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Relationship of Supplemental Instruction and Attitude of Students Enrolled in College Algebra

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**RELATIONSHIP OF SUPPLEMENTAL INSTRUCTION AND ATTITUDE OF
STUDENTS ENROLLED IN COLLEGE ALGEBRA**

by

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B.S. May 2017, Old Dominion University

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ABSTRACT

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The problem of this study was to determine the relationship of supplemental instruction on the attitudes of college algebra students at a Southeastern university. The population for this study consisted of college algebra students enrolled in M102 and M103 courses in the Summer 2018 semester. While M102 and M103 cover the same material, M103 requires mandatory tutoring in addition to the classroom instruction. A survey of these students provided data on their attitudes toward mathematics at the beginning and end of their college algebra course. The first research question of this study asked to what extent attitudes differ, if at all, for students in college algebra courses with and without supplemental instruction. This question was examined using a two-sample t -test assuming equal variances and a Wilcoxon sign test. The results and conclusions of the study suggest supplemental instruction does not significantly impact the attitudes of college algebra students.

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Kele Anne McKaig

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CHAPTER I

INTRODUCTION

Mathematics is often a challenging subject for students at all experience levels. At the college level, mathematics is a general education requirement necessary for most degree programs. Some students who do not meet the prerequisites to register for the mathematics course needed by their degree program may be placed in developmental courses or early college courses that are below the required level for their degree program. For example, a student pursuing engineering may score into a precalculus level course, but the engineering degree program only rewards credit for calculus and above. Developmental courses focus on building skills needed for students to reach credit bearing levels of college instruction (Jones, Yarema, & Windham, 1996). Developmental courses are needed by approximately one-third of freshman college students, in both 2-year colleges and 4-year universities. Only half of these students successfully complete the developmental courses necessary to reach the credit bearing course for their degree program (Benken, Ramirez, Li, & Wetendorf, 2015).

Often students view developmental and early college mathematics as a barrier that impedes them from proceeding with their education (Guy, Puri, & Cornick, 2016). This view of mathematics as an unnecessary course may be problematic. Several studies have been completed to evaluate the effect of attitudes on academic success. Negative attitudes toward mathematics often result in poor engagement, high dropout rates, and failure (Hodges & ChanMin, 2013).

One approach to address the completion rates for high failure courses, such as developmental and early college mathematics, is supplemental instruction (SI). Supplemental instruction sessions are often used as a voluntary, recitation-style supplement to lectures. These extra sessions emphasize students working cooperatively and are generally led by peers who show proficiency in the subject. This model of intervention has undergone modifications and

adaptations by different universities since its start in 1974 (Peterfreund, Rath, Xenos, & Bayliss, 2008). While supplemental instruction has been used to address issues such as improving pass rates for mathematics, its impact on student attitude has not been assessed. Negative attitudes toward mathematics have been associated with high dropout rates (Hodges & ChanMin, 2013), which would make investigating the impact of instructional strategies on attitudes worth pursuing. This study addresses the gap between supplemental instruction and attitudes of students towards college level algebra.

Statement of the Problem

The purpose of this study is to determine the relationship between supplemental instruction and college algebra students' attitudes toward mathematics at a Southeastern University.

Research Questions

To guide this study, the following research questions were:

RQ₁: To what extent do attitudes differ, if at all, for students in college algebra courses with and without supplemental instruction?

H₀: Supplemental instruction does not change college student's attitudes toward mathematics.

H₁: Supplemental instruction improves college student's attitudes toward mathematics.

Background and Significance

General education requirements at the Southeastern university include lower-division mathematics. While the specific required course varies with degree program, undergraduates must receive or transfer credit for critical thinking mathematics, college algebra, precalculus, or elementary statistics. This level of mathematics provides a foundation for skills, such as logical reasoning and data interpretation, needed to progress through a degree program. The most

common required mathematics course for degree programs at the Southeastern university are College Algebra M102 or College Algebra with Supplemental Instruction M103. The Southeastern University requires students with a Math SAT score less than or equal to 450, or high school GPA less than 3.0, to register for M103 (Math, 2018). Supplemental instruction is a mandatory part of M103, worth 7% of the final grade for the course. Each lecture section of M103 is given several supplemental instruction sessions, referred to as SI sessions, which act as a recitation-style course. The SI sessions are held once a week in fall and spring semesters, and three times a week during summer semesters. The Math and Science Resource Center (MSRC) employs the SI leaders, undergraduate and graduate students that have shown proficiency with the course, to act as the facilitators for the sessions. Students are encouraged to work together to solve problems. The SI leader gives each student marks based on attendance and participation, which is in turn provided to the lecture instructors (A. Stephen, personal communication, July 7th, 2018).

