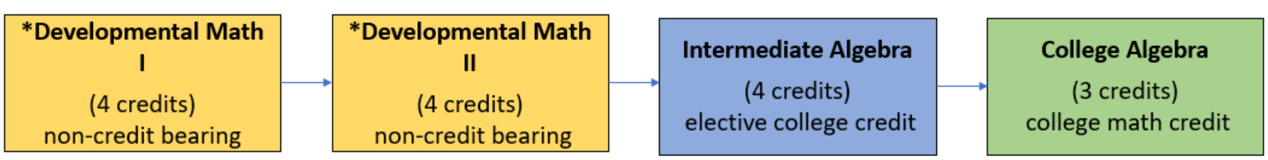


Figure 1: JCC Prerequisite Math Course Sequence for College Algebra

Note. A five-credit combined developmental math course is also available in lieu of developmental math I and II. Sequence chart created by the researcher.

Whether a student is placed into Intermediate Algebra or a developmental (remedial) course depends upon exemption status defined by Florida Senate Bill 1720 (SB1720). Exempt students must be Florida standard high school diploma recipients who entered 9th grade in a Florida public school 2003-2004 and thereafter or be a student on active military duty (Senate Bill 1720, 2013). Since most JCC students meet exemption status, they are not required to take a mathematics placement exam and may bypass developmental math and enroll directly into Intermediate Algebra. As such, any given Intermediate Algebra class may include students of highly varied skill levels with no minimal prerequisite skill requirements.

Problem Statement

Nationally, nearly 50% of all first-year college students and 70% of first-year community college students require at least one remedial course, and only half of those students complete them (Barringer-Brown & Lynch, 2022; Chambers, 2020; Chen, 2014). Requiring completion of remedial courses before entering gateway college-level mathematics courses, such as College Algebra, often hinders degree attainment for many first-year college students (Childers et al., 2021). Early failures in college math courses impede students' access to gateway mathematics courses and lower math self-efficacy and motivation—factors that often prove detrimental to success and persistence rates (Bailey et al., 2010; Hiller, 2021; Kosiewicz & Ngo, 2020). Studies show these consequences are most dire for underprepared students on the cusp of testing into college-level courses (Boatman & Long, 2018; Ngo, 2019). Due to the SB1720 exemption status of students enrolled in Intermediate Algebra, how can students on the borderline of being "college ready" for College Algebra be distinguished from those with more extensive skills deficits? This poses a unique issue for JCC when deciding which students would benefit most from a corequisite College Algebra course. Some studies suggest the net benefits of enrolling all underprepared students, regardless of skills gaps, outweigh the risks of offering traditional remediation pathways (Logue et al., 2019). However, most research agrees that specific subsets of students benefit most from corequisite learning where levels of remediation are commensurate with the need of the parent, gateway course (Boatman and Long, 2018; Childers, 2021; Lake et al., 2017; Ngo, 2019). The challenge for JCC is identifying such subsets to maximize students' potential for success.

This quasi-experimental quantitative study examines the effects of a scaffolded corequisite curriculum on achievement and motivation for underprepared students enrolled in a corequisite College Algebra course. The scaffolding is three-fold in design: content-based scaffolding within the corequisite course curriculum provides timely instruction to fill gaps in mathematical skills and concepts necessary to understand College Algebra content; pedagogy-based scaffolding incorporated through course design and delivery targets student motivation and self-efficacy; and support-based scaffolding focuses on proper placement and advising before enrollment and academic guidance and intervention strategies throughout enrollment in the corequisite course. By offering the scaffolded corequisite course to underprepared JCC College Algebra students, data gathered on student achievement and motivation throughout the study will offer insight into the effectiveness of intervention and provide insight into which subsets of students, if any, most benefit from the corequisite model.

Theoretical Framework

The theoretical framework of this dissertation utilizes Vygotsky's (1978) sociocultural theory of learning and the concept of scaffolding. As part of the theory, Vygotsky (1978) explained the zone of proximal development (ZPD) as the gap between understanding fundamental concepts and learning concepts at a higher-level capacity. In relation to this study, students' ZPD represents any gaps between rudimentary algebra concepts and College Algebra material. This study uses a scaffolded corequisite curriculum of advising, academic support, and timely delivery of fundamental mathematics to promote motivation and success in College Algebra.

The goal shared by student participants in the study is to successfully complete College Algebra via an accelerated course pathway that includes bypassing the prerequisite course (Intermediate Algebra) and enrolling directly into the gateway College Algebra course with supplemental corequisite instruction. To maximize the potential for students to accomplish this goal, the scaffolded curriculum focuses on three primary design elements: academic-related skills, student motivation, and academic support. Figure 2 illustrates the three elements of scaffolding embodied by the theoretical framework of this study.

The first element of design, Academic-related Skills, is delivered through a corequisite model of supplemental learning offering just-in-time (JIT) remediation of skills needed for the parent College Algebra course. The timely intervention of remedial concepts supports Vygotsky's (1978) concept of ZPD by closing skills gaps to allow for higher-level learning. Extensive research touts the corequisite design as an effective strategy for accelerating underprepared students through remediation while producing higher success and persistence rates than traditional prerequisite course pathways (Childers et al., 2021; Logue et al., 2019; Waschull, 2018; Wenner, 2011). In addition, research asserts that acquiring academic-related skills is a strong predictor for retention among college students (Robbins et al., 2006; Zientek et al., 2022). To measure the effects on academic achievement of students enrolled in the corequisite College Algebra course, skills-based pre- and post-assessment and final course letter grades will be collected, analyzed, and compared to students in a traditional College Algebra course.

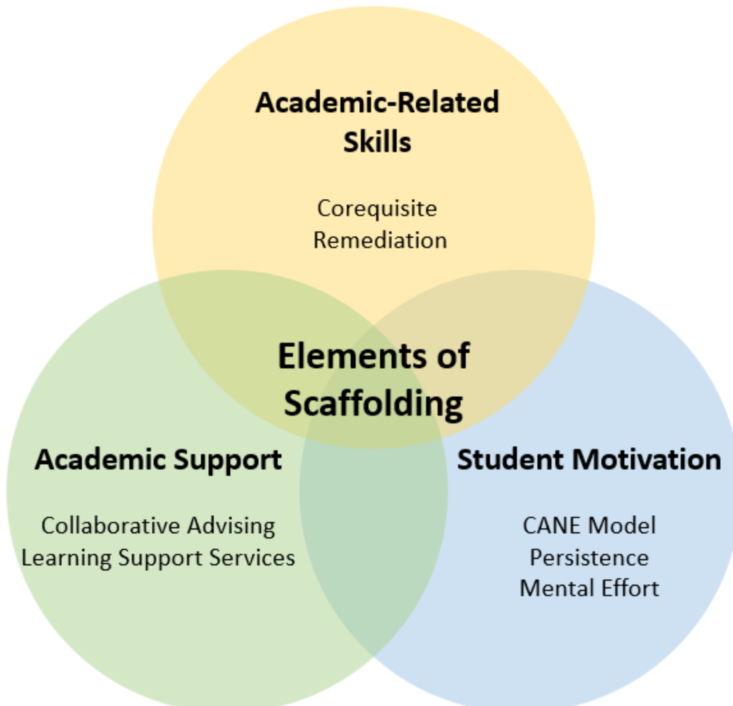


Figure 2: Three Elements for Scaffolded Corequisite Curriculum

Note. Elements of scaffolding model created by the researcher.

The second element, Academic Support, represents another element of the scaffolding design and includes students receiving proper advising before enrolling in a corequisite course and adequate academic support and resources while completing the course. Brower et al. (2021) claim academic support through campus coordination is essential for promoting college readiness for students underprepared for college-level work. In fact, academic support and academic-related support both represent critical tactics in a scaffolded instructional approach that Brower et al. (2021) coin as a “pedagogy of preparation” (p. 1). The study conducted by Brower et al. (2021) is particularly relevant to this dissertation as the data collected and examined is from other state colleges affected by SB1720. As such, many of the design elements for the academic support and academic-related skills components of the scaffolded curriculum framework stem from recommendations provided in Brower et al.'s (2021) research.

The final element of design for the scaffolded corequisite curriculum, Student Motivation, incorporates Deci and Ryan's (2022) self-determination theory (SDT) and associated research related to students' motivation and attitudes toward college mathematics. Teaching strategy recommendations from relevant studies guided the scaffolding components aimed at promoting student motivation. To measure the effects on motivation of underprepared College Algebra students experiencing the scaffolded corequisite curriculum intervention, the Commitment and Necessary Effort (CANE) model of motivation instrument will be utilized. The CANE model identifies key components of student motivation through metrics of goal commitment (including self-efficacy, affect, and task value) and mental effort (Reynolds, 2003). The CANE model is appropriate for this dissertation study as the measurement instrument was created by a former JCC mathematics professor and validated through a study conducted at the college.

Significance of Problem

At many post-secondary education institutions, especially two-year colleges, underprepared college students must complete remedial mathematics before enrolling in their first credit-bearing, college-level math course (gateway course). Traditional developmental course sequences include as many as three developmental courses that often do not count for credit but are required if students lack prerequisite skills defined by the gateway course. Studies show that many college students required to follow a traditional developmental math pathway get lost in the pipeline and experience low success and retention rates (Attewell et al., 2006;

Chen & Simone, 2016; Childers et al., 2021). Due to the poor success rates, many underprepared students never enroll in college-level mathematics, particularly College Algebra. Providing students an accelerated pathway to college-level mathematics courses without the barriers of completing traditional remedial course sequences may increase student attainment of college math credits (Childers et al., 2021; Logue et al., 2016). Limited research exists, however, identifying which students most benefit from corequisite interventions. The scaffolded corequisite curriculum intervention designed for underprepared students at JCC aims to effectively remove barriers imposed by mandated remedial courses while identifying subsets of students who most benefit from the intervention. This dissertation chronicled the design process and evaluated the effects of a scaffolded remediation curriculum on student achievement in College Algebra at JCC and their motivation and attitudes toward math. Through a comprehensive analysis of this scaffolded remediation approach, JCC and other institutions may gain insight into productive remediation strategies and pedagogies that best equip underprepared students for success in college-level mathematics.

Purpose of Study

The purpose of this study is to evaluate the effects of a scaffolded corequisite curriculum on achievement and motivation for students enrolled in corequisite College Algebra course sections at JCC. Data from evaluative instruments was disaggregated and examined from various angles to identify trends, patterns, or commonalities among subsets of students. Determining which students made academic and motivational gains (or losses) may assist in more effective student advisement/placement and provide insight for future implementation of corequisite course offerings in College Algebra as well as other college-level math courses or disciplines.

CHAPTER TWO: LITERATURE REVIEW

Introduction

This chapter provides an overview of the foundational theories, research, and literature used to develop the scaffolded corequisite curriculum examined in this study. The scaffolded elements of the curriculum were derived from three components: academic-related skills, student motivation, and academic support (see Figure 2). The corequisite intervention utilized in this study incorporated research-based strategies and pedagogies supportive of each element to create an accelerated learning opportunity for underprepared JJC students seeking enrollment in College Algebra. This chapter offers literature-based justification for the researcher's inclusion of each component to create a holistic learning experience for these students. This literature review plan may provide existing research with additional data to support scaffolded instructional strategies and identify gaps in the research that need further study.

Scaffolding

Factors surrounding how students learn are complex and boundless. As such, teaching strategies to enhance student learning or performance often require a multi-dimensional approach to maximize effectiveness. The intervention described in this study is no different. The backbone of this intervention is a corequisite College Algebra course designed to provide a shortened pathway for underprepared students to receive College Algebra credit without following the traditional developmental course sequence. While many corequisite designs focus solely on closing content-based skills gaps, this intervention utilizes a scaffolded corequisite curriculum that incorporates academic support, student motivation strategies, and academic-related skills.

Research indicates that providing a multi-layered, scaffolded approach to academic preparation is most effective in fostering college readiness (Bailey et al., 2010; Brower et al., 2017; Brower et al., 2021; Richard & Dorsey, 2019). Non-content-related domains, such as social engagement and motivational strategies, also represent essential components for promoting college readiness (Robbins et al., 2006). Brower et al. (2021) describe the scaffolding elements as essential components in a "pedagogy of preparation" (p. 1). Their study suggests tangible strategies and tactics that faculty and staff should offer to best prepare students for college-level coursework. Findings and recommendations from the Brower et al. (2021) study helped guide the structure of the scaffolded curriculum examined in this dissertation.

Corequisite Remediation

Remediation of prerequisite mathematical concepts represents the academic-related skills element of the scaffolded corequisite design. Corequisite models exist in various forms and across many disciplines. However, the primary characteristic that defines corequisite learning is the placement of underprepared students directly into college-level courses while integrating timely academic support to close skills gaps (Richardson & Dorsey, 2019). Corequisite remediation has grown in popularity over the last decade, with early versions, referred to as Accelerated Learning Programs (ALP), emerging in the late 1990s (Adams et al., 2009). Since the inception of early models, numerous studies exist measuring the effectiveness of corequisite remediation as an accelerated pathway for underprepared students to enroll and succeed in college-level math courses without first requiring completion of developmental courses. Overwhelming evidence suggests corequisite learning can be highly effective by closing skills gaps and reducing students' time in the developmental course pipeline, thus removing exit points that lead to lower attrition rates (Bailey et al., 2010; Childers et al., 2021; Logue et al., 2019; Waschull, 2018; Wenner, 2011).

