The Impact of "Real World" Experiences through Academic Service Learning on Students' Success Rate, Attitudes, and Motivation in Intermediate Algebra at a Public University

by

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This dissertation was prepared under the direction of the candidate's dissertation advisor, Dr. Joseph M. Furner, Department of Curriculum Culture and Educational Inquiry, and has been approved by the members of his supervisory committee. It was submitted to the faculty of the College of Education and was accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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Abstract

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A report issued in 2012 by the United States Government Accountability Office (US Government Accountability Office, 2012) concluded that the United States is not producing enough graduates in Science, Technology, Engineering, and Mathematics (STEM) to meet the demands of its economy. According to the National Center for Educational Statistics (2001), fewer than fifty percent of students nationally possess a solid command of mathematical content. This study tested whether the insertion of Academic Service Learning (ASL) into intermediate algebra courses improved students' performance, their motivation to learn the subject, and attitudes towards mathematics learning. ASL is an educational strategy that integrates meaningful community service with instruction and reflection to enrich the learning experience, teach civic responsibility, and strengthen communities (Duffy, Barrington, West, Heredia, & Barry, 2011).

The subjects in this study were thirty-four students enrolled in intermediate algebra at a large public university in southeast Florida. The participant group consisted of fifteen students who completed the requirements of the ASL program and the comparison group consisted of nineteen students who initially showed interest in the program but dropped out of the study early in the semester.

Through a mixed method analysis, the study found that the proportion of students who passed the course in the ASL group was greater than the proportion of students in the non-ASL group. Similarly, the mean final course grade in the ASL group was higher than the mean final course grade in the non-ASL group.

The results of the qualitative analyses showed that all the participants enjoyed the ASL experience. In addition, some participants felt that the ASL project raised their motivation to learn mathematics and increased their competence in mathematics. However, both quantitative and qualitative analyses revealed that the students' participation in the ASL project did not affect their attitudes towards mathematics learning. The study concluded that Academic Service Learning has the potential to help improve students' success rates in developmental mathematics courses as well as increase their motivation to learn the subject.

Dedication

To my late father and mother Jean-Camille and Guilda Antonine Toussaint, who instilled in me that love of learning; to my wife Martilanie Toussaint, whose support and understanding of my educational goals has never wavered; to my children Marnio, Marnino, and Stassie for their support and understanding. To my children and future grandchildren: well, this is the bar.

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Chapter 1. Introduction

Students at all levels of the educational spectrum struggle to understand basic mathematical concepts and they are considerably deficient in their ability to comprehend and solve application problems (Gallo & Odu, 2009). At many two-year and four-year colleges in the state of Florida, over 60 % of entering freshmen test as needing at least one remedial math course (Scott, 2013; Ross, 2012). Since the implementation of Florida Senate Bill 1720 (FSB 1720), which prohibits mandatory remediation for exempt students enrolled in the Florida College System (FCS), students are no longer required to enroll in basic remediation courses. Therefore, a large percentage of entering students are placed in intermediate algebra.

Close to two-third of students who enroll at public tertiary institutions in the United States do not successfully complete a degree within five years of enrolling in college. Moreover, half of these students quit during their freshman year (Twigg, 2009). First year college students usually find it difficult to successfully complete introductory mathematics courses during their first attempt. Some students take these courses multiple times before successfully completing the sequence of mathematics courses necessary to qualify for graduation, some switch to majors that require less rigorous mathematics courses, and some end up dropping out of school altogether.

Many college students consider mathematics as one of the most challenging courses they must successfully complete in order to satisfy graduation requirements. Gallo and Odu (2009) found that many factors must be considered in order to explain the high rate

of failure in mathematics courses. Factors such as student under-preparation for college level work, student misconceptions, student attitude towards mathematics, and lack of motivation have been cited as possible explanations, among others.

Statement of the Problem

The problem of students' lacking motivation to learn mathematics and students' negative attitude towards mathematics can be observed at all levels of the educational spectrum and in almost every mathematics classroom (Burns, 1998; Gallo & Odu, 2009; Taylor 2008; Spradlin & Ackerman, 2010; Wheland, Konet, & Butler, 2003). Enlace Florida, one of the leading organizations in the State of Florida working to help increase academic success among minority students, asserts that although Florida is among the states with the highest graduation rates; it still needs to increase its graduation rate in order to meet the demands of its economy (Enlace Florida, 2009). It is projected that by the year 2025, the State of Florida will be 391,000 graduates short of projected workforce demands (Fountain et al., 2010). "Such an alarming economic outlook should provoke universities, colleges, departments, and professors to do everything they can at the local level to facilitate the success of students who enroll in their classes, particularly those introductory courses that must be passed in order for students to enroll in higher level courses" (George, 2010, p.2).

According to a report issued in 2012 by the United States Government Accountability Office (GAO), the United States is not producing enough graduates in Science, Technology, Engineering, and Mathematics (STEM) to meet the demands of its economy. In the state of Florida, there will be a demand for 385,010 STEM jobs by 2018, up from 322,560 in 2008 (Carnevale, Smith, & Melton, 2011). Eighty-nine percent of

these jobs require a postsecondary education and training in higher level mathematics beyond arithmetic and basic algebra. At the same time, a significant number of students are entering college classrooms unprepared or underprepared for rigorous work in mathematics. This problem is exacerbated by the teaching methodologies used in most mathematics classrooms wherein students are expected to learn concepts from exposition of the material and then master the necessary skills by solving a set of practice exercises from a worksheet or a computer software. In most cases, the assignments consist of problems totally unrelated to real life situations. As a result, many students fail to see the connection between the mathematics they learn in the classroom and their everyday lives. Preuss (2008) reported that between 61 percent and 89 percent of students entering higher education require developmental course work in mathematics. The high percentage of students in need of remediation coupled with the low success rates in developmental mathematics courses presents an enormous challenge for educators.

Purpose of the Study

Academic Service Learning (ASL) is a teaching and learning strategy that integrates meaningful community service with instruction to enhance students' learning experiences. ASL comprises the following major components: "projects or placements that meet academic course objectives, the meeting of real community needs, and reflection on the part of the students to relate the service to the subject matter of the course, and reciprocity with the community partner" (Duffy et al., 2011, p.2).