This study could provide information on the relationship between the type of supplemental instruction program implemented at the Southeastern university and student attitudes toward mathematics. The findings of this study could also be used to inspire further development of resources for developmental mathematics courses at the Southeastern university.

Limitations

The following are limiting factors to the study:

1. The study is limited to a sample of students at a Southeastern university in the United States.
2. The data collection for the study is limited to one form of data collection in the form of a questionnaire.

Assumptions

The study is based on the following assumptions:

1. Students respond honestly to the questionnaire.
2. Students possess the reading comprehension skills in English to understand the items on the questionnaire.
3. Students in the M103 group attend the mandatory supplemental instruction sessions.

Procedures

This is a quasi-experimental, quantitative study to determine the relationship between supplemental instruction and attitudes toward mathematics. Participants of the study include the Southeastern university students from sections of college algebra with supplemental instruction and sections of college algebra without supplemental instruction. The measure for the study, the Attitudes Toward Mathematics Instrument (ATMI), created by Tapia (Tapia & Marsh, 2004), was given to the participants twice during the semester: once before the first test, and again before the final examination for the course. The instrument is comprised of 40 items using a 6-point Likert scale ranging from “Strongly Agree” to “Strongly Disagree”. The results of the study will give an indication as to whether supplemental instruction can influence attitudes toward mathematics.

Definition of Terms

The following are a list of terms used in this report. These definitions are given to assist the reader in understanding the study.

1. Attitude: a mental position, feeling, or emotion to a fact or state (Dictionary by Merriam-Webster, 2017).
2. Supplemental Instruction (SI): group study session that is mandatory for M103.

3. Math and Science Resource Center (MSRC): The office under the College of Sciences which provides tutoring, supplemental instruction, and workshops for math and science students.
4. M102: the section of college algebra at the Southeastern University that does not include supplemental instruction.
5. M103: the section of college algebra at the Southeastern University that does include supplemental instruction.

Overview of Chapters

Chapter I provides an introduction to the purpose of this study and the issue with student attitudes toward mathematics. While there is separate research on developmental and early college mathematics, attitudes toward mathematics, and supplemental instruction, there are gaps in literature that examine the relationship between these topics. This study will assess the kind of relationship between the supplemental instruction offered at the Southeastern University and the attitudes of the students enrolled specifically in college algebra.

Chapter II provides a review of literature to examine previous studies on developmental mathematics, attitudes and beliefs towards mathematics, and supplemental instruction. This review identifies gaps in the literature to further the investigation into the relationship of supplemental instruction and attitude, as it pertains to developmental mathematics. Chapter III outlines the methods and procedures used to collect the data for this study.

CHAPTER II

REVIEW OF LITERATURE

The purpose of this study is to investigate the relationship of supplemental instruction and attitude of students at a Southeastern university. This review of literature provides information on developmental mathematics, attitudes and beliefs toward mathematics, and supplemental instruction.

Developmental and Early College Mathematics

Mathematics courses are often seen as unnecessary hurdles by college students (Sierpinska, Bobos, & Knipping, 2008). Many students feel that the material covered in early college mathematics courses will not pertain to their career path. This lack of engagement with the course material often results in frustration towards mathematics (Sierpinska et al., 2008). Many students find themselves in developmental mathematics courses due to factors such as placement test scores or SAT scores, and an alarming number of students fail and subsequently repeat the courses (Giang-Nguyen, 2015). Repetition of a course is damaging to a student's confidence and general attitude towards the subject (Giang-Nguyen). Developmental mathematics courses often span multiple semesters and are seen as "gatekeepers" that prevent students from proceeding with their chosen degree and drain students' financial resources (Guy, et. al, 2016). When students struggle to pass an introductory mathematics class, continuing to a higher level of mathematics may be overwhelming.

Poor pass rates in developmental mathematics is a national problem. For 4-year universities, only half of the students that are initially placed in developmental mathematics will pass the sequence of courses necessary to attempt the credit bearing course (Benken, Ramirez, Li, & Wetendorf, 2015). The issue with retention of students in developmental and early college mathematics courses has inspired discussion on whether developmental courses are helpful for

preparing students for credit bearing courses. Requiring a long sequence of developmental courses can impair a student's ability to complete the necessary credit bearing course, which can dissuade the student from pursuing their chosen degree plan (Guy et al., 2016).

Despite the poor achievement rates in developmental and early college mathematics courses, some argue the foundation is necessary for student success (Jones et al., 1996). Mathematics can support other discipline areas by improving problem-solving skills and introducing applications for mathematics, which can make graduates more impressive candidates for jobs (Champion, Parker, Mendoza-Spencer, & Wheeler, 2011). Mathematical exercises like word problems can help students contextualize the information and transfer their knowledge by giving them practical applications (Jaafar, 2015). While the specific course content for developmental mathematics may not be applicable to students' careers, the analytical ability gained through these courses is important (Champion et al., 2011).