While most studies agree corequisite models can improve success rates for underprepared students, they lack consensus on pinpointing which strategies prove most effective and the appropriate level of intervention to provide to specific students. Logue et al. (2019) suggest corequisite courses replace traditional developmental courses, claiming students in their study increased assigned course pass rates and graduation rates. Other studies, however, claim corequisite courses most benefit students on the cusp of testing into the parent (Boatman & Long, 2018). Ngo (2019) expands on this claim, asserting that borderline students experience adverse effects when required to take remedial math, while students testing in lower developmental math courses experienced few negative effects from enrolling in basic math or pre-algebra courses. As such, research suggests that the level of preparation should be considered when determining which students benefit most from corequisite courses. In this study, any student eligible for Intermediate Algebra may enroll in the corequisite College Algebra course. Since SB1720 qualifies all exemption-status students for Intermediate Algebra, these students are automatically eligible for corequisite College Algebra. Without requiring placement exams or other measures of skill or ability, the participants in this study likely represent students with varied degrees of skill gaps and abilities. This presents a unique opportunity in this study to examine relationships between subsets of students and their achievement and motivation.

Academic Support

Academic support represents another design element for this dissertation and encompasses a broad range of services essential to the scaffolded curriculum. Such support occurs through collaborative advising and communication before the semester begins and providing learning support services for students throughout the semester. Brower et al. (2021) identify adequate academic support as an essential element in a scaffolded design to foster college readiness. Effective academic support requires campus-wide coordination involving faculty, staff, advisors, and administrators.

Advisors play an integral role in the scaffolded curriculum as they represent all students' initial point of contact. Corequisite remediation may not be well-suited for all students. The corequisite College Algebra implemented in this study requires lab and lecture components equivalent to a five-credit-hour course. Advisors should determine if eligible students have the schedule and capacity to commit to the time and rigor demanded by the corequisite course. Since any Intermediate Algebra-eligible student, regardless of skill level, may enroll in the corequisite College Algebra course, determining students' suitability for the course should be individualized based on multiple factors. While most eligible students lack placement scores due to the exemption status of SB1720, studies indicate high school GPA and course history may represent strong indicators of success in college-level courses (Barnett et al., 2018; Belfield & Crosta, 2012; Ngo et al., 2018, Scott-Clayton, 2012). Ngo et al. (2018) suggest considering high school GPA, course history, and non-cognitive constructs like time commitment, motivation, and support from family and peers to determine student suitability for corequisite remediation. While advisors may not have quantifiable data for all constructs, they may use personal connections and student demographics to take a holistic, individualized approach to identify ideal candidates for corequisite College Algebra.

For faculty and advisor coordination, Brower et al. (2021) recommend that faculty present advisors with detailed information about the curriculum during enrollment periods to ensure proper advising recommendations. Such information should include a description of the corequisite course, course requirements (e.g., eligibility, lab, and lecture components/structure), and a summary of course content coverage. Providing infographics, pre-designed email prompts for contacting advisees, and checklists for determining suitability for the course may prove effective in facilitating collaboration among faculty and advising staff. Training sessions between math faculty, particularly those teaching the corequisite course, advisors, staff, and administrators should be offered to create awareness of the accelerated math remediation opportunity and foster campus-wide coordination.

The other primary facet of academic support is providing supplemental learning services to corequisite students during student enrollment in the corequisite course. Brower et al. (2021) encourage coordination between faculty and academic support staff throughout the semester to leverage tutoring and academic services to supplement the corequisite curriculum. At JCC, academic support is provided through the Learning Support Center (LSC). Faculty should communicate with LSC staff to ensure adequate and timely tutoring services are available. Supplemental workshops should be considered, especially for rigorous segments of the course requiring significant skills acquisition from the corequisite component. Also, faculty members may consider peer tutoring throughout the semester. Feeling connected with classmates and observing the successes of others (vicarious experiences) can improve math self-efficacy and lead to improved outcomes (Usher & Pajares, 2008; Zientek, 2019).

Motivation

Student motivation represents the third element of design for the scaffolded corequisite curriculum. In this study, motivation is an umbrella term intertwined with measures of math self-efficacy and math anxiety since research indicates these constructs influence motivation (Chan & Bauer, 2014, Wang et al., 2015). Ryan and Deci's (2022) self-determination theory (SDT) guided the development of the motivation elements of the scaffolded corequisite curriculum. However, other foundation theories, such as Usher and Pajares's (2008) self-efficacy theory, also influenced the instructional design. This study utilizes the Commitment and Necessary Effort (CANE) model of motivation and uses two stages to measure student motivation: goal commitment (persistence) and mental effort (Clark, 1998, 1998; Reynolds, 2003). Stage 1, mathematical persistence, is measured by mathematical self-efficacy, mathematics anxiety, and mathematics task value, and stage 2, mental effort—using non-automated mental processes to complete a task—is dependent on self-efficacy (Reynolds, 2003).

Considering the multi-dimensional spectrum related to student motivation, particularly in mathematics, various research were examined to shape the scaffolded corequisite curriculum. Since SDT represents the basis for the theoretical framework, all motivational elements connect with the three innate psychological needs that foster intrinsic and extrinsic motivation: competence, autonomy, and relatedness (Ryan & Deci, 2022). Hiller et al. (2021) expand on this concept, determining that mastery experiences and positive social interactions heighten self-efficacy, contributing to improved math performance. These elements also corroborate two foundational components that Usher and Pajares (2008) identify in self-efficacy theory. Mastery experiences relate to the competence component of SDT, while positive social interactions relate to relatedness—feeling connected through shared experiences and meaningful relationships. Mastery learning is emphasized in the corequisite College Algebra course, as work completed through the learning platform MyMathLab (MML) provides instant feedback and allows for mastery through repetition. Positive social interaction will be promoted through condensed class sizes (12-15 students per section). This will enable the instructor and students to form connections and interact more personally, perhaps impacting overall student motivation.

Conclusion

The literature above offers expert perspectives on the influence of scaffolding, corequisite remediation, and motivational strategies, particularly for college mathematics students. The research indicates that each construct can promote academic achievement. While some articles intersect domains—for instance, several articles relate motivation to math anxiety—none address all three components. This is the gap in research I hope to address. It is also essential to review literature offering different perspectives or even opposing views. For instance, in a study measuring the effectiveness of alternative strategies for delivering developmental education, the authors found that the traditional model of developmental/prerequisite pathways prevailed among alternative models in student success (Kosiewicz et al., 2016). Reviewing research covering all angles when developing an innovative teaching strategy to provide support and justification for each element is crucial.

CHAPTER THREE: METHODOLOGY

This quasi-experimental quantitative study aimed to evaluate the effects of a scaffolded corequisite curriculum on achievement and motivation for underprepared College Algebra students at Juniper Community College (JCC). The scaffolded curricular framework incorporates corequisite instruction of remedial mathematics skills based on research-driven best practices and the theories measured by the CANE model of motivation. The research questions (RQs) aim to address the problem of low academic success of underprepared students in College Algebra and to identify subsets of students who most or least benefit from the corequisite intervention.

Research Questions

The following RQs will be investigated in this study:

RQ1: Do students enrolled in a scaffolded corequisite College Algebra course demonstrate equal or greater improvement of academic outcomes (as measured by an Intermediate Algebra Skills (IAS) assessment) when compared to students enrolled in a traditional College Algebra course?

RQ2: Do students enrolled in a scaffolded corequisite College Algebra course demonstrate equal or greater improvement in mathematics motivation (as measured by a pre- and post-test CANE model survey instrument) when compared to students enrolled in a traditional College Algebra course?

RQ3: Do any trends or patterns exist among the demographic data identifying subsets of students who most benefit from corequisite instruction relating to academic achievement or motivation?

Research Design

A quasi-experimental research design was used to analyze data gathered from pre- and post-instruments measuring performance and motivation. Data from both instruments were collected from the experimental group (three corequisite College Algebra sections) and control group (two traditional College Algebra sections). Since enrollment in each section was not random and data included multiple dependent variables, a quasi-experimental design proved most suitable (Creswell & Creswell, 2017).

Independent Variable: Scaffolded Corequisite Intervention

Dependent Variables:

1. Performance (Academic Outcomes)
    a. Pre-posttest (as measured by peer-review assessment of Intermediate Algebra skills)
    b. Final course letter grades
2. Motivation
    a. Pre-posttest (as measured by Commitment and Necessary effort (CANE) model Likert-type survey instrument)

Variables for post-hoc analysis: age, gender, first time in college (FTIC), Pell-eligibility, and race/ethnicity.

Sample and Recruitment

Participants in this quasi-experimental quantitative study consisted of 30 students enrolled in three College Algebra with Corequisite Lab courses (treatment group) and 33 students enrolled in two traditional College Algebra courses (control group). Of the 63 participants, samples used for analysis were based on students who completed both pre and post-assessments. Juniper Community College faculty volunteers taught the corequisite courses, while the researcher taught the traditional courses in this study. Students enrolled voluntarily based on conditional admission requirements. Faculty volunteers received training for the course through a spring 2022 corequisite College Algebra course pilot. Due to the lack of random assignment of students in each course, this study represents a quasi-experimental design (Creswell & Creswell, 2017). To enroll in a corequisite College Algebra course, students must be eligible for the prerequisite course, Intermediate Algebra. Eligibility includes receiving a minimum score on a college placement exam (e.g., ACT, PERT, ACCUPLACER), completing the prerequisite developmental mathematics course, or meeting exemption status for Senate Bill 1720. For SB 1720 exemption, a student must have entered 9th grade in a Florida public school from 2003-2004 or thereafter and earned a Florida standard high school diploma or be a student on active military duty (Senate Bill 1720, 2013).

Coordination efforts among advisors and counselors at both the college and local high schools were essential for heightening student awareness of the corequisite opportunity, as special permission was necessary for enrollment to ensure students meet minimum admission requirements. The traditional College Algebra sections, however, were open enrollment for any student meeting the course prerequisites. It should be noted that due to a specific campus agreement, a certain allotment of seats in the traditional College Algebra sections was reserved for qualified students from our partnered university affiliate (approximately 25% of capacity). These students must meet the same course prerequisites as JCC students to enroll. However, university student data were excluded from the control group sample to ensure homogeneity between-group comparisons. The corequisite College Algebra sections consisted entirely of JCC students, so all data from eligible treatment group students were included.

Structure

The researcher developed the corequisite College Algebra course while enrolled in Instructional Design and Technology courses. The corequisite course was structured as an Accelerated Learning Program (ALP) with lab-based, "just-in-time" instruction delivered concurrently with the gateway College Algebra course (Complete College America, 2016). Each corequisite lab incorporated supplemental learning/instruction for prerequisite mathematics skills needed for the upcoming College Algebra lesson. Labs were taught by the primary College Algebra instructor and met immediately before the College Algebra course. All learning modules were built and designed using the same Learning Management System (LMS) and online learning platform to ensure seamless integration and consistency between the lab and parent course.

The corequisite course was beta-tested in the fall of 2020. Due to restrictions from COVID-19, the course was offered virtually with limited capacity. The course was offered again in fall 2021 in a face-to-face modality with a limited enrollment of nine students. Due to limited face-to-face enrollment and lack of demand, this study was delayed until the fall 2022 semester. The time between the initial pilot and this study was used to refine the course and train other faculty volunteers interested in offering a corequisite College Algebra course on their campus. In fall 2023, enrollment and demand for face-to-face corequisite College Algebra courses were adequate to conduct this study. Three faculty volunteers offered three sections of corequisite College Algebra (treatment), and the researcher offered two sections of traditional College Algebra (control). Two of the three faculty members agreed to offer a corequisite College

Algebra section using the researcher-designed course, which had identical College Algebra components to the two traditional College Algebra sections. The third faculty volunteer taught one corequisite College Algebra section with the same course objectives but used a different learning platform other than MyMathLab. The IAS assessment and CANE survey were administered in each of the five course sections as pre- and post-evaluations.

The corequisite College Algebra courses included two components: a 50-minute lab to teach just-in-time (JIT) remedial skills and a 75-minute traditional College Algebra lecture. In this study, the professor taught the corequisite lab and lecture for each section. The labs delivered scaffolded instruction focused on improving student motivation and performance in the paired College Algebra course. The 75-minute College Algebra sections of each course were taught using similar teaching strategies and assignments, so the supplemental corequisite instruction represented the distinguishing intervention between the treatment group (students in the College Algebra with Corequisite Lab sections) and the control group (students in the traditional College Algebra sections). It should be noted that each professor used his or her assessments, final exam, and grading discretion to determine final course grades in the College Algebra component of the course. The corequisite component of the courses, which does not receive a letter grade, followed a more homogeneous structure. Figure 3 provides a visual flowchart for a sample week of corequisite College Algebra course instruction.