The purpose of this mixed method study was to determine whether the infusion of "real world" experiences through Academic Service Learning into an intermediate algebra course would have a significant impact on students' mathematics achievement,

their motivation to learn mathematical concepts, and their attitudes towards mathematics learning.

Research Questions

The study was guided by the following research questions:

Question 1) Does "real world" experience through Academic Service Learning make a difference on college students' mastery of learning objectives in intermediate algebra compared to students enrolled in the same course who elected not to participate in the ASL program at a public university?

Question 1A) Does the effect of ASL on students' mastery of learning objectives vary by gender in intermediate algebra at a public university?

Question 1B) Does the effect of ASL on students' mastery of learning objectives vary by race in intermediate algebra at a public university?

Question 2) How does the infusion of "real world" experiences through Academic Service Learning affect students' motivation to learn mathematical concepts in an Intermediate Algebra course at a public university?

Question 2A) Does the effect of ASL on students' motivation to learn mathematics vary by gender in intermediate algebra at a public university?

Question 2B) Does the effect of ASL on students' motivation to learn mathematics vary by race in intermediate algebra at a public university?

Question 3) How does the infusion of "real world" experiences through Academic Service Learning affect students' attitudes towards mathematics learning in intermediate algebra at a public university?

Question 3A) Does the effect of ASL on students' attitudes towards mathematics learning vary by gender in intermediate algebra at a public university?

Question 3B) Does the effect of ASL on students' attitudes towards mathematics learning vary by race in intermediate algebra at a public university?

Hypotheses

In this study, ten hypotheses were tested: (1) the proportion of students who successfully complete the course would be greater in the ASL group than in the non-ASL group, (2) the mean final course grade would be greater in the ASL group than in the non-ASL group, (3) in the ASL group, male students would have higher final course grade than female students, (4) in the ASL group, white and non-white participants would have different final course grades, (5) students in the ASL group would have higher motivation than the students in the non-ASL group, (6) in the ASL group, male students would display higher motivation than female students, (7) in the ASL group, white and non-white participants would have different levels of motivation, (8) students in the ASL group would exhibit a more positive attitude towards mathematics learning than the students in the non-ASL group, (9) males students would have a more positive attitude towards mathematics learning than female students, (10) students' attitudes towards mathematics would be different for white and non-white students.

The following null hypotheses resulted:

Hypothesis 1. H_0: $\mu_1 = \mu_2$, the mean final course grade is the same for both the ASL and the non-ASL groups.

Hypothesis 1A. H_0: $\mu_1 = \mu_2$, the mean final course grade, in the ASL group, is the same for both male and female students.

Hypothesis 1B. H_0: $\mu_1 = \mu_2$ the mean score for the course is the same for both white and non-white students.

Hypothesis 2. H_0: $\mu_1 = \mu_2$, the mean motivation score is the same for both the ASL and the non-ASL groups.

Hypothesis 2A. H_0: $\mu_1 = \mu_2$, the mean motivation score is the same for both male and female students in the ASL group.

Hypothesis 2B. H_0: $\mu_1 = \mu_2$ the mean motivation score is the same for both white and non-white participants.

Hypothesis 3. H_0: $\mu_1 = \mu_2$, the mean attitude score is the same for both the ASL and the non-ASL groups.

Hypothesis 3A. H_0: $\mu_1 = \mu_2$, the mean attitude score is the same for both male and female students in the ASL group.

Hypothesis 3B. H_0: $\mu_1 = \mu_2$, the mean attitude score is the same for both white and non-white participants.

Theoretical Framework

This study based its assertions in the theory of constructivism. Constructivism is a theory of knowledge which asserts that learners generate new knowledge from their own experiences. Unlike cognitive constructivism which emphasizes how individuals' brains construct knowledge, social constructivism advances that knowledge exists in social settings and must be shared with others as opposed to exclusively being constructed in the minds of the individuals (Kolb, 1976). When applied to a classroom setting, constructivism suggests that the learners must be actively engaged with the material in order for meaningful learning to take place.

John Dewey (1938) argued that deep understanding of concepts occurs only when the learners interact with their environment. He believed that students' interaction with their environment is essential for constructing new knowledge; therefore students should be engaged in activities in their community. "I assume that amid all uncertainties there is one permanent frame of reference: namely, the organic connection between education and personal experience" (Dewey, 1938, p.25). Similarly, Christine Sleeter has been an advocate for a "culturally relevant pedagogy in which teachers intentionally connect teaching to the lived experiences and knowledge frameworks of their students and students' communities" (Sleeter, 2005, p.14).

Academic Service Learning provides students the opportunity to construct their own understanding of the material under consideration by affording them the opportunity to reflect on the concept they are learning (Ash, Clayton, & Moses, 2009; Baratian, Duffy, Franco, Hendricks, & Renner, 2007). Students are not computers who can sit passively and store in their memory everything they hear, see, or read (Montessori, 1912). Constructivism asserts that current understanding is the basis for learning new concepts; Academic Service Learning coaxes students to assess their current understanding of the course material since they have to go out in the community and share that knowledge with others.

Further, social constructivism affirms that social interaction is necessary for meaningful learning to occur because it gives students the opportunity to form their own ideas, compare them to other ideas, and correct misconceptions when necessary (Kolb, 1976). Academic Service Learning can help educators create communities of

learners within the classroom that inspires students to take charge of their own learning through interaction with other students and members of their community.

Finally, Academic Service Learning helps educators implement another principle of constructivism which advances that meaningful learning occurs when learners engage in authentic tasks (Dewey, 1938). The implementation of an Academic Service Learning project requires students to have a deep understanding of the concepts they are studying so that they can go out and use these concepts in "real world" settings. This study advanced that Academic Service Learning has the potential to help students gain a deeper understanding of course materials and help motivate them to continue learning.

Definitions of Terms

Academic Service Learning.

Academic Service Learning is a pedagogical method that incorporates relevant community service with instruction and reflection to enhance the learning experience, teach responsible citizenship, and strengthen communities. "Service Learning is defined here as a hands-on learning approach in which students achieve academic objectives in a credit-bearing course by meeting real community needs." (Duffy et al., 2011, p.2). Academic Service Learning comprises the following major components: "projects or placements that meet academic course objectives, the meeting of real community needs, and reflection on the part of the students to relate the service to the subject matter of the course, and reciprocity with the community partner." (Duffy et al., 2011, p.2).