College algebra is a common early college mathematics course that consistently has poor student performance (Porter, 2010). College algebra is a common type of high-risk mathematics course, in which at least 30% of students receive a failing or withdrawal grade (Phelps & Evans, 2006). At the Southeastern university, college algebra acts as a general education requirement for many degree programs. However, for STEM degree programs, the general education requirement for mathematics is several levels above college algebra. For STEM majors, college algebra falls under the developmental mathematics category, where, despite providing elective credits, it does not fulfil the degree requirement.

Students' perceptions of difficulty play a large role in their confidence in the subject (Giang-Nguyen, 2015). Often, students perceive the expectations of the course to be beyond their capabilities, even if the student has confidence in their technical ability (Jaafar, 2015). Students often tend to drop out of these developmental mathematics courses after the first test or

evaluation (Jones et al., 1996). Motivation and confidence of students in developmental mathematics can be improved by revising the material to appear relevant to students (Giang-Nguyen, 2015). Implementing “second-chance” methods, such as allowing students to retake tests, or pass the course if they pass the final, could be a motivational tool to boost retention in developmental mathematics courses (Jones, Yarema, and Windham, 1996).

Attitudes and Beliefs Toward Mathematics

There are consistent and strong positive correlations between attitude and achievement (Schoenfeld, 1989). Similarly, negative attitudes toward mathematics can damage students’ abilities to engage with the course material. Poor engagement with course material often leads to high dropout rates and failure to pass the course (Hodges & ChanMin., 2013). The belief that mathematics is an unnecessary part of education is also problematic, and that attitude can harm the achievement of students in mathematics courses. There have been several studies exploring how attitudes and beliefs factor into success in mathematics and what factors may alter these attitudes and beliefs.

Many studies have been done to determine the relationship between gender and attitudes toward mathematics. Kwiatkowski, Dammer, Mills, and Jih (1993) supported previous research by finding that college male students show greater interest in mathematics than college female students, which suggests males possess a more positive attitude towards mathematics. However, Arslan, Canh, and Sabo (2012) investigated the differences in attitude and behavior towards mathematics based on gender in 6th, 7th, and 8th grade students. They found that young female students were more positive about mathematics and had greater success than young male students.

Attitudes and beliefs toward a subject can change over time. In a study conducted with 7th, 10th, and 12th grade students, Ing and Nylund-Gibson (2017) found that large portions of

students possess malleable attitudes towards mathematics, as opposed to consistently positive or negative attitudes. Attitudes in mathematics can be altered by the process of working problems, the perceived difficulty of the subject, the purpose of the exercises, and factors of the learning environment (Lin, 1982). Attitudes are also subject to change based on differences in instructors and the method of instruction (Ing & Nylund-Gibson, 2017). Achievement and the feeling of progress can be positive influences on an individual's attitude. The mathematics scores a student receives in secondary school have a positive correlation with their attitude toward mathematics during postsecondary education (Karjanto, 2017).

Strategies to improve attitudes and beliefs toward mathematics are important because these feelings can have an impact on students' career decisions (Hodges & ChanMin, 2013). Attitudes and interests in mathematics heavily affects student pursuit of STEM careers (Rice, Barth, Guadagno, Smith, & McCallum, 2013). Mathematics is generally highly valued by students, even if it is not a part of their field of study, because of a belief that mathematics is an important subject in technical fields (Lin, 1982). While the belief in the value of mathematics is important for interest in the subject, strategies need to be implemented to improve the motivation of students to pursue mathematics heavy fields. Success in pursuing science related fields requires a strong background in mathematics, which is tied to the attitude and motivation of the student (Karjanto, 2017).

Sources of frustration for mathematics students include fast pacing, inefficient learning strategies, forced prerequisites, insufficient academic and moral support, and poor prior achievement (Sierpinska et al., 2008). These frustrations can negatively impact the motivation, confidence, and attitudes of students. Authentic representations of real world applications can be difficult to translate to students who feel the material itself is not relevant (Champion et al., 2011). When students feel the material is irrelevant, it can be harmful to their attention to the

subject and motivation to continue the course (Giang-Nguyen, 2015). Even if a project demonstrates skills that are valued by prospective employers, students often can feel these projects are not representative of their career goals, and thus express disinterest (Champion et al., 2011). In addition, students who think less of their abilities tend to believe their successes can be attributed to luck rather than their own work (Schoenfeld, 1989). Assuming success in a subject is due to luck or another uncontrollable factor is harmful to the overall motivation to learn.