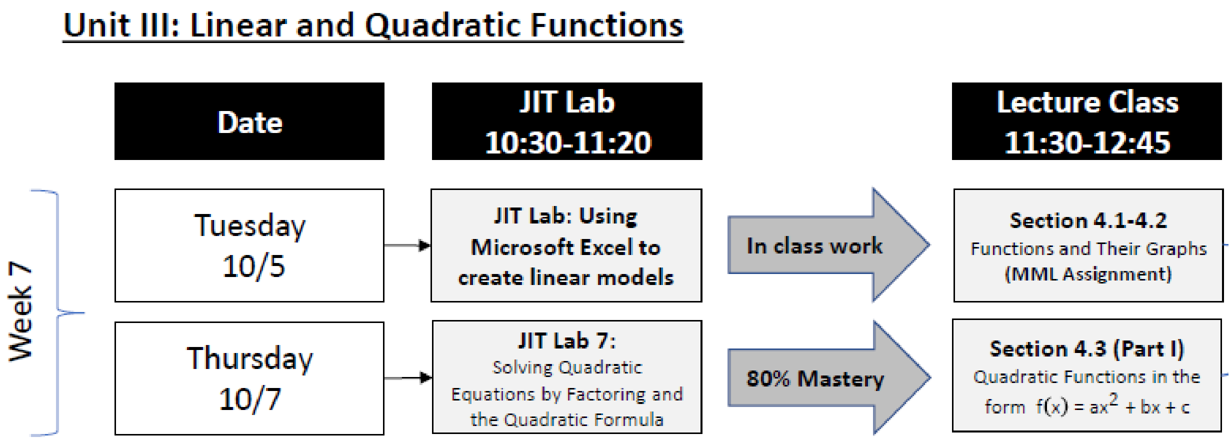


Figure 3: JCC Sample Weekly Flowchart of Instruction

Note. Class times and dates will vary. The duration of lab and lecture times are the same.

Instrumentation

This study used two primary instruments: 1) a peer-reviewed Intermediate Algebra Skills (IAS) assessment and 2) a Commitment and Necessary Effort (CANE) model survey. The IAS assessment was used in this study to measure academic achievement. Questions from the IAS were chosen based on coverage of course objectives and difficulty level. Intermediate Algebra is a prerequisite course for College Algebra. However, both courses deliver the same course objectives. Questions for the IAS (Appendix A) were intentionally pooled from common course objectives. Since students in the traditional College Algebra group met course prerequisites, they presumably have been exposed to these course objectives. The same cannot be assumed of the control group. Because these objectives are covered in both the corequisite and traditional courses, it ensures that all students in the study were exposed to the content by the end of the semester. Each question was chosen from a question bank from Pearson's MyMathLab (MML), the online learning platform used in the course delivery of the treatment and control groups. The MML analytics uses historical data and student performance to assign a difficulty metric to each question (easy, moderate, hard, very hard). IAS questions were chosen to provide a balance of easy, moderate, and hard questions. The course objective and level of difficulty for each question are provided in Appendix B.

The CANE survey (Appendix C) was used in this study to measure student motivation. Reynolds (2003) developed the CANE survey to measure the role of mathematics anxiety in mathematical motivation in college math students. The study verified the validity and reliability of the instrument for measuring motivation through four factors: 1) anxiety, 2) task value, 3) persistence, and 4) expectancy (Reynolds, 2003). The instrument contains a total of 30 questions. Of these questions, 27 were categorized into one of the four factors. The other three questions were identified as neutral. Each question uses a Likert-type scale from 1 to 5, where 1 is least favorable, and 5 is most favorable for that motivational factor. Thus, higher scores are interpreted as positive indicators of motivation. The survey results were measured as a holistic composite score and by factor sub-scores.

Within the first two weeks of the semester, students were administered the Intermediate Algebra Skills (IAS) assessment, and again during the last two weeks. The IAS instrument consisted of 10 multiple-choice questions that assessed prerequisite algebra skills necessary for College Algebra concepts (Appendix A). The questions were chosen from overlapping topics included in the Intermediate Algebra and College Algebra course curricula to ensure all student participants were exposed to the material. The Commitment and Necessary Effort (CANE) survey was also administered within the first two weeks and last two weeks of the semester via a Qualtrics survey link or QR code (Appendix C). Upon conclusion of the semester, pre- and post-data were collected from 30 corequisite course students and 33 traditional course students. While initial enrollment was higher in the corequisite and traditional courses, the combined 63 results were collected from students who remained enrolled and completed both the pre- and post-assessments. A further reduction in sample sizes was necessary for portions of the analysis due to incomplete or missing information. The final sample size of pre- and post-scores from the IAS assessment and CANE survey used for analysis included 52 and 53 results, respectively.

Data Collection

The following steps chronicle the data collection process for the semester of the study:

- **Step 1**: During the first week of class, the researcher/instructor explained relevant information about the study to each class, avoiding details that may compromise the integrity of the results. Consent forms for agreement to participate were disseminated, signed, and collected to determine the study sample.
- **Step 2**: Within the first two weeks, students completed the IAS pre-assessment and the pre-survey of the CANE model instrument. After administering and collecting student data from both instruments, faculty participants delivered all results to the researcher of the study.
- **Step 3**: The researcher compiled all the results from the treatment and control group. All rosters were verified, and students with incomplete or missing data were identified. The researcher then requested demographic and background data for each student from JCC Institutional Research. This data included first-time-in-college (FTIC) status, ethnicity, gender, age, full-time/part-time status, Pell eligibility, ACT/SAT math scores, and Senate Bill 1720 exemption status.
- **Step 4**: During the final two weeks of the course, students completed the follow-up post-assessment and post-survey, which were identical to the pre-data collection instruments.

Course scores (averages) and letter grades were assigned. Data from the post-instruments and final course scores were delivered to the researcher and compiled for analysis.

- **Step 5**: The researcher matched all pre- and post-data results with respective student identification numbers. This was compiled with student demographic and background data. Official final course grades were verified through the JCC Institutional Research Office and matched to the respective student identification numbers. After the step, each student participant had documented pre- and post-scores for the IAS assessment and CANE survey, as well as all respective information potentially needed for ad hoc analysis. Students with incomplete data or missing pre and post-results were removed from the sample.

Data Analysis

Descriptive data of study participants combined with motivation and performance data was collected from the pre-post instruments and end-of-course scores to gather data for analysis necessary to address each RQ. To address **RQ1:** *Do students enrolled in a scaffolded corequisite College Algebra course demonstrate equal or greater improvement of academic outcomes when compared to students enrolled in a traditional College Algebra course?*, results from the pre- and post-assessment of Intermediate Algebra Skills were used to make the following comparisons:

- Differences between the groups at the start of the study
- Differences between the groups at the end of the study
- Differences for both groups between the beginning and the end of the study

Since this study combines a between-groups factor (comparison of pre-post scores between the treatment group and the control group) and a within-subjects factor (comparison of pre-post scores within the treatment group and within the control group), a mixed factorial ANOVA is required to conduct such analysis.

A similar strategy was used for **RQ2:** *Do students enrolled in a scaffolded corequisite College Algebra course demonstrate equal or greater improvement in mathematics motivation (as measured by a pre- and post-test CANE model survey instrument) when compared to students enrolled in a traditional College Algebra course?* In this comparison, however, operationalized scores from the CANE model of motivation survey are used to measure pre- and post-improvement in mean scores between the treatment and control groups and within each group. As before, a mixed factorial ANOVA test will generate outcomes measuring the significance of each comparison group to determine whether motivation levels improved and, if so, by how much.

To address **RQ3:** *Do any trends or patterns exist among the demographic data identifying subsets of students who most benefit from corequisite instruction relating to academic achievement or motivation?*, data was analyzed through post-hoc analysis. This required examination of statistical differences on multiple dependent variables, particularly with demographic and descriptive statistics (i.e., gender, race/ethnicity, Pell eligibility) with IAS and CANE survey results. Two multiple linear regressions (MLR) were conducted to examine if any subgroups of students demonstrated a statistically significant correlation between IAS scores and CANE survey results. Differences in pre- and post-scores were used as the independent variable for each MLR.

For RQ1 and RQ2, a mixed factorial ANOVA statistical model was performed to analyze differences among means. The mixed factorial ANOVA will compare the mean scores of each between and within the group and provide F-values, significance levels, and effect sizes (partial eta squared). These metrics, particularly significance levels of .05 or below, would indicate statistically significant differences in the comparison groups, which allows readers to interpret the effect of the corequisite intervention on the treatment group in comparison to growths gained from no treatment in the control group.

For RQ3, two MLR tests were applied to measure the relationship between multiple variables (course, gender, ethnicity, FTIC, grade, Pell eligibility, and SB 1720 exemption status) and differences in pre- and post-IAS and CANE scores. The effect size, F-value, and significance levels for each subgroup variable were considered for post hoc analysis.

CHAPTER FOUR: FINDINGS

Introduction

The purpose of this study was to examine the effects of a scaffolded corequisite College Algebra curriculum on motivation and achievement for students who lacked the prerequisites necessary to enroll in a traditional College Algebra course. The scaffolded curriculum consisted of three elements: academic-related skills, academic support, and student motivation. Academic-related skills were targeted through a corequisite College Algebra course created with concurrent learning labs designed to deliver just-in-time (JIT) instruction of math skills needed for upcoming College Algebra concepts. To promote academic support and motivation, proper advising, learning support services, and research-based teaching practices were applied before and during the semester. Sample recruitment items are provided in Appendix F and G.

This chapter details the findings from a study conducted at Juniper Community College (JCC) with the participation of 63 students, with 30 students enrolled in three corequisite College Algebra courses and 33 students enrolled in two traditional College Algebra courses. An Intermediate Algebra Skills Assessment (IAS) and Commitment and Necessary Effort (CANE) survey were administered to student participants at the beginning and end of the semester to measure academic achievement and motivation, respectively. Results from the instruments used in this quantitative study were compiled with student demographic and academic information to address the following RQs:

> **RQ1**: Do students enrolled in a scaffolded corequisite College Algebra course demonstrate equal or greater improvement in academic outcomes when compared to students enrolled in a traditional College Algebra course?

RQ2: Do students enrolled in a scaffolded corequisite College Algebra course demonstrate equal or greater improvement in mathematics motivation when compared to students enrolled in a traditional College Algebra course?

RQ3: Do any trends or patterns exist among the demographic data identifying subsets of students who most benefit from corequisite instruction relating to academic achievement or motivation?

The sections in this chapter detail the results of administering the IAS and CANE instruments to gather data, describe the student participant profile, and explain the statistical analysis used for the data to address each RQ.

Study Design

The study used a quasi-experimental research design, as placement in the traditional and corequisite College Algebra sections was not random. Students in the traditional College Algebra sections enrolled voluntarily during the fall enrollment period. All three traditional College Algebra sections were offered onsite at the Downtown Campus and taught by the same instructor (the author of this study). All students enrolled in the traditional sections met the course prerequisites (i.e., minimum placement test score, successful completion of Intermediate Algebra or equivalent).

Enrollment in the corequisite College Algebra sections required special permission and manual enrollment. A different instructor taught each of the three corequisite sections. Two sections were offered onsite on the East Campus, and one was offered onsite on the West Campus. Advising efforts targeted students who did not meet course prerequisites to enroll directly into traditional College Algebra courses. Since Intermediate Algebra is the prerequisite course for traditional College Algebra, most corequisite students were eligible to enroll in Intermediate Algebra. However, some would not have met the minimum requirements for traditional College Algebra.

Course Design and Enrollment

The study was conducted at Juniper Community College (JCC) in Fall 2022. Collegewide, JCC offered fifty-five sections of onsite College Algebra courses across all campuses with a total enrollment of 1,142 students. This study collected data from a sample of five onsite College Algebra courses with a total of 63 participants. The sections included three corequisite College Algebra sections (treatment group, n=30) and two traditional College Algebra sections (control group, n=33). Three full-time faculty members, who are math professors, taught each corequisite section, while the researcher of this study taught the two traditional sections. Enrollment in the sections representing the sample was voluntary based on eligibility.

Student Participant Profile

The population of this study included eligible students from three Juniper Community College (JCC) campuses. The corequisite courses were offered on East Campus (two sections) and West Campus (one section), while both sections of traditional College Algebra were delivered on Downtown Campus. Due to the effects of the COVID-19 pandemic, reduced face-to-face student enrollment and faculty participation resulted in a limited sample size; however, analysis deemed the sample adequate for statistical significance. Table 1 displays the demographic data of each student participant in the sample of 63 students (n = 30 for corequisite College Algebra, n=33 for traditional College Algebra). The baseline characteristics were wellbalanced in both groups. Male and female genders had equal representation in the corequisite sample—however, females comprised 57.6% of the traditional College of Algebra student sample. Hispanic students represented half of the corequisite sample and 39.4% of the traditional sample, representing 44.4% of the complete sample. The SB 1720 exemption status was the two groups' most notable difference. Most corequisite students (56.7%) were SB1720 exempt, whereas only 39.4% of traditional college algebra students were exempt. To be exempt, a student must have entered ninth grade in a Florida public school from 2003-2004 or thereafter and earned a Florida standard high school diploma or be a student on active military duty (Senate Bill 1720, 2013). Exempt students are not required to take a mathematics placement exam, allowing them to bypass developmental math and enroll directly into Intermediate Algebra. To enroll in College Algebra, however, students must meet the minimum requirements through testing (e.g., placement exams, ACT, SAT) or complete Intermediate Algebra with a C or better. Since most students at JCC meet SB1720 exemption criteria, it is logical that most students in the corequisite class have exempt status.