In this study, students in intermediate algebra were asked to go to local social agencies and provide group tutoring or one-on-one tutoring on mathematical concepts related to the course to 4^{th} and 5^{th} grade children in after care programs. The students who

agreed to participate in the program were asked to perform up to 20 hours of community service during the semester. In addition, the researcher requested that the students keep a journal that details their experiences during the duration of the project as well as reflect on those experiences.

The coordinating office for Academic Service Learning at SEU and the researcher served as liaison between the university and the community partners where the students performed the services. The researcher was responsible for keeping a record of the number of service hours performed by the students and for advertising and educating students as well as faculty about the program.

Intermediate algebra.

Intermediate Algebra is a course designed for students with strong arithmetic skills and an algebra background. This course is designed to extend the students' algebra skills and includes topics such as solving radical, rational, quadratic, and absolute-value equations; and recognizing relationships between radical expressions and rational exponents; complex numbers are introduced in this course as well. Problem solving involving real-life scenarios is an integral part of the curriculum. In this course, students will enhance their problem-solving abilities and their ability to communicate concepts of algebra in the language of mathematics, both orally and written (Broward College, n.d.; Florida Atlantic University, 2014).

Public university.

In the mid 1850's, the Florida legislature voted to establish two institutions of higher education which later became Florida State University (FSU) and the University of Florida (UF).The State University System of Florida has expanded and currently

includes twelve public universities with an enrollment of over 337,000 students. The State University System of Florida and the Florida College System (FCS) form Florida's system of public higher education. The expansion of the State University System (SUS) in Florida occurred as a result of population growth, the space age, the protests that occurred in the 1960's, and the desire by political leaders to increase access to higher education to citizens of modest means (Kalb, 1978).

Mastery of learning objectives.

Mastery of learning objectives is defined here as students achieving a final course average of 65% or better as stated in the course syllabus. The researchers assumed that the students who are able to obtain a grade of C or better as their final course grade from various assessments throughout the course have achieved mastery of the course learning objectives (Gallo & Odu, 2009). In general, students who do not achieve a grade of C or better in a course at the College level are not permitted to advance to the next course.

"Real world" experience

"Real world" experience is defined here as the realm of practical experience as opposed to the abstract, theoretical, or idealized sphere of the classroom or laboratory (Baratian et al., 2007). In this study, the participants agreed to go to local social agencies and provide group tutoring or one-on-one tutoring on mathematical concepts related to the course to 4^{th} or 5^{th} grade children in after care programs. This project provided the college students the opportunity to discuss pre-requisite concepts as well as concept covered in the classroom with 4^{th} and 5^{th} graders (Ash et al., 2009; Baratian et al., 2007). In addition, the students agreed to keep a journal that included reflections on their experiences.

Traditional method of teaching.

The traditional lecture format consists in a teacher explaining concepts and solving problems on the board while students listen and take notes without engaging in discussions. The traditional method of teaching is grounded in social cognitive theory, which asserts that students can change their behavior or thinking pattern by observing teachers (Eggen & Kauchak, 2006). This belief is particularly prevalent among teachers of mathematics who believe that they must first model the desired skills involved in a concept and then ask the students to imitate the behaviors they observed (Eggen & Kauchak, 2006; Doyle, 2008). This study investigated whether the insertion of Academic Service Learning as a supplement to the traditional lecture method resulted in an improvement of the students' passing rate, their motivation to learn mathematics, and their attitude towards the subject.

Significance of the Study

Mathematics has become increasingly important in today's world; with the advancement of technology, an increasing number of career choices require individuals to possess a solid command of basic mathematics concepts. At the same time, the majority of students enter college unprepared or under-prepared for rigorous work in mathematics. Intermediate Algebra is an introductory course in which many students are exposed to rigorous mathematical thinking for the first time. This course provides students the foundation necessary to be able to successfully complete later courses in advanced mathematics and the sciences.

As a result, there is a pressing need for educators to uncover efficient ways to increase the passing rate in intermediate algebra. A growing number of policy makers

and educators are calling for a focus on finding ways to improve students' performance in mathematics and science. This study tested the hypothesis that Academic Service Learning can be used as a tool to improve students' performance in developmental mathematics courses, increase their motivation to learn mathematical concepts, and improve their attitudes towards the subject.

Delimitations

This study only investigated intermediate algebra because it is the first course in a series of courses students must complete at the college level in order to satisfy graduation requirements. In addition, the sample consisted of students enrolled in intermediate algebra at one public university in southeastern Florida. The researchers theorized that if students have meaningful experiences with mathematics early in their college careers, they will be more likely to have the desire to learn more advanced mathematical concepts and less likely to develop negative attitudes towards the subject.

Limitations

Because service learning is not widely used at the college level in mathematics courses, it was impossible to use random sampling to recruit participants. As a result, the researchers used purposeful sampling to conduct this study. To investigate the effects of Academic Service Learning in intermediate algebra, the researcher selected six sections of intermediate algebra taught by one instructor during the fall 2015 and spring 2016 semesters and infused them with ASL. Students enrolled in the courses decided whether or not to participate in the ASL program after listening to a presentation by the researcher and the director of the coordinating office for ASL at the university. The group of students who completed the ASL program was compared to the students who initially

showed interest but elected not to participate in the program. This sampling method limited the internal validity of the study as the subjects were not randomly assigned to the two groups. Therefore, the differences found between the participants and the non-participants may be applicable only to the subjects included in this study.

Summary

The next chapter will present a review of the literature. In Chapter Three, the subjects, sampling method, procedures, and instrumentation are discussed. Details of the quantitative statistical methods as well as the qualitative methods used in the study are also provided. In Chapter Four, the results are presented and discussed. Finally, in Chapter Five, The research questions are discussed in light of the results obtained. The implications of the results for educators and other stakeholders are discussed as well.