Several studies have focused on possible learning strategies to improve attitudes and limit student frustration toward mathematics. Greater social support for mathematics and science subjects has been shown to support better attitudes and perceptions of students' own abilities (Rice et al., 2013). Hodges and ChanMin (2013) found that even short interventions in the form of motivational videos can positively impact the attitudes and achievements of students in mathematics.

Supplemental Instruction

Supplemental instruction (SI) is a learning intervention that encourages students to learn course material through practice, group interaction, and shared learning. SI sessions are generally peer-lead, voluntary, and focus on cooperative learning, although modifications to this format have been done by different universities (Peterfreund et al., 2008). The SI sessions at the Southeastern university were modified to be mandatory for M103. The SI intervention began in 1974 with Martin from the University of Missouri-Kansas City to improve achievement in high-risk courses. Many universities have adopted a form of this model for high risk STEM courses.

The goals of SI are to improve achievement and retention of students in traditionally difficult subjects (Porter, 2010). SI implementation has shown positive learning gains, increases in retention, and higher levels of achievement, particularly for lower-ability students (Lazari & Simons, 2003). SI also encourages cooperation among students and respect for diverse ways of

learning (Congos, 2002). Interaction between peers can give students different perspectives on the course material and offer new approaches to solve problems (Jaafar, 2015). SI particularly improves problem-solving skills. For example, students perform better on word problems when they attempt to solve the problems in groups.

With SI intervention, students who scored significantly lower on the SAT can perform to the same standard on college algebra finals as those with higher SAT scores (Lazari & Simons, 2003). While all levels of students showed benefits from SI, the weaker students had a lower failure rate, which made them comparable to students with higher prior math achievement (Malm, Bryngfors, & Morner, 2011). In addition, underrepresented minorities have largely positive score outcomes and overall increased academic performance with the addition of SI (Peterfreund et al., 2008). For all levels of students, those with average or high attendance for the SI sessions significantly increase their chances of passing the course (Malm et al., 2011).

The academic and achievement benefits of SI, particularly for students who start at a disadvantage, have been the subject of numerous studies. However, there exists a gap in research for the relationships of SI intervention and student attitude.

Summary

Developmental and early college mathematics, attitudes and beliefs toward mathematics, and supplemental instruction have been researched extensively. However, there are a limited number of studies that examine the relationships between these areas. Developmental and introductory mathematics courses have poor retention rates. Attitudes of students affect achievement in courses. Supplemental instruction is an instructional strategy designed for high risk courses such as developmental mathematics, and it may affect the attitudes of students enrolled in such courses. Chapter III outlines the methods and procedures used to collect the

data for this study. The chapter describes the design, population and sample, measure, procedure, analytic approach, and validity of the study.

CHAPTER III

METHODS

The purpose of this study was to determine the relationship between supplemental instruction and college algebra students' attitudes toward mathematics at a Southeastern university. This chapter will cover the methodology used for this study, including sections on the design, population and sample, measure, procedure, analytic approach, and validity.

Design

This was a quasi-experimental research study to determine the relationship between supplemental instruction and students' attitudes toward mathematics. The design of this study was quasi-experimental, using intact course sections of college algebra at the Southeastern university. The sample included the students from two established college algebra course sections, two sections with supplemental instruction, M103, and one section without, M102. The design for the study was two group, treatment and comparison, with a pretest-posttest. Data were collected using a questionnaire designed to gauge the attitude of the students toward mathematics. This questionnaire was given twice during the class: once before the first test, and again before the final examination.

Population and Sample

The target population of this study was undergraduate college students who take college algebra in the United States. The undergraduate college population included over 20 million students, where females had a slight majority, traditionally students were between 18 – 24 years old, and there was a greater percentage of white students enrolled than any other race/ethnicity (Fast Facts, 2017).

The study sample was drawn from undergraduate students at a Southeastern University enrolled in a college algebra course. The sample was purposefully taken from college algebra

students enrolled in College Algebra M102 and College Algebra with Supplemental Instruction M103. M102 and M103 award interchangeable credit, but students whose Math SAT was less than or equal to 450, or whose High School GPA was less than 3.0 enrolled in M103 (Math, 2018). The instructors and students of M102 and M103 for the summer semester of 2018 were contacted and briefed on the content and intention of the study. The study had approximately 50 participants, 25 students from M102 and 25 students from M103. Participation of the students was voluntary with no compensation.

The results of this study may generalize to a larger population. The purpose of the study was to give insight on the relationship between supplemental instruction and attitudes toward mathematics from an individual's perspective. The topic of the study is suited to the target population because changes to methods of college course instruction can affect all manner of college students.