Table 1: Demographic Characteristics of Participants at Baseline

Baseline Characteristic	**Corequisite College Algebra**		**Traditional College Algebra**		**Full Sample**	
	n	**%**	***n***	**%**	***n***	**%**
Gender						
Female	15	50.0	19	57.6	34	54.0
Male	15	50.0	13	39.4	28	44.4
No Response	0	0.0	1	3.0	1	1.6
Ethnicity						
Asian	2	6.7	2	6.1	4	6.3
Black	4	13.3	6	18.2	10	15.9
Hispanic	15	50.0	13	39.4	28	44.4
White	7	23.3	11	33.3	18	28.6
Other	2	6.7	1	3	3	4.8
Enrollment						
Full- Time	21	70.0	25	75.8	46	73.0
Part-Time	9	30.0	8	24.2	17	27.0
Pell Eligible						
No	26	86.7	29	87.9	55	87.3
Yes	4	13.3	4	12.1	8	12.7
FTIC [a]						
No	19	63.3	21	63.6	40	63.5
Yes	11	36.7	12	36.4	23	36.5
SB1720 Exempt [b]						
No	13	43.3	20	60.6	33	52.4
Yes	17	56.7	13	39.4	30	47.6

Note. $N = 63$ ($n = 30$ for corequisite College Algebra, n=33 for traditional College Algebra). Participants were, on average, 19.0 years old ($SD = 2.4$), and participant age did not differ by condition.

[a] First Time in College (FTIC) represents any student who has never attended any college prior to enrolling at JCC.

[b] Exempt students in accordance with Florida Senate Bill 1720 (Senate Bill 1720, 2013).

Data Preparation

As indicated in Table 1, demographic data was collected for students in the corequisite College Algebra (treatment) and traditional College Algebra (control) groups. The sample of 63 students consisted of 30 corequisite students and 33 traditional students. The first RQ addressed differences in achievement on a pre- and post-assessment for students in the corequisite College Algebra courses and the traditional College Algebra courses. An Intermediately Algebra Skills (IAS) skills assessment was administered to measure academic achievement. Raw percentages from IAS pre- and post-assessments were collected for analysis. Students who lacked both pre- and post-IAS scores were removed from the sample. The final sample of IAS scores included results from 25 corequisite students and 27 traditional students.

Research question two addressed differences in motivation for students in the corequisite College Algebra and traditional College Algebra groups. Commitment and Necessary Effort (CANE) surveys were administered to measure motivation. Students lacking both pre- and post-survey results were omitted from the analysis. The final sample of CANE surveys included results from 25 corequisite students and 28 traditional students.

The CANE survey is a 33-question instrument requiring students to provide responses of 1-5 on a Likert-type scale for questions measuring motivation subscales of anxiety, task value, persistence, and expectancy. The researcher disaggregated each CANE question into one of the four factors and used an exploratory factor analysis to measure correlation within factors. For questions with negative values, reversed scoring was applied to ensure a high score (5) indicated a favorable response and a low score (1) represented an unfavorable response. Appendix H provides the questions categorized by subscale and indicates which questions required reversed scaling.

Research question three determined if any trends or patterns exist among the demographic data identifying subsets of students who most benefited from corequisite instruction relating to academic achievement or motivation. To prepare data for this analysis, individual demographic data, IAS scores, and CANE scores were sorted by student using student ID numbers.

Analysis of Research Questions

Research Question 1

The first RQ was, "Do students enrolled in a scaffolded corequisite College Algebra course demonstrate equal or greater improvement of academic outcomes when compared to students enrolled in a traditional College Algebra course?" Academic outcomes were measured using scores from the IAS assessment. Of the 63 participants, a sample of 52 data entries was used for analysis after omitting students who did not complete both pre- and post-IAS tests or were missing identification information. The IAS assessment included ten multiple-choice questions, allowing for a possible range of scores from 0 to 100. Table 2 provides the summary statistics for pre- and post-IAS assessment results for students in the corequisite and traditional College Algebra courses.

Table 2: Summary Statistics for IAS Assessment Scores in College Algebra

	Corequisite Course (Experiment) N=25		**Traditional Course (Control) N=27**	
	M	***SD***	***M***	***SD***
Pretest	52.4	17.1	58.2	19.8
Posttest	75.2	14.8	76.7	19.8
Change	22.8		18.5	

Note. N = sample size, M = mean, SD = Standard Deviation. Scores are based on percentage of correct responses.

Students in the corequisite course scored lower on the IAS pre-assessment than students in the traditional College Algebra course, with means of 52.4% and 58.2%, respectively. The post-assessment results produced similar results for corequisite and traditional course students, with means of 75.2% and 76.7%, respectively.

To address RQ1 one, a two-way repeated measure ANOVA test was utilized. The ANOVA test measured the differences in means of one variable (IAS scores) in pre and post-assessments between the two independent groups (corequisite College Algebra and traditional College Algebra students). Table 3 provides the results from the ANOVA test.

Table 3: Results of Two-Way Repeated Measure ANOVA Analysis for IAS Scores

Source	**Sum of Squares**	**Df**	**Mean Square**	***F***	**p**	η^2
Between Subjects						
Group (Corequisite/Traditional)	337.848	1	337.848	.634	.430	.013
Error	26665.037	50	515.48			
Within Subjects						
Measurement (pre-test, post-test)	11080.514	1	11080.514	91.995	<.001	.648
Group*Measurement	118.976	1	118.976	.988	.325	.019
Error	6022.370	50	120.447			

Note. Computed using alpha = .05

The treatment group saw the largest gain in pre- and post-IAS means scores, with a change of 22.8 percentage points, when compared to an 18.5 percentage point change with the control group. However, due to variability in both groups, the difference in gains was not statistically significant. Results from the repeated measure ANOVA applied to the pre and post-

IAS assessments of participants from the corequisite College Algebra course (treatment group) and traditional College Algebra course (control group) suggest no statistically significant difference in mean scores between the treatment and control group ($F(1,50)=.634$; $p<.430$; $\eta^2=.013$). Alternatively stated, the gains in mean pre and post-IAS scores for the corequisite students were not statistically significantly different from the gains in pre and post-IAS scores of traditional students. Within each group, however, corequisite and traditional students collectively demonstrated significant gains in mean IAS scores from pre to post-assessment ($F(1,50)=91.995$; $p<.001$; $\eta^2=.648$). These findings indicate that students in both groups saw significant gains in mean IAS test scores at the end of the semester when compared to the pre-assessment means. However, neither group saw significantly higher gains than the other. Research question one aims to determine if the corequisite group shows equal or greater gains in IAS scores than the traditional group, as measured with the between-subjects statistics. While there are no statistically significant gains between the two groups, both groups shared similar IAS mean scores upon completion of the course.

Research Question 2

Research question two was, "Do students enrolled in a scaffolded corequisite College Algebra course demonstrate equal or greater improvement in mathematics motivation (as measured by a pre- and post-test CANE model survey instrument) when compared to students enrolled in a traditional College Algebra course? Like RQ1, a two-way repeated measure ANOVA test was utilized to measure significant changes within and between the control and treatment groups.

The CANE survey results were collected from students in treatment and control groups to measure motivation in College Algebra. As shown in Appendix H, scores were disaggregated into the four motivation subfactors: anxiety, task value, persistence, and expectancy. Student motivation was examined using the total CANE score and subscale. Twenty-seven questions from the instrument were used for analysis. Specific questions were reverse scaled to ensure scores of 1 correspond with low motivation and scores of 5 represent the most favorable. The range of scores for an individual subject is 27 (all scores of 1) to 135 (all scores of 5). A summary of descriptive statistics of total CANE survey results from the treatment and control groups is provided in Table 4.

Table 4: Summary Statistics for CANE Survey Scores in College Algebra

	Corequisite Course (Experiment) N=25		**Traditional Course (Control) N=28**	
	M	***SD***	***M***	***SD***
Pre-survey	78.4	16.3	83.0	14.0
Post-survey	83.6	12.9	84.0	17.5
Change	5.2		1.0	

Note. N = sample size, M = mean, SD = Standard Deviation. The survey includes 27 questions on a Likert-type scale of 1 (low) to 5 (high). Total survey scores for each subject can range from 27-135.

The mean scores for the corequisite treatment group and traditional control group increased from pre- to post-survey. The corequisite group demonstrated a pre-survey mean score of 78.4 and a post-survey mean score of 83.6. The traditional group registered mean scores of 83.0 on the pre-survey and 84.0 on the post-survey. Both groups exited the course with similar total motivation scores. However, corequisite subjects entered the course with a lower mean motivation score of 78.4, closing a 5.2-point gap from pre- and post-survey when compared to a one-point gap with traditional students.

To further address RQ2, a two-way repeated measure ANOVA test was utilized. The ANOVA test measured the differences in means of one variable (CANE total score) in pre- and post-assessments between the two independent groups (corequisite College Algebra and traditional College Algebra students). Table 5 provides the results from the ANOVA test.

Results from the repeated measure ANOVA applied to the pre- and post-CANE assessments of participants from the corequisite College Algebra course (treatment group) and traditional College Algebra course (control group) indicate no statistically significant difference in mean scores between the treatment and control group ($F(1,51)=.416$; $p<.522$; $\eta^2=.008$). This suggests the gains in mean pre- and post-CANE scores for the corequisite students were not statistically significantly different from the gains in pre- and post-CANE scores of traditional students. All students in both groups, however, demonstrated significant gains in mean CANE scores from pre- to post-assessment ($F(1,51)=4.265$; $p<.044$; $\eta^2=.077$).

Table 5: Results of Two-Way Repeated Measure ANOVA Analysis for CANE Survey

Source	**Sum of Squares**	**Df**	**Mean Square**	***F***	**p**	η^2
Between Subjects						
Group (Corequisite/Traditional)	169.845	1	169.845	.416	.522	.008
Error	20818.929	51	408.214			
Within Subjects						
Measurement (pre-test, post-test)	260.442	1	260.442	4.265	.044	.077
Group*Measurement	120.971	1	120.971	1.981	.165	.037
Error	3114.520	51	61.069			

Note. Computed using alpha = .05

While students from both groups demonstrated statistically significant gains in total motivation scores, further analysis is necessary to determine if differences existed in scores within the four motivational subfactors: anxiety, task value, persistence, and expectancy. Summary statistics from the CANE survey are provided in Table 6, separated by motivation factor.

Motivational scores increased across all four factors in the treatment and control groups from pre- and post-surveys, except for "expectancy" in the control group, which indicated a -0.2 difference between pre- and post-scores. The anxiety scores of the corequisite (treatment) group saw the highest gains from pre- to post-survey, with an increase of 2.9 points. Gains across other groups and factors varied incrementally from 0.0 to 0.8. Treatment groups saw higher gains than their respective control groups in all four factors.

Table 6: Summary Statistics for CANE Survey Scores in College Algebra

	Anxiety (Experiment) N=25		**Anxiety** (Control) N=28		**Task Value** (Experiment) N=25		**Task Value** (Control) N=28	
	[10 Questions, Score Range: 10-50]				[9 Questions, Score Range: 9-45]			
	M	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***
Pre-Survey	22.8	7.3	25.4	7.1	28.3	4.5	28.7	5.1
Post-Survey	25.7	5.4	26.1	7.3	28.9	4.6	28.7	6.0
Change	2.9		0.7		0.6		0.0	
	Persistence (Experiment) N=25		**Persistence** (Control) N=28		**Expectancy** (Experiment) N=25		**Expectancy** (Control) N=28	
	[4 Questions, Score Range: 4-20]				[4 Questions, Score Range: 4-20]			
	M	***SD***	***M***	***SD***	***M***	***SD***	***M***	***SD***
Pre-Survey	10.5	2.3	11.0	2.0	13.7	3.1	14.6	2.3
Post-Survey	11.3	2.2	11.5	2.4	14.5	3.2	14.4	3.7
Change	0.8		0.5		0.8		-0.2	

Note. N = sample size, M = mean, SD = Standard Deviation. Survey questions are calculated using a Likert-type scale of 1 (least favorable) to 5 (most favorable).

Further analysis to answer RQ2 was conducted using a two-way repeated measure ANOVA test of the CANE survey results for each of the four motivational subfactors. This test allows for analysis of changes in CANE scores between subjects in the corequisite and traditional groups and scores of subjects within each motivational subfactor. Table 7 provides the results of the ANOVA test based on each of the four motivational factors. No significant changes in motivational factors were indicated between the treatment and control groups. Two statistically significant increases were identified, however, within the corequisite treatment group. Subjects reported significant improvements in anxiety (($F(1, 51)=7.491$; $p<.009$, $\eta2=.128$) and persistence ($F(1,51)=4.668$; $p<.035$, $\eta2=.084$). It should be noted that an increase in anxiety score indicates a "favorable" impact on the anxiety motivational factor. No other significant gains were indicated within the $p=.05$ threshold within and between treatment and control groups. Anxiety scores of subjects within the control group also increased, but the gains fell short of statistical significance $F(1, 51)=2.619$; $p<.112$, $\eta^2=.049$).