Chapter 2. Literature Review

Introduction

Many intervention programs have been designed in the past three decades to improve students' performance in mathematics (Kodippili & Senaratne, 2008; Taylor, 2008; Stillson & Alsup, 2003; Spradlin & Ackerman, 2010; Zerr, 2007; Stephens & Konvalina, 1999; Verhovsek & Striplin, 2003; Odafe, 2012; Burks, Lindquist, & McMurran, 2008). This chapter starts with an overview of the most noteworthy programs that have been implemented in mathematics in recent years. The level of success achieved by these different programs is discussed and the reasons why Academic Service Learning may provide a better alternative are highlighted. As many of these programs involve the use of technology, this chapter begins first with an investigation of the impact of technology on students' performance in mathematics, their attitude toward the subject, and their motivation to learn mathematical concepts. Second, an exploration of the impact of "real world" problem-solving on students' achievement is undertaken. Third, a review of the literature on the factors that contribute to increased students' performance including motivation is conducted. Fourth, a review of the role of motivation in teaching and learning is undertaken. Fifth, a review of the literature on the insertion of Academic Service Learning in mathematics as well as its effects on students' performance, their attitudes towards mathematics learning, and their motivation to learn the subject is

presented. And finally a review of the literature on the differences in mathematics achievement based on gender and race is conducted.

The Role of Technology in Mathematics Teaching and Learning

The problem of student under-preparedness in mathematics is rampant in tertiary institutions in the United States (Gallo & Odu, 2009; Taylor, 2008; Spradlin & Ackerman, 2010; Wheland et al., 2003). Consequently, many educators have turned to computer technologies in an attempt to improve students' performance in mathematics. "Indeed, there is sufficient optimism in the potential of technology to have a positive impact on learning and achievement that colleges have established committees and task forces dedicated to identify and promote ways to deliver instruction with the use of technology" (Kodippili & Senaratne, 2008, p. 928).

One way computer technology can be integrated in education is by simulating "real world" situations. This section of the literature review investigates the use of different types of software programs used to enhance the teaching and learning of mathematics, as well as the degree to which these software programs have been successful in positively impacting student performance in mathematics. In addition, the focus of the review is on examining whether each type of software program can assist in improving students' attitudes toward mathematics and their motivation to learn the subject.

Martin (2008) conducted a study in which a hybrid approach that combines both qualitative and quantitative methods was used. The participants consisted of a diverse population of students enrolled at a community college in the southwestern United States. Of the 718 students enrolled in beginning algebra in the fall of 1999, 40% were male and

60 % were female. A combination of at least ten full-time and part-time faculty members attended a five-day workshop on how to use graphing calculators in developmental courses to improve students' understanding without weakening the standards of the courses.

The analysis of the qualitative data revealed that both faculty and students who participated in the study had mixed opinions about the use of graphing calculators in developmental courses. Some faculty became ardent supporters of this new initiative, some approved of some aspects of the program, and some completely rejected the calculator-based approach. The quantitative results were entirely positive as the passing rate in beginning algebra exceeded the fifty percent mark for the first time since the college began recording these data. Not only did the pass rates increase but also the withdrawal rates significantly decreased. Similarly, Adams (1997) found that graphing calculators have the potential to affect the students' problem-solving ability in the classroom.

Contrastingly, Herman (2007) found that a large percentage of the students viewed the graphing calculators as nothing more than a computational device. Further, Herman (2007) reported that some students felt overwhelmed by having to learn the features of the calculator in addition to the new mathematical concepts.

Martin (2008), Adams (1997), and Herman (2007) studied the effectiveness of graphing calculator technology to enhance "real world" problem-solving in the mathematics classroom. Other researchers sought to discern whether computer-generated interactive mathematics homework is more effective than traditional instructor-graded homework. Kodippili and Senaratne (2008) selected two instructors who are assigned to

teach two sections of college algebra and had already used MyMathLab (MML) as a teaching tool. Each of these instructors randomly selected one of the two sections of college algebra and assigned traditional paper-based homework, while students in the other section were assigned homework using MML. The mean and standard deviation of the final scores for the two groups were calculated and a t-test was used. Results from this study indicate that there was not enough evidence to claim that the students in the group using MML performed better than the students assigned traditional paper-based homework at the usual significance level alpha of 0.05. However, the students' success rate defined as a final grade of A, B or C in the course was higher in the MML group; seventy percent and forty-nine percent respectively.

Similarly, Hauk and Segalla (2005) studied the effects of an open source proprietary software program titled WebWork on students' performance in college algebra at a large publicly funded university in the western United States. This study found no significant difference with respect to performance between the students who used WebWork and the students who were taught using the traditional lecture format. Both faculty and students expressed mixed feelings about the usefulness of the program. Although not using the same software, the results from the Kodipili and Senaratne (2008) study contradicted the results of the study by Martin in that technology innovation did not appear to positively affect student performance. The inconsistent results with regard to technology innovation in mathematics classrooms suggest that more research is needed to determine whether and how such innovations affect performance and student success.

Taylor (2008) investigated the effects of a web-based technology centric course, Assessment and Learning in Knowledge Spaces (ALEKS), on the remediation of college

freshmen enrolled in intermediate algebra classes. The participants in this study included 54 freshmen students enrolled in experimental courses using ALEKS and 39 control students enrolled in traditional lecture courses at three colleges and two universities. Pretests and posttests were administered to both groups at the beginning and at the end of the semester. The data were analyzed using p-values, effect sizes, score validity and reliability statistics. Multivariate Analysis of Variance (MANOVA) and regression analysis were performed in order to compare the results from the two samples. Outcomes were as follows:

(1) The paired samples t-test indicated that mathematical achievement did improve with the use of ALEKS.

(2) Mathematics anxiety decreased at a greater rate in the experimental group than the control group; therefore, the anxiety of the experimental group was less than the anxiety in the control group.

(3) Even though the anxiety level of both groups decreased over time, the students in ALEKS seemed to be less anxious.

(4) There were no differences in mathematical achievement by gender, ethnicity, or age.

(5) The results showed that the experimental group's attitudes toward mathematics improved, but did not show statistical significance.

Stillson and Alsup (2003), Stephens and Konvalina (1999), Burch and Kuo (2010), and Zerr (2007) found similar results from their studies, Meagher (2012) found that “students often have a delicate relationship with technology and while they may

develop mastery in using a particular technology they don't see its use as necessarily advantageous" (Meagher, 2012, p. 13).