Instrument

This study used a questionnaire as the instrument for data collection. The Attitudes Toward Mathematics Instrument (ATMI) was used to measure the attitude of the selected university students towards their college algebra course. The ATMI, developed by Tapia (2004), was designed to assess underlying dimensions of self-confidence, value, motivation, and enjoyment of mathematics. The instrument underwent a pilot test and the calculated Cronbach's alpha coefficient was 0.96. The only alteration to this instrument was to change to a 6-point Likert scale from the 5-point Likert scale of the original instrument. This alteration was done to eliminate neutral responses and replace this option with "slightly agree" and "slightly disagree". The ATMI was made up of 40 closed-ended questions that use a 6-point Likert scale to measure attitudes about math from positive to negative. In addition to the ATMI, demographic data was collected including gender, race/ethnicity, and whether the student is retaking the course. The

questionnaire can be found in Appendix A, and the informed consent form for the study can be found in Appendix B.

Procedure

Supplemental instruction is a mandatory part of the Southeastern university's college algebra course, M103. Each lecture section of M103 has approximately 10-25 students who are divided, based on time availability, into smaller supplemental sections, which have approximately 10-15 students. These supplemental sections are one-hour long, face-to-face, recitation-style courses led by a supplemental instruction leader (SI leader). Students in the supplemental instruction course can receive up to five points for participation and attendance in each session and is worth 7% of the final grade in M103. The SI leader is an undergraduate or graduate student employed by the Math and Science Resource Center. SI leaders must pass a math examination, possess a GPA over 2.5, and have successfully passed a similar level of mathematics with a B or above in order to lead the SI sessions. SI leaders receive two days of training before the start of a semester (A. Stephen, personal communication, July 7th, 2018).

M102 and M103 cover identical material and are interchangeable for credit for college algebra degree requirements at the Southeastern university. Both sections, upon successful completion, also qualify the student to move to precalculus, M162. Students with a Math SAT score at or below 450, and students with a high school GPA under 3.0 must register for M103 (Math, 2018). Students above these requirements are able to register for either M102 or M103. This means that, in general, M103 students may enter the course at a lower level of proficiency in comparison to M102 students. However, because students who score above the requirements have the option of taking M102 or M103, it is possible that there are students with a higher ability that elect to take the supplemental course (A. Stephen, personal communication, July 7th, 2018).

The questionnaire was given during the lecture portion of each college algebra class, once in the week before the first test and again in the week before the final examination for the course, to establish a comparison of the students' attitudes before and after experiencing the course. The measure was the same for both the sections of M102 and M103.

Analytic Approach

The synthesis of the analytic approach is detailed in Table 1. This study is to determine to what extent attitude differs for students in a college algebra course with and without supplemental instruction. The independent variable is the presence of supplemental instruction. As there are only two options for college algebra courses, the independent variable is categorical. The dependent variable is the attitude of the student toward mathematics. As attitudes can range from positive to negative, this variable is continuous. A *t*-test was chosen based on these variables.

Table 1

Synthesis of Analytic Approach

Research Question	Independent Variable	Dependent Variable	Analytic Technique
To what extent does attitude differ for students in a college algebra course with and without supplemental instruction?	The presence of supplemental instruction. (course number M102 or M103; (categorical)	The attitude of the student toward mathematics. (positive to negative; (continuous)	<i>t</i> -test

Validity

The internal validity of this study is strengthened by using a pretest-posttest design that will allow for individual comparisons. Internal validity could be weakened by inconsistent attendance of students who may drop the course or not attend the lectures or supplemental instruction. The external validity may be weakened by using a sample of students in the summer session, which may not be representative of the traditional college population.

Summary

Chapter III reviewed the methodologies of the research study, including the design, population and sample, measure, procedure, analytic approach, and validity. The population for the study was drawn from college algebra students at the Southeastern university. The instrument for the study was the Attitudes Towards Mathematics Instrument. The survey was given to college algebra classes twice during the semester, once at the beginning of the course and again at the end. The data from the study was analyzed with a *t*-test. Validity of the study is strengthened by the design but may be weakened by inconsistent attendance of the participants. Chapter IV will include the findings of the research study, including an overview of the data collection, an investigation into the data, and a summary of the findings.

CHAPTER IV

FINDINGS

The purpose of this study was to determine the relationship between supplemental instruction and college algebra students' attitudes toward mathematics at a Southeastern university. The data for this study was obtained from one section of M102 and two sections of M103 from the Summer 2018 semester at a Southeastern university. This chapter provides an overview of the data collection method, an investigation of the data from participants in college algebra with and without supplemental instruction, and a summary of the findings.