Table 7: Results of Two-Way Repeated Measure ANOVA analysis for CANE Scores

Source		**Sum of Square**	**Df**	**Mean Square**	***F***	**p**	**η2**
Between Subjects							
Groups:	Anxiety	63.287	1	63.287	.780	.381	.015
Treatment,	Task Value	.246	1	.246	.005	.941	.000
Control	Persistence	3.236	1	3.236	.419	.520	.008
	Expectancy	4.226	1	4.226	.305	.583	.006
Error	Anxiety	4136.562	51	81.109			
	Task Value	2278.339	51	44.673			
	Persistence	393.500	51	7.716			
	Expectancy	706.000	51	13.843			
Within Subjects							
Treatment Group	Anxiety	88.946	1	88.946	7.491	**.009**	**.128**
	Task Value	1.815	1	1.815	.231	.633	.005
	Persistence	10.627	1	10.627	4.668	**.035**	**.084**
	Expectancy	3.209	1	3.209	.578	.451	.011
Control Group	Anxiety	31.097	1	31.097	2.619	.112	.049
	Task Value	2.344	1	2.344	.298	.588	.006
	Persistence	1.118	1	1.118	.491	.487	.010
	Expectancy	6.379	1	6.379	1.148	.289	.022
Error	Anxiety	605.545	51	11.873			
	Task Value	401.562	51	7.874			
	Persistence	116.109	51	2.277			
	Expectancy	283.394	51	5.557			

Note. SS = Sum of Squares. Computed using alpha = .05

Research Question 3

Research question three sought to determine, "Do any trends or patterns exist among the demographic data identifying subsets of students who most benefit from corequisite instruction relating to academic achievement or motivation? To address this question, two multiple linear regressions (MLR) were conducted using students' IAS and CANE instrument results (differences in pre- and post-scores) as dependent variables and demographic/descriptive subgroups as independent variables. The following subgroups were included: course, gender, ethnicity, FTIC, grade, Pell eligibility, and SB 1720 exemption status.

The first MLR examined factors that predicted differences in pre- and post-IAS test scores among students in various subgroups. Table 8 provides a summary of the results. Analysis across all predictor variables did not produce a significant correlation ($R^2 = .206, F(11, 50) = 1.18, p=.326$). The only variable subgroup reported as a statistically significant predictor of pre- and post-IAS score differences was SB 1720 exemption status (p=.029). The subgroup yielded an unstandardized B estimate of -9.967. This indicates that an SB 1720 exempt student, on average, reported a difference in pre-test and post-test IAS scores nearly 10 points lower than non-exempt students. Pell-eligible students demonstrated an unstandardized beta estimate of 12.116 with a significance level of .059, narrowly missing the p = .05 threshold for statistical significance. All other subgroups fell well outside the significance levels.

Table 8: Multiple Linear Regression Predicting Differences in Pre- and Post-IAS Scores

Variable	**B**	**Std. Error**	**95% CI**		**p**
			LL	**UL**	
Course [a]	5.513	4.272	-3.067	14.090	0.203
Gender [b]	-1.434	4.290	-10.050	7.180	0.740
Ethnicity [c]					
Asian or Pacific Islander	4.660	4.831	-5.044	14.360	0.339
Black or African American	-1.018	6.395	-13.862	11.830	0.874
Hispanic or Latino	5.139	8.643	-12.221	22.500	0.555
Other	3.490	10.471	-17.543	24.520	0.740
FTIC [d]	-2.160	4.195	-10.586	6.270	0.609
Grade [e]	1.695	1.924	-2.170	5.560	0.383
Pell Eligible [d]	12.116	6.275	-0.488	24.720	0.059
SB 1720 Exempt [d]	-9.967	4.443	-18.891	-1.040	**0.029**

Note. R^2 = .206, $F(11, 50) = 1.18$, p = .326. B = unstandardized estimate; CI = confidence interval; LL = lower limit; UL = upper limit. [a] 0 = corequisite course, 1 = traditional course, [b] 0 = female, 1 = male, [c] 0 = white or Caucasian, 1 = indicated ethnic group. [d] 0 = no, 1 = yes. [e] 0 = F, 1 = D, 2 = C, 3 = B, 4 = A.

The second MLR examined factors that predicted differences in pre- and post-CANE survey total scores among students in the same subgroups: course, gender, ethnicity, FTIC, grade, Pell eligibility, and SB 1720 exemption. Table 9 provides a summary of the results. Statistical significance was not demonstrated across all predictor variables (R^2 = .325, F(13, 37) = 1.37, p = .219). Two subgroups, however, emerged with statistical significance: course and grade. The “course” variable yielded a p-value of .039 and a B estimate of -0.309. For the course subgroup, corequisite College Algebra courses represent the reference group. Therefore, the B estimate suggests that a student in traditional College Algebra demonstrated a 0.309 decrease in pre- and post-CANE motivation score differences when compared to corequisite students. The “grade” variable subgroup produced a p-value of .002 and an unstandardized B estimate of 0.252. Grade categories were coded as follows: 0 = F, 1 = D, 2 = C, 3 = B, 4 = A. The B estimate suggests that differences in pre- and post-CANE total motivation scores increased by 0.252 points as grades increased by a letter grade.

Table 9: Multiple Linear Regression Predicting Differences in Pre- and Post-CANE Scores

Variable	**B**	**Std. Error**	**95% CI**		**p**
			LL	**UL**	
Course [a]	-0.309	0.144	-0.601	-0.016	**0.039**
Gender [b]	0.068	0.153	-0.242	0.378	0.660
Ethnicity [c]					
Asian or Pacific Islander	-0.258	0.290	-0.845	0.329	0.379
Black or African American	0.056	0.239	-0.428	0.539	0.817
Hispanic or Latino	-0.193	0.176	-0.550	0.165	0.282
Other	-0.422	0.315	-1.060	0.217	0.189
FTIC [d]	-0.113	0.147	-0.411	0.185	0.447
Grade [e]	0.252	0.078	0.095	0.409	**0.002**
Pell Eligible [d]	-0.008	0.199	-0.411	0.199	0.967
SB 1720 Exempt [d]	0.023	0.154	-0.288	0.154	0.881

Note. R^2 = .325, F(13, 37) = 1.37, p = .219. B = unstandardized estimate; CI = confidence interval; LL = lower limit; UL = upper limit. [a] 0 = corequisite course, 1 = traditional course, [b] 0 = female, 1 = male, [c] 0 = white or Caucasian, 1 = indicated ethnic group. [d] 0 = no, 1 = yes. [e] 0 = F, 1 = D, 2 = C, 3 = B, 4 = A.

Conclusion

Chapter Four provides the results of statistical analyses necessary to address the three RQs. Research questions 1 and 2 each utilized a two-way repeated measure analysis of variance (ANOVA) test to examine if corequisite College Algebra students demonstrate equal or greater improvement in academic outcomes and motivation, respectively, when compared to traditional College Algebra students. For RQ3, two multiple linear regressions (MLR) were analyzed to determine if specific subsets of students demonstrated statistically significant differences in pre- and post-test scores on the Intermediate Algebra Skills (IAS) assessment or Commitment and Necessary Effort (CANE) survey.

For RQ1, a two-way repeated measure ANOVA test results revealed that the treatment group did not significantly outperform the IAS when compared to their traditional counterparts. Both groups, however, collectively saw statistically significant gains from pre- and post-IAS assessment within their cohort. Corequisite students demonstrated larger gains from pre-IAS mean scores to post-IAS scores than traditional College Algebra students, and both groups scored comparably on the IAS post-assessment.

For RQ2, pre- and post-CANE survey scores were examined based on total survey scores and four subfactors: anxiety, task value, persistence, and expectancy. Both treatment and control groups indicated improvements in total motivation from the beginning to the end of the semester. Combined, both groups saw statistically significant improvement in mean CANE scores from pre- to post-survey. Neither group individually demonstrated statistically significant improvement in mean scores within or between each group. When examined by subfactors, however, two groups emerged with significant gains in motivational scores. Students in the treatment group indicated an improvement in anxiety and persistence motivational factors. While other subfactors did not yield statistically significant gains, the treatment group improved in all four subcategories and had larger gains than the control group subjects.

To address RQ3, results from two multiple linear regressions (MLR) were analyzed to determine if certain subsets of students demonstrated statistically significant differences on IAS and CANE instruments. Differences in pre- and post-assessment scores were used as the output variable for each MLR. The first MLR measured differences in pre- and post-IAS scores across various subgroups. Senate Bill 1720 exemption status was the only subgroup variable reported as a statistically significant predictor of pre- and post-IAS score differences with a p-value of .029 and an unstandardized B estimate of -9.967. The second MLR follows a similar structure using differences in pre- and post-CANE survey total scores. Two variable subgroups emerged as statistically significant predictors of motivation: course and grade. The “course” variable yielded a p-value of .039 and a B estimate of -0.309. For the course subgroup, the reference group represented students in corequisite College Algebra courses. The B estimate suggests that the average student in traditional College Algebra performed 0.309 lower in pre- and post-CANE motivation score differences when compared to corequisite students. The “grade” variable subgroup produced a p-value of .002 and an unstandardized B estimate of 0.252. Grade categories were coded as follows: 0 = F, 1 = D, 2 = C, 3 = B, 4 = A. Therefore, the B estimate suggests that differences in pre- and post-CANE total motivation scores improved by 0.252 points for each increase in letter grade.

CHAPTER FIVE: DISCUSSION AND CONCLUSION

Introduction

Chapter Five provides discussions, significant findings, limitations, and recommendations for future research based on the data analysis examined in Chapter Four. The purpose of the study was to evaluate the effects of a scaffolded corequisite curriculum on achievement and motivation for students enrolled in corequisite College Algebra course sections at Juniper Community College (JCC). The corequisite College Algebra course was designed for students lacking course prerequisites to enroll in traditional College Algebra directly. By enrolling in the corequisite College Algebra course, students may bypass the prerequisite course (Intermediate Algebra) and enroll directly in College Algebra. To bridge skills gaps, remedial content from the prerequisite course is delivered concurrently with the college-level coursework through supplemental learning sessions or labs. This study collected data from a sample of five onsite College Algebra courses with a total of 63 participants. The sections included three corequisite College Algebra sections (treatment group, n=30) and two traditional College Algebra sections (control group, n=33). Participants' demographic data and scores from a pre- and post-intermediate algebra Skills (IAS) assessment and a Commitment and Necessary Effort (CANE) survey were collected to measure academic achievement and motivation, respectively.

Research suggests that providing a multi-layered, scaffolded approach to academic preparation can improve college readiness (Bailey et al., 2010; Brower et al., 2017; Brower et al., 2021; Richard & Dorsey, 2019). While the corequisite course represented a core component of the study, a holistic scaffolded curriculum was the overarching intervention. The scaffolded curriculum incorporated three elements to provide a holistic learning opportunity for corequisite students: academic-related skills, academic support, and student motivation.

Academic-related skills were supported in the corequisite course design through just-in-time (JIT) supplemental instruction taught concurrently with College Algebra topics. The skills were bolstered through academic support, including collaborative advising efforts—before and throughout the semester—and learning support services/tutoring. Both design elements embrace Vygotsky's (1978) theories of the zone of proximal development (ZPD) and scaffolding by offering JIT remediation and timely intervention of support to close skills gaps and allow for independent, high-level learning. The third element of design focused on math self-efficacy and math anxiety, as both are influencing constructs of motivation (Chan & Bauer, 2014, Wang et al., 2015). Ryan and Deci's (2022) self-determination theory (SDT) guided the development of the motivation design element. Mastery experiences and positive social interactions represent contributing factors to heightened self-efficacy (Hiller et al., 2021). Such experiences were promoted through the corequisite curriculum design, learning support services, and sense of community within each cohort.

The discussions of findings use the demographic data, IAS, and CANE scores from the treatment group (corequisite College Algebra students) and control group (traditional College Algebra students) to address each of the three RQs:

> **RQ1:** Do students enrolled in a scaffolded corequisite College Algebra course demonstrate equal or greater improvement of academic outcomes (as measured by an Intermediate Algebra Skills (IAS) assessment) when compared to students enrolled in a traditional College Algebra course?
>
> **RQ2:** Do students enrolled in a scaffolded corequisite College Algebra course demonstrate equal or greater improvement in mathematics motivation (as

measured by a pre- and post-test CANE model survey instrument) when compared to students enrolled in a traditional College Algebra course?

RQ3: Do any trends or patterns exist among the demographic data identifying subsets of students who most benefit from corequisite instruction relating to academic achievement or motivation?