Unlike Taylor (2008), Spradlin and Ackerman (2010) found that ALEKS did not improve students' mathematics achievement when compared to students who are taught using the traditional lecture method. However, Spradlin and Ackerman (2010) agreed with Taylor (2008) that the use of ALEKS lessened students' mathematics anxiety and that there were no differences in mathematical achievement by gender, ethnicity, or age. These findings are important to this study, although not studying math anxiety, seeks to establish whether the insertion of Academic Service Learning may provide a better alternative than computer technology to increase students' performance in mathematics.

Hoffman and Hunter (2003) conducted a large scale study on the use of multimedia and animation at a community college in Montgomery, Alabama. The researchers hypothesized that students' motivation towards learning mathematics would improve by improving students' attitude towards the subject. Data gathered from the attitudinal surveys administered at the beginning and the end of the semester as well as a comparison of the performance of the students taught with the old curriculum with the students taught with the new curriculum revealed that too much emphasis was being placed on symbolic manipulation without context. The students taught with the traditional curriculum felt they were never going to use the skills learned again. The new curriculum consisted of simulating "real world" problems with the use of multimedia and animations. The majority of the faculty supported the implementation of the new curriculum; furthermore, the passing rate for the students taught with the new curriculum was significantly higher than the passing rate for the students taught with the traditional

curriculum. Unlike the studies that used technology as a complement to classroom instruction, the difference was statistically significant.

Crouch and Haines (2004) analyzed the manner in which students processed information and examined the changes that occurred in the students' ability to solve modeling problems over a period of time. In a manner similar to Hoffman and Hunter (2003), the authors examined the problem solving abilities of two groups of students. The experimental group of students completed an intervention program made up of four modeling activities. Modeling activities involved activities in which students interpret problems, construct models for possible solutions to the problems, and evaluate the solutions for the best possible outcomes. "Mathematical modeling involves moving from a 'real world' situation to a model, working with that model, and using it to understand and to develop or solve 'real world' problems" (Crouch and Haines, 2004, p. 197).

Contrary to Hoffman and Hunter (2003), Crouch and Haines (2004) did not use technology and did not provide any specific details concerning projects; their study was based on the responses provided by the students to multiple-choice questionnaires as well as interviews. They found a connection between the process the students use when solving problems and the marks obtained for the answers. In addition, the results suggested that students are weak when it comes to making the connection between the mathematical world and the "real world."

Basson, Krantz, and Thorton (2006) investigated whether a computer lab equipped with computer software and hardware technologies that allow students to conduct experiments as well as collect and analyze data would impact students' mastery of learning objectives in a calculus course; the authors examined whether the laboratory

experiments would be effective in teaching calculus concepts to the students, and whether the labs would help the students' performance in future mathematics and science courses. In order to answer their research questions, the authors polled the students at different times during the semester to check for satisfaction and to ascertain knowledge of learning objectives. The responses were categorized. The study reported that 60 to 70 percent of the students felt that the experiments reinforced the calculus concepts and that they enjoyed seeing the "real world" applications of calculus in the laboratory. In addition, 88 percent of the students stated that the experiments enabled them to make connections between calculus concepts and "real world" applications. The results of this study suggested that the simulation of "real world" problems had a significant impact on students' mastery of learning objectives.

The literature suggests that technology is used mostly as an extension of the traditional lecture method by providing practice and drills inside or outside the classroom (Kodippili and Senaratne, 2008; Taylor, 2008, Stillson and Alsup, 2003; Spradlin and Ackerman, 2010; Zerr, 2007; Meagher, 2012; Stephens and Konvalina, 1999; Burch and Kuo, 2010). Hoffman and Hunter (2003) suggested that integrating "real world" problems into the teaching of mathematics may improve students' attitudes toward mathematics and thereby improve their motivation to learn the subject. All of the aforementioned studies informed the current study in that the researcher is seeking to ascertain the effectiveness of Academic Service Learning to improve students' success rates, attitudes, and motivation in intermediate algebra. Next, the impact of inserting "real world" problems in mathematics courses is explored.

The Impact of "Problem-Based Learning" (PBL) on Students' Mastery of Learning Objectives

Various educators in arts, letters, and the sciences have experimented with the integration of mathematics with other content subjects. Erickson and Shore (2003) investigated whether the integration of developmental mathematics content with physical therapy content can increase student success and student motivation to learn mathematics. Through a survey and a post-test administered to the participants, the study reported that students enrolled in the integrated class had significantly higher scores than students enrolled in either a developmental mathematics course or a physical therapy course taught with the traditional lecture method. Comparably, Verhovsek and Striplin (2003) analyzed the use of Problem-based Learning (PBL) in a mathematics course for allied health students. "Problem-based Learning focuses on the learning that takes place as a result of the process of working towards and resolving a problem. It involves self-acquisition of knowledge, directed learning strategies, teamwork and problem solving tasks, all of which reflect the "real world" dynamics involved in solving problems" (Verhovsek & Striplin, 2003, p. 382). The researchers examined whether a change from a teacher-centered method of instruction to a learner-centered method of instruction would result in students learning the content in a meaningful way. The study's results indicated that the paradigm shift from a teacher-centered method of instruction to a learner-centered method of instruction had a statistically significant impact on students' performance on the final exam when compared to students taught with the traditional lecture method. The authors concluded that PBL not only improved the learning environment, but also it is an excellent supplement to the traditional methods of instruction.

Allied Health professionals need to have a strong understanding of certain mathematical concepts in order to administer ionizing radiation to patients and to successfully handle the application of contrast media and radiopharmaceuticals, for example. Shore and Shore (2003) conducted a study in which students who were enrolled in developmental mathematics and also had an interest to become healthcare professionals were exposed to health related applications through problem-based learning. The researchers reported that PBL was successful in engaging the students. Furthermore, the students became aware of the use of mathematics in the professional lives of healthcare professional on a daily basis.

Matthews, Adams, and Goos (2009) examined how students' perceptions and beliefs are affected by an inter-disciplinary mathematics and science course at the University of Queensland in Australia. The study included 569 students of which 54 percent were female. 89 percent of the students were between 16 and 19 years of age. The authors applied a mixed method research design that included the collection of data through pre- and post-surveys as well as focus groups. The results of the study provided strong evidence that "while the vast majority of the students recognized that mathematics is important in science, fewer acknowledged the relationship between the two" (Matthews et al., 2009, p. 897). Since the study was done in Australia, the characteristics of the students included in this study may differ from the characteristics of the students typically enrolled in tertiary institutions in the United States. However, this study still informed the current study as students in the United States also fail to make the connections between mathematics and its "real world" applications (Crouch & Haines, 2004).