Overview of Collected Data

The data were collected at the Southeastern university during the Summer 2018 semester. The total number of participants was 45. Of the 45 participants, 23 completed both the pretest and posttest. 17 of the paired responses were from participants in M103, and 6 responses were from M102. The participants were given identifiers based on the class section attended. The low number of paired responses is due to participants not able to complete both surveys, due to late admission to the course, withdraws from the course, and absences.

Data Analysis

The survey was comprised of 40 items addressing students' attitudes toward mathematics. Each item was responded to using a 6-point Likert scale including (1) Strongly Agree, (2) Disagree, (3) Slightly Disagree, (4) Slightly Agree, (5) Agree, and (6) Strongly Agree. The response to each of the 40 items on the survey was recorded for each participant. The developer of the instrument identified the negatively-worded items and provided instructions to correct them for analysis. Negatively worded items were corrected by taking the item response subtracted from seven. As an example, if a negatively worded item received an answer of (2) Disagree, the corrected score was calculated by taking $7 - 2$, resulting in the positively worded

score of (5) Agree. The total positive score was calculated by summing up the corrected responses.

RQ₁ asks to what extent do attitudes differ, if at all, for students in college algebra courses with and without supplemental instruction? H₀ proposes supplemental instruction does not change college student's attitudes toward mathematics and H₁ proposes supplemental instruction improves college student's attitudes toward mathematics.

A two-sample *t*-test assuming equal variances was calculated to answer RQ₁. The result of which is given in Table 2.

Table 2

Two-Sample t-test Assuming Equal Variances

	<i>MeanDiff102</i>	<i>MeanDiff103</i>
Mean	9.833333333	4.529411765
Variance	176.5666667	290.0147059
Observations	6	17
Pooled Variance	263.003268	
Hypothesized Mean Difference	0	
df	21	
t Stat	1.865061033	
P(T<=t) one-tail	0.038104235	
t Critical one-tail	1.720742903	
P(T<=t) two-tail	0.07620847	
t Critical two-tail	2.079613845	

The test resulted in $t_{(21)} = 1.865$ and $p < .05$. The result of this test was statistically significant and indicates that participants in M102 had higher attitudinal scores than participants in M103.

To compensate for the small sample size and because normal distribution could not be assumed, a Wilcoxon sign test was chosen as a non-parametric alternative to the *t*-test. The Wilcoxon test was used to measure the dependency in the pretest and posttest scores of the M103 group. The results of this test are given in Table 3.

Table 3

M103 Wilcoxon Sign Test

Difference	Positive	Diff	Rank	Signed Rank
12	1	12	9	9
-10	-1	10	8	-8
16	1	16	12	12
20	1	20	15	15
-45	-1	45	17	-17
-6	-1	6	6	-6
31	1	31	16	16
13	1	13	10	10
14	1	14	11	11
0	-1	0	1	-1
2	1	2	4	4
4	1	4	5	5
-1	-1	1	3	-3
-8	-1	8	7	-7
16	1	16	12	12
0	-1	0	1	-1
19	1	19	14	14
				108 Positive Sum
				-43 Negative Sum
				43 Test Statistic

The test resulted in $z_{(17)} = -1.588$, $p = .056$. This indicates there is not sufficient evidence to suggest a difference in pretest and posttest scores for M103. This means the initial hypothesis of H_0 is accepted, and the addition of supplemental instruction led to no significant difference in the attitudes of these participants.

Summary

The findings for the research study were presented in Chapter IV. Data for the study were obtained from a Southeastern University. The data were obtained from the responses of participants in college algebra courses with and without supplemental instruction during the Summer 2018 semester. A level of significance was reported for the t -test and Wilcoxon sign test. Chapter V will provide a summary, conclusion, and recommendations resulting from this research study.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of the result study to determine the relationship between supplemental instruction and the attitudes of college algebra students toward mathematics. This chapter will provide a summary, conclusions based on the findings detailed in the previous chapter, and recommendations for further research.

Summary

Students who have poor engagement with course material often feel frustrated by the subject (Sierpinska et al., 2008). Developmental and early college mathematics courses, such as college algebra, often have poor achievement rates (Jones et al., 1996). Attitude and achievement are positively linked, indicating the poor achievement rates in introductory mathematics may reflect the negative attitudes of students in these courses (Schoenfeld, 1989). One solution to improve the attitudes of college algebra students is supplemental instruction. To study the relationship of supplemental instruction and the attitudes of college algebra students, the following research question was established:

RQ₁: To what extent do attitudes differ, if at all, for students in college algebra courses with and without supplemental instruction?