Discussion of Research Question 1

The first RQ was: *Do students enrolled in a scaffolded corequisite College Algebra course demonstrate equal or greater improvement of academic outcomes (as measured by an Intermediate Algebra Skills (IAS) assessment) when compared to students enrolled in a traditional College Algebra course?*

Summary statistics and a two-way repeated measure ANOVA test from IAS scores were examined to measure academic outcomes from control and treatment groups. Based on the summary statistics, there is an argument that corequisite students demonstrate equal or greater improvement in IAS scores compared to traditional students. Corequisite pre-post scores closed a larger gap (22.8 percentage points) than traditional pre-post scores (18.5 percentage points). Both Corequisite and Traditional post-IAS scores were comparable at 75.2% and 76.7%, respectively. Since corequisite students bypassed the pre-requisite Intermediate Algebra course, it is reasonable to expect IAS entry scores to be lower for corequisite students than traditional College Algebra students who met the minimum course requirements. However, since both groups finished with comparable post-IAS scores, one may deduce that corequisite students achieved at least equal improved academic achievement (as defined by the IAS assessment) to traditional students.

Another outcome of the summary statistics worth noting is the variance in pre- and post-IAS scores within each group. Corequisite students produced a mean pre-test score of 52.4% with a standard deviation (SD) of 17.1 compared to traditional students' mean score of 58.2% with a SD of 19.8. Although corequisite students scored lower on average than traditional students on the pre-IAS, they had less variance in scores. The post-IAS scores produced similar mean scores for both groups. However, the SD of corequisite student scores decreased to 14.8, while the SD of traditional student scores remained at 19.8. This suggests that corequisite students entered the course with a lower mean IAS score than traditional students, but their scores were less dispersed than traditional student scores. The post-IAS mean scores were comparable for both groups, yet corequisite mean scores decreased in variance while traditional student scores' remained more widely dispersed. This interpretation suggests that corequisite students not only demonstrated equal or greater improvement in academic outcomes, but corequisite students' scores were less dispersed than their traditional cohort.

Other evidence to support RQ1 was offered with the ANOVA test, which measured the differences in means of pre- and post-IAS scores between and within corequisite College Algebra students and traditional College Algebra students. Gains in mean pre- and post-IAS scores for the corequisite students were not statistically significantly different from traditional students' gains in pre- and post-IAS scores. The limited sample sizes of each group should be considered when analyzing significance levels. Collectively, however, all students showed statistically significant gains in mean scores from pre- to post-IAS assessment. This result also supports RQ1, suggesting that corequisite students demonstrate at least equal improvement in academic outcomes as traditional College Algebra students. This outcome, along with the discussion of summary statistics, corroborates other studies that attribute corequisite remediation to success in college-level math courses (Childers et al., 2021; Daugherty et al., 2018; Logue et al., 2019).

Discussion of Research Question 2

The second RQ was: *Do students enrolled in a scaffolded corequisite College Algebra course demonstrate equal or greater improvement in mathematics motivation (as measured by a pre- and post-test CANE model survey instrument) when compared to students enrolled in a traditional College Algebra course?*

Summary statistics and a two-way repeated measure ANOVA test from CANE scores were examined to measure mathematics motivation from corequisite and traditional College Algebra groups. Like the results from RQ 1, the ANOVA test indicated a statistically significant improvement in mean total CANE motivation scores from all students in both groups. Neither group, however, saw statistically significant differences in pre-post CANE scores in comparison to the other. Again, sample size and variability should be considered when analyzing significance.

To gain a further understanding of the ANOVA results, the summary statistics should be noted. The mean scores for both groups increased from pre- to post-survey. The corequisite group demonstrated a 5.2-point increase, with a post-survey mean score of 83.6. The traditional group registered a one-point gain, with mean scores of 83.0 on the pre-survey and 84.0 on the post-survey. Although corequisite students entered the course with a lower mean motivation score of 78.4, both groups concluded the course with similar total motivation scores. This suggests corequisite students gained mathematical motivation throughout the semester to a level comparable to their traditional counterparts. Furthermore, the ANOVA produced a moderate effect size for eta squared .077 for within-subjects (all students). The observed change in mean scores of corequisite students is larger than the change in mean scores for traditional students, which should be considered when interpreting the overall impact of the corequisite remediation. To partially address RQ 2, one may conclude that corequisite students experience at least equal improvement in motivation as traditional students.

To further address RQ 2, analysis was applied to the motivational subfactor scores to examine differences in scores for questions measuring anxiety, task value, persistence, and expectancy. A two-way repeated multivariable analysis of variance (MANOVA) test of the CANE survey results was implemented for each of the four motivational subfactors to analyze changes in CANE scores between subjects in the corequisite and traditional groups and scores of subjects within each motivational subfactor. While no significant changes in motivational subfactors were indicated between the treatment and control groups, two statistically significant increases were identified within the corequisite treatment group: anxiety and persistence. This suggests that within the corequisite cohort, students gained motivation by reducing anxiety and are more willing to persist in mathematics.

Limited research exists on the effects of corequisite remediation on motivation, so the findings of this study may provide more insight into a less-studied aspect of the intervention. Literature indicates that self-efficacy and anxiety play essential roles in mathematics achievement (Hiller et al., 2021; Hodges & Kim, 2013). Yet, these studies do not incorporate corequisite instruction. Zientek et al. (2017) assert that mastery experiences contribute to improved motivation through math self-efficacy. Since mastery experiences essential components of the corequisite model, the corequisite intervention organically impacts student motivation. Research question two explicitly targets the effects of corequisite remediation on mathematics motivation and corroborates that the intervention improves overall student motivation and achievement. In addition, the results pinpointed increased persistence and reduced anxiety as subfactors that corequisite students experienced. These findings support that corequisite students demonstrate at least equal improvement in overall mathematics motivation.

Discussion of Research Question 3

The third RQ was: *Do any trends or patterns exist among the demographic data identifying subsets of students who most benefit from corequisite instruction relating to academic achievement or motivation?*

Results from two multiple linear regressions (MLR) were analyzed to determine if specific subsets of students demonstrated statistically significant differences on IAS and CANE instruments. Differences in pre- and post-assessment scores were used as the output variable for each MLR. The first MLR measures differences in pre- and post-IAS scores across various subgroups. Senate Bill 1720 exemption status was the only subgroup variable reported as a statistically significant predictor of pre- and post-IAS score differences with a p-value of .029 and an unstandardized B estimate of -9.967. As such, the difference in pre- and post-IAS scores was 9.967 points lower for students with SB 1720 exemption status than students who were not exempt. SB 1720 exempt students are not required to take placement examinations and cannot be required to complete remedial math courses. As such, SB 1720 exempt students may enroll directly into Intermediate Algebra—the prerequisite course for College Algebra. Consequently, these students qualified to enroll in MAC 1105 Corequisite College Algebra. Since SB 1720 exempt students often lack placement scores and bypass potentially needed remedial math courses, their math background and preparedness level are unknown. This uncertainty may explain the statistically significant negative relationship with differences in pre-test and post-test IAS scores.

The second MLR followed a similar structure using differences in pre- and post-CANE survey total scores. Two variable subgroups emerged as statistically significant predictors of mathematics motivation: course and grade. The "course" variable yielded a p-value of .039 and a B estimate of -0.309. For the course subgroup, the reference group represented students in corequisite College Algebra courses. Therefore, the B estimate suggests that the average student in traditional College Algebra reported 0.309 lower in pre- and post-CANE motivation score differences when compared to corequisite students. Conversely, one may view that corequisite College Algebra students gained in differences between pre- and post-CANE scores.

The "grade" variable subgroup emerges as a strong predictor of motivation with a p-value of .002 and an unstandardized B estimate of 0.252. Grade categories were coded as follows: 0 = F, 1 = D, 2 = C, 3 = B, 4 = A. Therefore, the B estimate suggests that differences in pre- and post-CANE total motivation scores improved by 0.252 points for each increase in letter grade. This positive correlation is intuitive, as one may expect increases in motivational scores (from pre to post) as grades improve.

Significance of the Findings

This section addresses the significant contributions and implications of this study's findings. The results serve to add to the evidence from existing studies touting the academic effectiveness of the corequisite model while including the effect of the intervention on student motivation. To add dimension to the concept of "corequisite learning," this study implemented a scaffolded corequisite curriculum of advising and academic support aimed at improving student performance and motivation. This study also endeavored to identify subgroups of students who most benefit from the corequisite model.

Numerous studies exist measuring the effectiveness of corequisite remediation as an alternative pathway for underprepared students to enroll and succeed in college-level math courses without completing traditional developmental course sequences. (Bailey et al., 2010, Childers et al., 2021; Logue et al., 2019; Waschull, 2018; Wenner, 2011). Findings from RQ 1 corroborate these studies as corequisite students saw significant gains in academic performance on the Intermediate Algebra Skills (IAS) assessment. While corequisite students did not demonstrate statistically significant greater gains in IAS scores than their traditional counterparts, both groups reported similar results on the IAS post-assessment. Considering that corequisite students scored nearly six percentage points lower than traditional students on the IAS pre-assessment, the conclusion that the semester had similar outcomes is a testament to the effectiveness of the intervention on academic performance. Students who entered College Algebra with lower preparedness levels (based on IAS pre-assessment scores) obtained knowledge of prerequisite math skills through corequisite instruction adequate to perform similarly to their traditional counterparts. In addition, corequisite students reported decreased variability in mean scores from pre- to post-IAS assessment. This suggests that the intervention was effective in closing knowledge gaps within the corequisite cohort. Corequisite students entered the course with more dispersed IAS scores than when they concluded the course, whereas traditional College Algebra students saw no change in variability.

This suggests that despite corequisite students entering College Algebra with lower IAS scores than traditional students and exhibiting a wide dispersion of abilities, the intervention closed knowledge gaps within the corequisite cohort to produce post-IAS scores with less variability than they started.

Fewer studies exist measuring the effects of corequisite remediation on mathematics motivation. Research question 2 aimed to add to the body of research by determining whether students in corequisite College Algebra exhibit equal or greater improvement in mathematics motivation (as measured by the Commitment and Necessary Effort (CANE) survey) when compared to traditional College Algebra students. Again, summary statistics reported lower mean mathematics motivation scores from corequisite students on the CANE pre-survey than traditional students. However, both groups recorded comparable means on the CANE post-survey. The changes in scores within each group were less dramatic than the IAS results. Nevertheless, both groups improved over the semester. Students from both groups demonstrated statistically significant gains in differences in mean scores from pre- to post-CANE assessment, and the corequisite group closed a larger gap in score differences. Significant findings also emerged when dissecting motivation into four subfactors: anxiety, task value, persistence, and expectancy. The MANOVA analysis revealed that corequisite students reported statistically significant improvements in anxiety and persistence. No statistical significance emerged from subgroups within the control group. These findings revealed that the intervention positively impacted mathematics motivation of students in the corequisite College Algebra courses. This improvement is significant since research suggests higher motivation improves academic success (Acee & Weinstein, 2010; Collins, 2013; Simpkins et al., 2006; Wigfield & Eccles, 2000).

This study also aimed to identify subsets of students who most benefit from corequisite instruction relating to academic achievement or motivation. Subgroups included course (traditional or corequisite), gender, ethnicity, FTIC, course grade, Pell eligibility, and SB 1720 exemption status. Most subgroups did not demonstrate statistically significant improvement in pre- and post-test scores on the IAS or CANE instruments. This suggests the majority of students from various backgrounds had similar experiences within both groups. This is minimally supported, however, since most subgroups were limited in size. Nonetheless, three subgroups emerged with statistically significant differences in pre- and post-test scores: course, grade, and SB 1720 exemption. Perhaps the most interesting finding was from students with Senate Bill 1720 exemption status. Exempt students demonstrated a -9.967 decrease in IAS score differences from pre- to post-assessment to non-exempt students. This includes exempt students from both corequisite and traditional groups. Identifying potential factors influencing the negative relationship between exemption status and IAS score differences could impact the academic advising element of the scaffolded design. Since SB 1720 exempt students are not required to take placement exams, advisors may consider alternative measures for optimal course placement for College Algebra. Studies suggest a more holistic approach for placement using high school GPA, course history, or non-cognitive factors like measures of adjustment, motivation, and leadership can be effective predictors of success in college-level courses (Barnett et al., 2018; Belfield & Crosta, 2012; Ngo et al., 2018, Scott-Clayton, 2012; Sedlacek, 2004).

Limitations

A few limitations arose during this study. It is essential to report any limitations to the study to determine any threats to the interval validity or statistical validity of the study. Recruitment and enrollment, particularly following the aftermath of the COVID-19 pandemic, proved challenging. This study represented a quasi-experimental design, as there was no random placement of subjects. Qualified students were allowed open enrollment in the two traditional sections of College Algebra. However, to enroll in one of the three corequisite College Algebra sections, students were required to meet specific requirements and request permission to enroll.

As such, the groups were not equivalent. Also, due to social distancing protocols, class sizes were limited, affecting sample sizes.

The researcher developed the content and course shells used in both the corequisite and traditional courses and was the sole instructor for the control groups. This ensured consistency in the traditional College Algebra courses; however, since each corequisite course was taught by a different instructor, complete uniformity in the treatment groups was not possible. This may also result in a possible lack of fidelity in implementation. Since the researcher taught both traditional sections, prior knowledge of research, implicit biases, or the use of research-based pedagogies may have unintentionally affected learning and motivational outcomes. Since each corequisite course professor was trained on the course delivery, was aware of the purpose of this study, and was a tenured, full-time math faculty member, it is assumed both groups received equitable instructional quality. It should also be noted that one of the corequisite courses was taught using a different learning platform and course shell, but the coverage of learning outcomes was consistent across each section.