Moreover, Judd and Keith (2007) examined how an integrated approach to mathematics and science curriculum can result in competent graduates at the United States Military Academy (USMA). The curriculum incorporated laboratory activities that promoted hands-on experiences and provided cadets with a better understanding of scientific concepts. In addition, "the use of technology facilitated learning by allowing cadets to visualize scientific and mathematical ideas and to solve more sophisticated and complex problems" (Judd and Keith, 2007, p. 12). The authors of the study gathered qualitative data in order to reach their conclusions. They sent surveys to the cadets' field commanders and conducted focus group interviews. The results demonstrated that the commanders agreed that the academy was providing the cadets with the tools necessary in mathematics and science that allowed them to become competent problem solvers for the remainder of their careers. "Cadets come to view mathematics and science as a unified whole rather than as a collection of independent topics." (Judd & Keith, 2007, p. 12). Although, the sample considered in this study is quite different from the typical student enrolled in a public university, college curricula should be designed so that by the time students reach graduation, they perceive mathematics and science as a unified whole.

Burks et al., (2008) explored how the use of problem-solving strategies and modeling helped students discover the connections between mathematics and science. The course included many topics covered in a traditional pre-calculus class and incorporated "real world" problems from the biological sciences. "For our capstone experience, instructors chose two or three modules from topic areas including cardio-respiratory endurance, epidemic planning, radio-carbon dating, and the application of

Leslie models to study age-structured populations" (Burks et al., 2008, p. 72). The problem-solving activities involved the following: (1) the students had to convert a word problem depicting a "real world" situation into a system of equations; (2) convert the system of equations into a matrix-vector product; (3) multiply a vector by a matrix; (4) raise a matrix to an integer power and; (5) interpret the results and communicate them to the client. A Leslie matrix is defined as a square matrix in which the number of columns is equal to the number of age intervals for the population under consideration. The authors contended that the students enjoyed the new curriculum and had a better grasp of the course material. They determined that the assignments did a good job of helping the students understand the role that mathematics plays in the sciences. Although this article did not depict a research study, it informed the current study by describing a project that can be incorporated in an Academic Service Learning mathematics course in order to give the students interested in biology the opportunity to make connections between biological concepts and mathematical concepts they studied in the classroom.

Cline (2005) investigated the effects of open-ended projects on students' problem solving skills. Although the author did not describe the methodology she used to reach her conclusions, she included very detailed descriptions of the projects the students had to complete. The projects were designed to allow students to recognize when to use numerical methods, to choose an appropriate method, to successfully use the method to solve the problem, and to be aware of the errors and difficulties that may appear when solving "real world" problems. The author stated that the designers' philosophy when constructing the projects is that "students learn mathematics by doing, by working problems and doing assignments" (Cline, 2005, p. 275). The current study adhered to the

same philosophy that students learn mathematics by doing and working problems and assignments. Additionally, the overarching hypothesis is that learning is more meaningful when the assignments require the students to reflect on what they have learned and give them the opportunity to discuss the material with others.

Odafe (2012) investigated whether reading, interviewing, communicating, and class discussion would decrease students' misconceptions of the notion of limit. The study included 18 students enrolled in a first-year calculus class. The students had to read ten calculus books each; and interview eight college instructors as well as ten high school teachers. In order to test his hypotheses, the author administered a survey at the beginning of the semester; and another survey at the end of the semester. Although the methodology did not include a statistical analysis, the qualitative data extracted from the surveys reveal that students felt that they benefited from the assigned readings, interviewing the instructors, and writing about and discussing the limit concept. Further, the study found that not only the number of students with misconceptions decreased, but also that "communication, teamwork, and investigation are valuable in mathematics learning" (Odafe, 2012, p. 224). The author affirmed that the traditional lecture method alone may not be sufficient to explain the concept of limit or dispel misconceptions students may have concerning limits. According to Campus Compact (2012), Academic Service Learning affords students the opportunity to communicate with people in the "real world" about concepts covered in the classroom; and as a result of discussing and reflecting on mathematical concepts, students will be able to internalize those concepts and achieve a better understanding.

Chang (2011) analyzed the effects of inquiry-based learning on students' learning in a linear algebra class. Inquiry based learning consists of a series of well-directed questions in order to probe student thinking and uncover their misconceptions. Chang (2011) ascertained whether the adoption of a teaching strategy consisting of first motivating the students, and then expounding on the theory second, would promote conceptual understanding of key topics in the course. Further, the author investigated whether this approach would stimulate students' intellectual needs to learn. "Repeatedly showing students what we want them to learn will not automatically help students to translate the knowledge into their own. And simply doing a great job of telling and showing difficult concepts such as linear independence, may not significantly improve student learning of such topics, either" (Chang, 2011, p. 247).

Comparably, Shafii-Mousavi and Kochanowski (2006) explored the effects of an interdisciplinary project-based mathematics course linked to a computer technology course. The program consisted of learning mathematical concepts through the completion of "real world" industrial group projects. The projects come from local organizations such as banks, school corporations, industries, government agencies, and social organizations. "Projects are selected to emphasize finite mathematics tools, incorporate the use of computer technology, and are assigned to students who work in teams, with three or four students on each team" (Shafii-Mousavi & Kochanowski, 2006, p. 62). The authors described several projects in details, and discussed how they were designed to give the students the opportunity to apply core mathematical concepts learned in the classroom. In addition, students are given access to a computer laboratory equipped with computer software applications capable of generating mathematical

models for solving large scale “real world” projects. The authors concluded that the integration of mathematics across several disciplines produces a powerful teaching and learning experience even in introductory courses.

Unlike Chang (2011), Prevot (2006) did not conduct a systematic research study. He explored the benefit of a virtual internship that emulates an employment scenario to the students. He also gave very detailed explanations of the concepts the students encountered during the virtual internship. The author commented that “strictly lecturing about the analytical details of the subject matter, does not offer an optimal learning process for the students” (Prevot, 2006, p. 22). Prevot’s opinion is echoed in the results found by Odafe (2012), Cline (2005), and Burks et al. (2008).