The population of this study was college algebra students at a Southeastern university during the Summer 2018 semester. The instrument used for data collection was the Attitudes Toward Mathematics Instrument from Tapia (2004) consisting of 40 closed-ended questions. Data from the instrument were analyzed with a two-sample *t*-test assuming equal variances and a Wilcoxon sign test.

Conclusions

The following conclusions were drawn from the data collected at the Southeastern university:

RQ1: To what extent do attitudes differ, if at all, for students in college algebra courses with and without supplemental instruction?

According to the findings from the two-sample t -test assuming equal variances, the comparison of participants in M102 and M103 was statistically significant $t_{(21)} = 1.865, p = .05$), indicating M102 had higher scores for attitudes than participants from M103. Due to the small sample size, a Wilcoxon sign test was calculated, which resulted in no significant difference ($z_{(17)} = -1.588, p = .056$) in the pretest and posttest scores from M103. We can conclude from these results that H_0 is supported and supplemental instruction did not significantly change college algebra students' attitudes toward mathematics. This result is contrary to the improvement of attitudes through short interventions from Hodges and ChanMin (2013) and the support of better attitudes through social support from Rice et al. (2013). A possible explanation for this difference may stem from the students in M103 starting with lower achievement and proficiency in mathematics in comparison to the students in M102. The intervention of supplemental instruction may not be enough to change the perception of mathematics for students at this level.

Recommendations

The results and conclusions of this study suggest there is not significant change in attitudes of college algebra students in course with and without supplemental instruction. Several factors may have contributed to these findings. The results of the t -test indicate that students without supplemental instruction may have better attitudes toward mathematics. Due to the small sample and subsequent lack of normal distribution, this result could not be supported.

Each course had a different instructor and the differences in instruction for each class may have contributed to changes in attitude. Each course also had a different number of students and the increased individual attention to students in the smaller courses may change the attitudes of the students as well.

The researcher recommends the following, based on the data collected from the Southeastern university:

- 1) Further research should be conducted with larger sample sizes on the attitudes of students enrolled in college algebra and similar introductory mathematics courses in Fall and Spring semesters.
- 2) Additional research should be conducted on the effects of different forms of the supplemental instruction strategy on student attitudes.
- 3) Research should be conducted on how the attitudes of students change throughout their mathematics course.

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Please use these response codes:

- 1 – Strongly Disagree
- 2 – Disagree
- 3 – Slightly Disagree
- 4 – Slightly Agree
- 5 – Agree
- 6 – Strongly Agree

No	Statement	1	2	3	4	5	6
10	My mind goes blank and I am unable to think clearly when working with mathematics.	---	---	---	---	---	---
11	Studying mathematics makes me feel nervous.	---	---	---	---	---	---
12	Mathematics makes me feel uncomfortable.	---	---	---	---	---	---
13	I am always under a terrible strain in a math class.	---	---	---	---	---	---
14	When I hear the word mathematics, I have a feeling of dislike.	---	---	---	---	---	---
15	It makes me nervous to even think about having to do a mathematics problem.	---	---	---	---	---	---
16	Mathematics does not scare me at all.	---	---	---	---	---	---
17	I have a lot of self-confidence when it comes to mathematics.	---	---	---	---	---	---
18	I am able to solve mathematics problems without too much difficulty.	---	---	---	---	---	---
19	I expect to do fairly well in any math class I take.	---	---	---	---	---	---
20	I am always confused in my mathematics class.	---	---	---	---	---	---
21	I feel a sense of insecurity when attempting mathematics.	---	---	---	---	---	---
22	I learn mathematics easily.	---	---	---	---	---	---
23	I am confident that I could learn advanced mathematics.	---	---	---	---	---	---
24	I have usually enjoyed studying mathematics in school.	---	---	---	---	---	---

Please use these response codes:

1 – Strongly Disagree

2 – Disagree

3 – Slightly Disagree

4 – Slightly Agree

5 – Agree

6 – Strongly Agree

No	Statement	1	2	3	4	5	6
25	Mathematics is dull and boring.	---	---	---	---	---	---
26	I like to solve new problems in mathematics.	---	---	---	---	---	---
27	I would prefer to do an assignment in math than to write an essay.	---	---	---	---	---	---
28	I would like to avoid using mathematics in college.	---	---	---	---	---	---
29	I really like mathematics.	---	---	---	---	---	---
30	I am happier in a math class than in any other class.	---	---	---	---	---	---
31	Mathematics is a very interesting subject.	---	---	---	---	---	---
32	I am willing to take more than the required amount of mathematics.	---	---	---	---	---	---
33	I plan to take as much mathematics as I can during my education.	---	---	---	---	---	---
34	The challenge of math appeals to me.	---	---	---	---	---	---
35	I think studying advanced mathematics is useful.	---	---	---	---	---	---
36	I believe studying math helps me with problem solving in other areas.	---	---	---	---	---	---
37	I am comfortable expressing my own ideas on how to look for solutions to a difficult problem in math.	---	---	---	---	---	---
38	I am comfortable answering questions in math class.	---	---	---	---	---	---
39	A strong math background could help me in my professional life.	---	---	---	---	---	---
40	I believe I am good at solving math problems.	---	---	---	---	---	---

Math Student Disposition Questionnaire

Attitudes Toward Mathematics Instrument

First Name: _____

Last Name: _____

For each statement, please circle the response that best represents you.