Consistency in grading also serves as a limitation in this study. While the study aimed for homogeneity in the corequisite treatment, College Algebra final course grades were assigned at the discretion of each professor. Assessments and other assignments outside of the researcher-designed course likely impacted final course grades. The Intermediate Algebra Skills (IAS) skills assessment was uniform across all courses and served as the quantifier for “academic success.” Furthermore, letter grades were used as a subfactor in the multiple linear regression for research question three analysis. Replication of this study may benefit from the use of common assessments and a common grading scheme.

Students’ enrollment in other courses taken concurrently with the College Algebra courses examined in the study should also be considered a limitation. Experiences and performance in other courses that utilize mathematics, such as science or business courses, may represent latent variables influencing post-CANE scores. While course schedules were not monitored in this study, it is expected that both groups would experience similar effects.

Exemption status from SB 1720 also posed a unique challenge for this study. According to the state bill, a student must have entered 9th grade in a state of Florida public school from 2003-2004 or thereafter and earned a Florida standard high school diploma or be a student on active military duty (Senate Bill 1720, 2013). As such, these students can forgo math placement exams and enter directly into Intermediate Algebra. Developmental math courses cannot be mandated, regardless of skill level. This heavily impacted students in the corequisite courses, with 56.7% meeting exemption status. The main requirement to enroll in the corequisite course was student eligibility to enroll in Intermediate Algebra. Therefore, SB 1720 exemption allows students with widely varied baseline math skills to enroll in the corequisite course. Students who were not exempt (43.3%) consisted of students who either tested in Intermediate Algebra or successfully completed a prerequisite developmental math course. One may assume these students possess a similar algebra skill set since they demonstrated mastery in previous courses or placement exams. The same cannot be assumed with exempt students, further justifying the need for the pre- and post-Intermediate Algebra Skills (IAS) assessment.

Recommendations for Further Research

Based on this study's findings and an examination of existing literature on related subjects, the following recommendations are proposed for future research.

1. Further research should be conducted to replicate this study on a larger scale to ensure the merit of the results and provide more valuable insights into the effectiveness of a scaffolded corequisite curriculum.
2. Further research should replicate the study with a focus on instruction equivalency. Offer multiple sections of corequisite and traditional College Algebra taught by different professors, all of whom have been trained on course delivery and best practices to improve the fidelity of instruction.
3. Further research should examine potential confounding variables affecting the performance of SB 1720 exempt students to understand better the negative correlation between exemption status and differences in pre- and post-IAS scores.
4. Further research should examine potential relationships between time-effect and performance/motivation. Bill SB 1720 exempt students must have entered 9th grade in a Florida public school from 2003-2004 or thereafter and earned a Florida standard high school diploma or be a student on active military duty (Senate Bill 1720, 2013). Research should examine whether any relationships exist between the time since last completing a math course and academic performance and motivation.
5. Further research should focus on identifying subsets of students who most benefit from corequisite remediation and the implications on advising and recruitment. This may be achieved more effectively with larger sample sizes.
6. Further research should explore the use of scaffolding strategies in other college systems and institutions to develop a more comprehensive understanding of what constitutes a scaffolded curriculum. Brower et al. (2021) offer strategies for collaboration between advisors, learning

support services, and instructors, such as training for faculty, advising workshops, promotional campaigns, and social engagement/motivational strategies for students.

7. Further research may consider the effects of a corequisite curriculum based on prior course success, including students who completed Intermediate Algebra and opted to enroll in a corequisite course for the supplemental instruction.
8. Further research is needed to investigate the long-term impact of corequisite instruction on student academic success in future college-level math courses or courses that require significant math skills.
9. Further research should study the effects of a corequisite model on other disciplines, grade levels, and trades/professions.

Conclusion

This study aimed to examine the effectiveness of a corequisite model implemented with a scaffolded curriculum. When incorporating academic support and proper advising with the "just in time" (JIT) remediation elements of corequisite learning, the study sought to examine the impact on student academic achievement and mathematics motivation. The findings of this study corroborate existing research that supports corequisite learning as an effective form of remediation. In addition to improving academic achievement, this study suggests corequisite courses can also improve student mathematics motivation. The analysis also identified the benefits of corequisite instruction with specific subgroups, which may strengthen the advising element of the curriculum. Overall, students saw greater gains in motivation and achievement than traditional students, and both groups demonstrated similar levels in both areas in post-course assessments. These results are promising for institutions wishing to implement a corequisite curriculum; however, the model may not benefit all subsets of students equitably.

Advisors should consider each student individually and determine if the intervention is best on a case-by-case basis. If students are advised properly and receive ongoing academic support (e.g., tutoring, mentoring) throughout JIT learning, students can experience gains in motivation and achievement similar to students in traditional College Algebra courses.

APPENDIX A: INTERMEDIATE ALGEBRA SKILLS (IAS) ASSESSMENT

Intermediate Algebra Skills Assessment | Name ______________________
MAC 1105 College Algebra | VID ______________________

*1. A car rental agency charges $225 per week plus $0.1 per mile to rent a car. How many miles can you travel in one week for $235?

- A. 248 miles
- B. 100 miles
- C. 75 miles
- D. 2350 miles

2. Cindy has scores of 71, 80, 84, and 90 on her biology tests. Use a compound inequality to find the range of scores she can make on her final exam to receive a C in the course. The final exam counts as two tests, and a C is received if the final course average is from 70 to 79.

- A. $70 \le \text{final score} \le 79$
- B. $12.5 \le \text{final score} \le 35$
- C. $47.5 \le \text{final score} \le 74.5$
- D. $95 \le \text{final score} \le 149$

3. Find $f(-2)$ when $f(x) = 2x^2 + 5x + 7$.

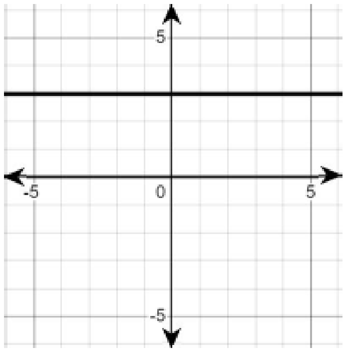
- A. 8
- B. 25
- C. -9
- D. 5

4. Find the slope and the y-intercept of the line.

$5y - 2x = -5$

- A. $m = -\frac{5}{2}$; $b = 1$
- B. $m = -\frac{2}{5}$; $b = -1$
- C. $m = \frac{2}{5}$; $b = 1$
- D. $m = \frac{2}{5}$; $b = -1$

*5. Write an equation of the line.



- A. $y = 3$
- B. $y = 3x$
- C. $y = x + 3$
- D. $x = 3$

6. Simplify.

$$\frac{4 + \frac{2}{x}}{\frac{x}{4} + \frac{1}{8}}$$

- A. 16
- B. $\frac{x}{16}$
- C. 1
- D. $\frac{16}{x}$

7. Multiply.

$(3x - 5)^2$

- A. $9x^2 - 30x + 25$
- B. $9x^2 + 25$
- C. $3x^2 + 25$
- D. $3x^2 - 30x + 25$

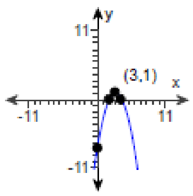
8. A ball is thrown downward with an initial velocity of 42 meters per second from a cliff that is 120 meters high. The height of the ball is given by the quadratic equation $h = -4.9t^2 - 42t + 120$ where h is in meters and t is the time in seconds since the ball was thrown. Find the time it takes the ball to hit the ground. Round your answer to the nearest tenth of a second.

- A. 2.4 sec
- B. 2.2 sec
- C. 2.3 sec
- D. 3.3 sec

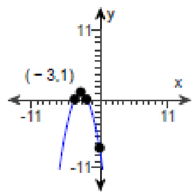
9. Match the function with its graph.

$f(x) = x^2 - 6x + 8$

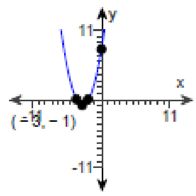
- ◯ **A.**



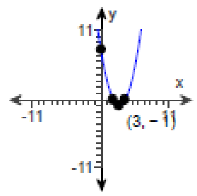
- ◯ **B.**



- ◯ **C.**



- ◯ **D.**



10. Find the domain of the rational function.

$f(x) = \dfrac{7x - 2}{x^2 - 81}$

- ◯ **A.** $\left\{x \mid x \text{ is a real number and } x \neq \frac{2}{7}\right\}$
- ◯ **B.** $\{x \mid x \text{ is a real number and } x \neq 9\}$
- ◯ **C.** $\{x \mid x \text{ is a real number and } x \neq 9, x \neq -9\}$
- ◯ **D.** $\{x \mid x \text{ is a real number and } x \neq 81\}$

APPENDIX B: IAS ASSESSMENT QUESTION OBJECTIVES AND DIFFICULTY

Student:
Instructor: R S

Course: Intermediate Alg Skills Assessment Course
Book: Martin-Gay: Intermediate Algebra, 8e

View Question Details

Assignment name	Intermediate Algebra Skills Assessment
Chapter coverage	2-3, 5-6, 8
Displays with chapters	8
Total oints	10
Estimated time:	
Metrics-based assignment difficulty	Easy (2), Moderate (4), Hard (2), Very Hard (0), No Indicator (2

#	Question ID	Objective
	*1.3-8 (tb)	Solve applications involving linear models.
2	2.5-9 (tb)	Solve compound inequalities containing "and" that also have the variable on the left and the right.
3	3.2-36 (tb)	Use function notation to find function values.
4	3.4-22 (tb)	Given the equation of a line, state its slope and y-intercept if they exist.
5	*7.4-18 (tb)	Write an equation of a line given the graph of the line.
6	6.3-16 (tb)	Simplify expressions with negative exponents.
7	5.4-13 (tb)	Use special products to multiply polynomials.
8	8.2-28 (tb)	Solve problems modeled by quadratic equations.
9	8.6-12 (tb)	Match functions with their graphs by finding the vertex and intercepts.
10	6.1-7 (tb)	Find the domain of a rational function.

APPENDIX C: COMMITMENT AND NECESSARY EFFORT (CANE) SURVEY

Qualtrics CANE Survey **Fall 2022**

Demographics

Hello! You are being asked to participate in a research study designed to gather information on the attitudes and behaviors of students in mathematics classes. This project is for research purposes only and no one except the research team will have access to your responses. All responses, and your identity, will be kept confidential. Your student ID number is used for demographic data and your responses will not be identified with your name.

Your participation is completely voluntary, You do not have to answer any questions you do not wish to answer. Whether you choose to participate or not your course grade will not be affected.

Will you participate and allow your responses to by collected by Professor Sandefur for research purposes?

- ○ YES, I will participate.
- ○ No, I prefer not to participate.

Are you 18 years of age or older?

- ○ YES, I am 18 years old or older
- ○ No, I am younger than 18

Which college is your primary institution?

- ○ Valencia College
- ○ UCF

Required: Enter your college identification number. PID (for UCF students) or VID (for Valencia College students). If no ID, provide the last four digits of SS #.

What course are you in?

- ○ MAC 1105 College Algebra (traditional course)
- ○ MAC 1105 College Algebra (COREQUISITE course)
- ○ MAT 1033C Intermediate Algebra

What campus are your taking this course?

- ○ East
- ○ Osceola
- ○ Downtown
- ○ Lake Nona

State the name of your instructor and your class meeting day and time. For example, "Professor Smith, MW from 10-11:15 am."

What is your gender?

- ○ Male
- ○ Female
- ○ Other

What is your age?

- Under 18
- 18 - 24
- 25 - 34
- 35 - 44
- 45 - 54
- 55 - 64
- 65 - 74
- 75 - 84
- 85 or older

Are you of Hispanic, Latino, or Spanish origin?

- Yes
- No

Which of the following best describes you?

- Asian or Pacific Islander
- Black or African American
- Hispanic or Latino
- Native American or Alaskan Native
- White or Caucasian
- Multiracial or Biracial
- A race/ethnicity not listed here

Questionnaire

Please choose the response that best matches your reaction to each of the following questions. Individual responses are confidential, so thank you for your honest and careful consideration of these questions.

Compared to other students, how well do you expect to do in math this year.

1) much worse	2) worse	3) the same	4) better	5) much better
○	○	○	○	○

I have usually been at ease during math tests.

1) strongly disagree	2) disagree	3) neutral	4) agree	5) strongly agree
○	○	○	○	○

How much do you like doing math?

1) not at all	2) not much	3) neutral	4) somewhat	5) very much
○	○	○	○	○

I feel that, to me, being good at solving problems which involve mathematical reasoning is important.

1) strongly disagree	2) disagree	3) neutral	4) agree	5) strongly agree
○	○	○	○	○

If I have trouble understanding a math problem, I go over it again until I understand it.

1) strongly disagree	2) disagree	3) neutral	4) agree	5) strongly agree
○	○	○	○	○

How well do you think you will do in math this year?