Flegg, Mallet, and Lupton (2012) studied the experiences of students enrolled in a first-year engineering mathematics course at a university in Australia. In this mixed method study, the authors reported on the students’ views of the relevance of mathematics to engineering and how they experience the process of learning mathematics as a subject in its own right, as a tool for the study of other subjects, and as a tool for handling “real world” problems. Twenty-seven of the 193 students who completed the course provided short written answers to open-ended questions regarding the relevance of the skills they were taught in the mathematics course to engineering. Thirty-four students answered questionnaires, and five students were selected for in-depth interviews regarding their perceptions of the relevance of mathematics to their future study and career. The qualitative data obtained were coded and analyzed.

The study found that the majority of the students agreed that mathematics is relevant to their future career and study. However, some students felt there was no

relevance; while others saw some relevance to their future study at the university but no relevance to their future career in the "real world". The authors stated "we cannot take for granted that engineering students see the relevance for themselves when they are in their first-year of study. We would argue that it is important to emphasize the relevance at every opportunity" (Flegg et al., 2012, p. 728). Although the data was collected in Australia, the results have two major implications for the current study: (1) if first-year engineering students do not make the connection between mathematics and the "real world", should developmental mathematics students be expected to make these connections? (2) How can educators emphasize the relevance of mathematics throughout the curriculum? The current study examined whether the insertion of "real world" experiences through Academic Service Learning motivated students to learn mathematics and impacted their disposition towards the subject.

The Impact of "Real World" Experiences through Academic Service Learning on Students' Mastery of Learning Objectives

Duffy et al., (2011) studied the benefits of Academic Service Learning to students enrolled in the college of engineering at a university in Massachusetts. "Service Learning is defined here as a hands-on learning approach in which students achieve academic objectives in a credit-bearing course by meeting real community needs." (Duffy et al., 2011, p. 2). Service Learning comprises the following major components: "projects or placements that meet academic course objectives, the meeting of real community needs, reflection on the part of the students to relate the service to the subject matter of the course, and reciprocity with the community partner." (Duffy et al., 2011, p. 2). The authors' investigation is detailed in the table below.

Table 1 Summary of the study of Duffy, Barrington, West, Heredia, and Barry (2011)

Research Question	Data Collection Method	Results
Would faculty members accept service Learning and develop into practitioners of Service Learning?	Faculty surveys and interviews, tracking the number of ASL courses, tracking faculty participation.	Half of full time faculty participated in the program. Most committed to continue ASL in at least one course.
Would students accept Service Learning and benefit from the program?	Faculty surveys and interviews, student surveys and interviews, alum interviews.	Most students carried out ASL in core courses and reported benefiting from it.
Would recruitment and retention increase, especially among underrepresented groups?	Faculty surveys, student surveys, international research data, college of engineering data.	Recruitment and retention were aided. Underrepresented groups indicated more positive attitudes toward ASL.
Would positive cognitive and affective changes occur in students?	Faculty surveys and interviews, student surveys and interviews, alum interviews.	Students were more motivated to learn basic course subject matter and voluntarily spent more time on ASL projects.

Table 1 Summary of the study of Duffy, Barrington, West, Heredia, and Barry (2011) (Continued)

Research Question	Data Collection Method	Results
Would students learn the academic subject matter better?	Faculty surveys and interviews, student surveys and interviews, alum interviews, tracking changes in students' grades.	Learning and interest in the subject matter were improved. Students spent more time on course material.
Would teamwork, communication skills increase among the participants?	Faculty surveys and interviews, student surveys and interviews, alum interviews.	Teamwork and communication skills were improved.
Is Service Learning spread throughout the core curriculum more effective than one intensive course?	Student surveys and interviews.	Integration of SL throughout the curriculum is a good way to achieve a wholesale change in attitude.
Is a mixture of required and elective Service Learning projects more effective than either one or the other?	Faculty surveys and interviews, student surveys and interviews, alum interviews.	A mixture of required and elective Service Learning projects appeared to be reasonable.

Table 1 Summary of the study of Duffy, Barrington, West, Heredia, and Barry (2011) (Continued)

Research Question	Data Collection Method	Results
Could Service Learning decrease the time it takes for students to complete the engineering programs?	Faculty surveys and interviews, student surveys and interviews, alum interviews.	No definitive answer yet. A longitudinal study underway.
Would the local and international community benefit?	Faculty surveys and interviews, student surveys and interviews, alum interviews, community interviews, tracking the number of community partners, community engagement award.	Community partners reported benefitting from Service Learning programs.

The study found that Service Learning afforded the students the opportunity to solve open-ended "real world" problems. In addition, Service Learning gave students the chance to deal with socially important issues while providing relevant services to the community. Some of the research questions listed above are similar to the questions the current study sought to answer. The current study explored whether the insertion of "real world" activities through Academic Service Learning would increase students' performance in an intermediate algebra course as well as increase their attitudes and motivation to learn the subject. In order to address their research questions, Duffy at al.

(2011) conducted interviews with community partners, faculty, administrators, and conducted student focus groups. They also gathered quantitative data in the form of pre and posts surveys. Most faculty members as well as the majority of the students agreed that the integration of Service Learning with academic coursework led to an improvement of the learning, teamwork, and interest in the subject matter under consideration. In addition, the study reported that the faculty who inserted Service Learning into their courses afforded the students the opportunity to encounter open-ended "real world" problems while giving them the chance to use their creativity to solve such problems.