Gender:

- Male
- Female
- Other
- Would not like to specify

Race/Ethnicity:

- White
- Hispanic or Latino
- Black or African America
- Native American or American Indian
- Asian or Pacific Islander
- Other
- Would like to not specify

Have you taken M102 or M103, at this university, before?

- Yes
- No

B: Informed Consent Form
INFORMED CONSENT DOCUMENT
OLD DOMINION UNIVERSITY

PROJECT TITLE: Relationships of Supplemental Instruction and Attitudes of Students Enrolled in College Algebra

INTRODUCTION

The purposes of this form are to give you information that may affect your decision whether to say YES or NO to participation in this research, and to record the consent of those who say YES.

RESEARCHERS

Responsible Principle Investigator (RPI)

Investigator

Dr. Philip Reed

Kele McKaig

Professor of STEM Education & Professional Studies

Graduate Student

Ph.D. in Education, Curriculum and Instruction

Old Dominion University

Old Dominion University

Darden College of Education

Darden College of Education

DESCRIPTION OF RESEARCH STUDY

Several studies have been conducted looking into the subject of attitudes towards mathematics. Research on the relationship of supplemental instruction on attitudes towards mathematics is limited.

If you decide to participate, then you will join a study involving research of student attitudes toward mathematics using a questionnaire for data collection. This questionnaire will be given to you twice during the duration of your college algebra course. The questionnaire consists of 40 items, which should take approximately ten minutes to complete. You are expected to respond truthfully to the items on the questionnaire. If you say YES, then your participation will last for the duration of the semester in which you are enrolled in the college algebra course at Old Dominion University. Approximately fifty college algebra students will be participating in this study. Your choice to participate in this study will not affect your grade or your relationship with your instructor.

EXCLUSIONARY CRITERIA

To the best of your knowledge, you should not have limitations that would keep you from participating in this study.

RISKS AND BENEFITS

RISKS: If you decide to participate in this study, there are no foreseen risks to you. As with any research, there is some possibility that you may be subject to risks that have not yet been identified.

BENEFITS: There is no benefit to you for participating in this study.

COSTS AND PAYMENTS

The researchers want your decision about participating in this study to be absolutely voluntary. Your participation should pose no cost or inconvenience to you. The researchers are unable to give you any payment for participating in this study.

NEW INFORMATION

If the researchers find new information during this study that would reasonably change your decision about participating, then they will inform you.

CONFIDENTIALITY

All information obtained about you in this study is strictly confidential unless disclosure is required by law. The results of this study may be used in reports, presentations and publications, but the researcher will not identify you.

WITHDRAWAL PRIVILEGE

It is OK for you to say NO. Even if you say YES now, you are free to say NO later, and walk away or withdraw from the study -- at any time. Your decision will not affect your relationship with Old Dominion University, or otherwise cause a loss of benefits to which you might otherwise be entitled.

COMPENSATION FOR ILLNESS AND INJURY

If you say YES, then your consent in this document does not waive any of your legal rights. However, in the event of harm arising from this study, neither Old Dominion University nor the researchers are able to give you any money, insurance coverage, free medical care, or any other compensation for such injury. In the event that you suffer injury as a result of participation in any research project, you may contact the responsible principal investigator or investigator at the following emails or Dr. Jill Stefaniak, Chair of the Darden College of Education Human Subjects Review Committee, Old Dominion University, at jstefani@odu.edu, who will be glad to review the matter with you.

Dr. Philip Reed

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Kele McKaig

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VOLUNTARY CONSENT

By participating in this study, you are saying that you have read this form or have had it read to you, that you are satisfied that you understand this form, the research study, and its risks and benefits. The researchers should have answered any questions you may have had about the research. If you have any questions later on, then the researchers should be able to answer them:

If at any time you feel pressured to participate, or if you have any questions about your rights or this form, then you should contact Dr. Jill Stefaniak, Chair of the Darden College of Education Human Subjects Review Committee, Old Dominion University, at jstefani@odu.edu.