1) very poorly	2) poorly	3) fair	4) good	5) very good
○	○	○	○	○

It wouldn't bother me at all to take more math courses.

1) strongly disagree	2) disagree	3) neutral	4) agree	5) strongly agree
○	○	○	○	○

If I run into a difficult homework problem, I usually give up and go on to the next problem.

1) strongly disagree	2) disagree	3) neutral	4) agree	5) strongly agree
○	○	○	○	○

I get a sinking feeling when I think of trying hard math problems.

1) strongly disagree	2) disagree	3) neutral	4) agree	5) strongly agree
○	○	○	○	○

Is the amount of effort it takes to do well in math worthwhile to you?

1) not at all	2) not much	3) neutral	4) somewhat	5) very much
○	○	○	○	○

I try to complete homework assignments as fast as possible without checking my accuracy.

1) strongly disagree	2) disagree	3) neutral	4) agree	5) strongly agree
○	○	○	○	○

Math makes me feel uncomfortable and nervous.

1) strongly disagree	2) disagree	3) neutral	4) agree	5) strongly agree
○	○	○	○	○

If I have trouble solving a homework problem, I use the help features in MyMathLab.

1) strongly disagree	2) disagree	3) neutral	4) agree	5) strongly agree
○	○	○	○	○

How good at math are you?

1) not at all good ○ 2) not good ○ 3) fair ○ 4) good ○ 5) very good ○

Math makes me feel confused and uneasy.

1) strongly disagree ○ 2) disagree ○ 3) neutral ○ 4) agree ○ 5) strongly agree ○

How useful is learning math for what you want to do after you graduate and go to work?

1) not at all ○ 2) not much ○ 3) neutral ○ 4) somewhat ○ 5) very much ○

If I have trouble solving a problem, I try to get someone else to solve it for me.

1) strongly disagree ○ 2) disagree ○ 3) neutral ○ 4) agree ○ 5) strongly agree ○

I almost never get uptight while taking math tests.

1) strongly disagree ○ 2) disagree ○ 3) neutral ○ 4) agree ○ 5) strongly agree ○

In general, I find working on math assignments ____________.

1) very boring ○ 2) boring ○ 3) neutral ○ 4) interesting ○ 5) very interesting ○

How useful is what you learn in math for your daily life outside of school?

1) not at all 2) not much 3) neutral 4) somewhat 5) very much

○ ○ ○ ○ ○

When I read something in my homework that doesn't make sense, I skip it and hope that the teacher explains it in class.

1) strongly disagree	2) disagree	3) neutral	4) agree	5) strongly agree
○	○	○	○	○

How have you been doing in math this year?

1) very poorly	2) poorly	3) fair	4) well	5) very well
○	○	○	○	○

I get really uptight during math tests.

1) strongly disagree	2) disagree	3) neutral	4) agree	5) strongly agree
○	○	○	○	○

If I have trouble solving a math problem, I am likely to guess at the answer rather than to look at examples and try to figure it out.

1) strongly disagree	2) disagree	3) neutral	4) agree	5) strongly agree
○	○	○	○	○

I have usually been at ease in math courses.

1) strongly disagree	2) disagree	3) neutral	4) agree	5) strongly agree
○	○	○	○	○

My mind goes blank and I am unable to think clearly when doing math.

1) strongly disagree	2) disagree	3) neutral	4) agree	5) strongly agree
○	○	○	○	○

When I run into a difficult homework problem, I keep working at until I think it is solved.

1) strongly disagree	2) disagree	3) neutral	4) agree	5) strongly agree
○	○	○	○	○

How important is it to you to get good grades in math?

1) not at all	2) not much	3) neutral	4) somewhat	5) very much
○	○	○	○	○

I usually don't worry about my ability to solve math problems.

1) strongly disagree	2) disagree	3) neutral	4) agree	5) strongly agree
○	○	○	○	○

If you were to order all the students in your class from the worst to the best in math, in which group would you put yourself?

1) the worst	2) bad	3) average	4) good	5) the best
○	○	○	○	○

APPENDIX D: INFORMED CONSENT SCRIPT

Project: Study of Effects of Corequisite Curriculum on Motivation and Achievement

Meta-data Location: Time and date: Place: Zoom web-conferencing app; Principal Investigator: Patrick Ryan Sandefur Audience: MAC 1105 College Algebra students

Script:

Hello, my name is Ryan Sandefur. I'm a doctoral student from the University of Central Florida and a math professor at Valencia College. Thank you for taking the time to talk with me today.

I am conducting a study this semester of the corequisite and traditional models of College

Algebra offered by Valencia College, comparing student motivation and achievement.

By allowing us to use your data, the Mathematics Department at Valencia College will better understand which version of the course is most likely to help students who take this course in the future.

As a part of your College Algebra course, you will be completing a survey about your motivation to learn math and a test of your math skills at the beginning and end of the semester. These are required whether you consent to participate or not. You will take the motivation survey online, and it will take about 10 minutes. You will take the math test in class, and it will take about 20 to 30 minutes. You will take both during the first week of course and again during the last week of the semester. To consent to participate in the study, you only need to agree to allow your data to be collected and analyzed for study purposes.

Your participation in this study is voluntary. You are free to withdraw your consent and discontinue participation in this study at any time without prejudice or penalty. Your decision to participate or not participate in this study will in no way affect your relationship with Valencia College or UCF, including continued enrollment, grades, employment, or your relationship with the individuals who may have an interest in this study.

Do you understand the study's purpose? Do you have any questions? An informed consent email will be sent to each of you to offer consent to use your data in this study or to opt out. Please take a moment to respond to that email. If you have any further questions or concerns, please do not hesitate to reach out. My email address is rsandefur@valenciacollege.edu, or you can call/text me at 407-900-8378. Thank you for your time!

APPENDIX E: IRB EXEMPTION DETERMINATION

UCF

UNIVERSITY OF CENTRAL FLORIDA

Institutional Review Board
FWA00000351
IRB00001138, IRB00012110
Office of Research
12201 Research Parkway
Orlando, FL 32826-3246

EXEMPTION DETERMINATION

July 28, 2022

Dear Patrick Sandefur:

On 7/28/2022, the IRB determined the following submission to be human subjects research that is exempt from regulation:

Type of Review:	Initial Study, Exempt 1, 2ii
Title:	A Scaffolded Corequisite Curriculum for College Algebra Students: Effects on Achievement and Motivation
Investigator:	Patrick Sandefur
IRB ID:	STUDY00004525
Funding:	None
Grant ID:	None
Documents Reviewed:	• 4525 HRP-254-FORM Explanation of Research Sandefur UPDATED.pdf, Category: Consent Form; • CANE Survey Fall 2022, Category: Survey / Questionnaire; • HRP 255 Request for Exemption, Category: IRB Protocol; • Informed Consent Script Sandefur.docx, Category: Recruitment Materials; • Intermediate Algebra Skills Assessment.pdf, Category: Test Instruments; • MAC 1105 College Algebra (Corequisite) Syllabus with Course Schedule Fall 2022.pdf, Category: Other; • MAC 1105 College Algebra (Traditional) Syllabus with Course Schedule Fall 2022.pdf, Category: Other; • Study Invitation Script.docx, Category: Recruitment Materials;

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made, and there are questions about whether these changes affect the exempt status of the human research, please submit a modification request to the IRB. Guidance on submitting Modifications and Administrative Check-in are detailed in the

Investigator Manual (HRP-103), which can be found by navigating to the IRB Library within the IRB system. When you have completed your research, please submit a Study Closure request so that IRB records will be accurate.

If you have any questions, please contact the UCF IRB at 407-823-2901 or irb@ucf.edu. Please include your project title and IRB number in all correspondence with this office.

Sincerely,

Harry Wingfield
Designated Reviewer

APPENDIX F: COREQUISITE COURSE LETTER TO ADVISORS

Dear Advising Staff,

Greetings! I am writing to share with you a course that may benefit students needing MAC 1105 College Algebra but do not yet meet the course prerequisites. The Downtown Campus is offering one face-to-face section of **MAC 1105 College Algebra with Corequisite Lab (CRN: [redacted])** in during the following times:

Lab: M/W 12:00-12:50 pm

Lecture Class: M/W 1:00-2:15 pm

This course is equivalent to 5 contact hours, but students only pay tuition for 3 credits of instruction. The corequisite course allows eligible students to bypass Intermediate Algebra and enroll directly into College Algebra with concurrent corequisite labs designed to fill math skills gaps. This provides an accelerated pathway for students to receive College Algebra credits in one semester! **Any [Juniper State College] student eligible to enroll in MAT 1033C Intermediate Algebra is eligible to enroll in MAC 1105 College Algebra with Corequisite Lab (CRN: 14936) with department permission.**

However, while the corequisite course can represent a GREAT opportunity for students, the course may not be a good academic option for all eligible students. Based on literature studying corequisite models and my experience teaching the course, there are a few factors that research identifies as potential predictors of success for students in a corequisite course:

- **Math Skill Level:** Students "on the cusp" of testing into College Algebra often represent great candidates for corequisite courses, as they likely just need a refresher.
- **High School GPA:** Students who have a good high school GPA and had prior success in high school math course often do well in the corequisite course.
- **Commitment and Motivation:** It may be necessary to informally gauge whether a student is willing to commit the time and effort needed to be successful. This is a rigorous, 5-contact hour course.
- **Prior Successes:** Students who displayed prior successes in remedial courses and are now eligible to take MAT 1033C may also be great candidates for the corequisite course. Ex.: students who make an A in MAT 0028C or MAT 0022C Developmental Math Combined.

APPENDIX G: COREQUISITE COURSE RECRUITMENT FLYER

MAC 1105
COLLEGE ALGEBRA
WITH COREQUISITE LAB

DOWNTOWN CAMPUS: FALL 2022

Course Offerings:

Lab: M/W 12:00-12:50 pm

Class: M/W 1:00-2:15 pm

CRN: 14936

Is this course right for YOU?

- Are you eligible to take MAT 1033C? ☑
- Do you need MAC1105 for your degree? ☑
- Do you just need a refresher of math skills? ☑
- Can you commit the **time** and **effort**? ☑

WHAT IS THE COURSE?

This course is designed for students who need to take MAC 1105 College Algebra but have not yet met the prerequisites for the course. Eligible students may enroll directly into MAC 1105 College Algebra with corequisite labs designed to teach the math skills you need "just in time" for use in the College Algebra course.

WHO IS ELIGIBLE?

Any Valencia College student eligible to take MAT 1033C Intermediate Algebra may enroll in MAC 1105 College Algebra Corequisite Lab with special permission.

HOW TO REGISTER

SIGN UP TODAY!

For general questions, contact:
Professor Ryan Sandefur
rsandefur@valenciacollege.edu

APPENDIX H: CANE SURVEY QUESTIONS BY MOTIVATION SUBSCALE

Subscale	Question	Score	Reversed (R)
Factor 1: Anxiety			
Q2	I have usually been at ease during math tests.	0.719	
Q3	How much do you like doing math?	0.585	
Q9	I get a sinking feeling when I think of trying hard math problems.	-0.758	R
Q12	Math makes me feel uncomfortable and nervous.	-0.952	R
Q14	How good at math are you?	0.679	
Q15	Math makes me feel confused and uneasy.	-0.927	R
Q18	I almost never get uptight while taking math tests.	0.568	
Q23	I get really uptight during math tests.	-0.755	R
Q25	I have usually been at ease in math courses.	0.753	
Q26	My mind goes blank, and I am unable to think clearly when doing math.	-0.509	R
Factor 2: Task Value			
Q4	I feel that to me, being good at solving problems that involve mathematical reasoning is important.	0.682	
Q5	If I have trouble understanding a math problem, I go over it again until I understand it.	0.607	
Q7	It wouldn't bother me at all to take more math courses.	0.603	
Q10	Is the amount of effort it takes to do well in math worthwhile to you?	0.541	
Q16	How useful is learning math for what you want to do after you graduate and go to work?	0.517	
Q19	In general, I find working on math assignments _____________.	0.478	
Q20	How useful is what you learn in math for your daily life outside of school?	0.477	
Q28	How important is it to you to get good grades in math?	-0.46	
Q29	I usually don't worry about my ability to solve math problems.	0.439	
Factor 3: Persistence			
Q8	If I run into a difficult homework problem, I usually give up and go on to the next problem.	0.678	R
Q27	When I run into a difficult homework problem, I keep working until I think it is solved.	-0.561	
Q24	If I have trouble solving a math problem, I am likely to guess the answer rather than look at examples and try to figure it out.	0.532	R
Q21	When I read something in my homework that doesn't make sense, I skip it and hope that the teacher explains it in class.	0.527	R
Factor 4: Expectancy			
Q1	When compared to other students, how well do you expect to do in math this year?	0.76	
Q6	How well do you think you will do in math this year?	0.69	
Q22	How have you been doing in math this year?	0.508	
Q30	If you were to order all the students in your class from the worst to the best in math, in which group would you put yourself?	0.442	

Note. R=Reversed Scores from the CANE survey. Scores from a pattern matric within factors were used to justify reverse scoring. Questions 11, 13, and 17 were omitted from data analysis due to low correlation within subscales.

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