Contrary to the study conducted by Duffy et al., (2011), Sherman and MacDonald (2009) sought to understand why participation in Service learning programs is low in mathematics and science courses at a small undergraduate university. Sherman and MacDonald (2009) examined how professors and students became involved in the Service Learning program at the university. The authors gathered data from two professors; one teaching biology and one teaching mathematics. In addition, surveys of all the students enrolled in both courses were conducted as well as interviews with some students. The data collected from the interviews and the surveys were transcribed and the emerging themes were identified and categorized. The Service Learning program at the university was course based in that it sought to relate course concepts to issues in local community organizations such as nursing homes, senior centers, schools, day care centers, women centers, and other non-profit organizations. In the mathematics course students were partnered with teachers from local elementary schools and provided mathematics lessons to the children alongside the teachers. In the biology course, the

students had to work in small groups to gather and analyze data they collected from a local organic farm. This project was part of a conservation initiative. The results of the study indicated that both students and faculty perceived Service Learning to be a positive experience. Both professors indicated that their courses became more student-centered as a result of Service Learning. In addition, they felt that the students who participated in the Service Learning program demonstrated a deeper understanding of the subject matter than students enrolled in these same courses in previous semesters. Service Learning "was perceived as promoting tangible connections between classroom learning and the "real world" science and mathematics involved in the projects" (Sherman & MacDonald, 2009, p.241).

Sherman and MacDonald (2009) also found several barriers that prevent both faculty and students from participating in Service Learning activities, including the following: "(a) the time commitment required; (b) the nature of the immersion in the community context; (c) the perception of scientific rigor; and (d) the potential impact on career opportunities" (Sherman & MacDonald, 2009, p. 239). The study conducted by Sherman and MacDonald (2009) informed the current study in that it highlighted some substantial issues that were taken into consideration during the design phase of the current study.

In addition to the barriers found by Sherman and MacDonald (2009), Carr (2002) conjectured that the lack of cooperation among faculty from different departments is a major hindrance to the successful implementation of Service Learning programs at post-secondary institutions in the United States. Carr (2002) explored the role that cultural differences played between the science department and the teacher education department

in the science outreach program at a university in the Pacific Northwest. George Fox University (GFU) has a science outreach program in which students majoring in Science team up with students majoring in elementary education to teach science courses as a service to homeschooled children in the local community. The science courses were taught once per week for a period of eight weeks on the GFU campus using university facilities.

The participants in Carr's (2002) study included 50 elementary education students, one professor from the education department, one professor from the science department, and 20 science students. The author collected data in the form of field notes, interviews, student work, student self-reporting, and online surveys. The data were then cross-checked and triangulated in order to ensure credibility and reliability. The study found that the approach used in the program created student interest in the class; however some faculty members in the science department were concerned about rigor. The author stated that "different epistemological views of learning and knowing seem to underlie many of the obstacles to collaboration experienced by the participants" (Carr, 2002, p. 294).

Zang, Gutmann, and Berk (2000) conducted a study that is somewhat similar to the one conducted by Carr (2002). The Service Learning component of a Liberal Arts mathematics course required the students to tutor the mathematics portion of the General Education Development (GED) test to at-risk youth. The authors collected data consisting of students' responses to questions on social responsibility as well as reviews of journal entries, interviews and surveys. The six students who participated in the study reported a wide range of experiences. One student felt that her mathematics skills had

improved as a result of tutoring other students; she also reported that her level of mathematics anxiety was greatly reduced. “Students’ understandings of what it means to be socially responsible and their senses of mathematics and of themselves as learners of mathematics grew in ways which reflected both their individual backgrounds and their approaches to the project.” (Zang et al., 2000, p. 324). Similarly, in the current study, interviews were conducted with students engaged in an Academic Service Learning mathematics project in order to ascertain whether the project impacted their disposition towards the subject. The study conducted by Zang at al. (2000) guided the development of the survey instruments used in the current study.

Harcum College designed a six-week Service Learning program aimed at helping disadvantaged high school graduates enhance their skills in a variety of subjects such as mathematics, science, reading, writing, computer literacy, public speaking, and library research. Hilosky, Moore, and Reynolds (1999) conducted a study of the Service Learning program at Harcum College. During the project, the students created different brochures on health topics with the assistance of faculty from mathematics, science, and English. The goal of the program was for each student to present their chosen topic at a local community forum as well as distribute the brochures to the members of the community.

The students had to conduct computer searches to find information about a particular disease, explain the symptoms of the disease, and describe possible treatments. In addition, they had to provide information on current research on the disease and the location of medical facilities that provide treatment for the disease. The mathematics portion of the program prepared the students for laboratory math concepts such as

dilution. The authors analyzed the data obtained from administering surveys and other inquiries as well as data obtained from pretests and posttests using Stanford's test of academic skills. The results of the study indicated that the students made significant gains in all academic areas. Furthermore, the students' social skills markedly increased. The authors "firmly believe that this kind of project greatly helps disadvantaged students learn the strategies needed to succeed in college, regardless of their chosen discipline" (Hilosky, Moore, & Reynolds, 1999, p. 146).

The studies discussed in this section suggest that Service learning programs have the potential to help higher education institutions handle the issue of student under-preparedness and lack of motivation in mathematics. Public universities are faced with unique challenges in that they must serve a diverse group of students with varying levels of ability, unique cultural backgrounds, and different socio-economic statuses. By transforming what was supposed to be extra-curricular activities into essential components of coursework, Academic Service Learning may be able to provide solutions to some of the challenges confronted by post-secondary institutions (Serow, Calleson, Parker, & Morgan, 1996).

Although Academic Service Learning is emerging as one of the strongest trends in higher education, its insertion into mathematics courses is less apparent. A thorough search of the Education Resources Information Center (ERIC) and The Education Full Text databases yielded less than a dozen articles related to implementation and research on Service Learning in mathematics. A search of the Campus Compact website, which is one of the leading organizations on Academic Service Learning, produced only two examples of syllabi where Service Learning was integrated into mathematics courses at a

higher education institution. The following section of the literature examined the reasons why "real world" initiatives through Academic Service Learning may benefit students enrolled in mathematics courses.

The Role of Motivation in Mathematics Teaching and Learning

John Dewey and other progressive theorists believed that experiential education was one of the best ways of linking individuals to their communities and for preparing them for democratic citizenship. Furthermore, he argued that education is strongly connected to personal experience. Although Dewey made this argument over 70 years ago, his philosophy of education has not been widely implemented. This is especially true in mathematics where typically students sit passively listening to the professor lecturing and working out problems on the board. As a result, students fail to see the relevance of mathematics in their daily lives. Many students are not motivated to learn the subject; some fear it and view it as irrelevant; and many lack the prerequisite skills to successfully complete the sequence of mathematics courses required for graduation. In this section of the review, the motivating factors that contribute to improved performances in mathematics are investigated. This study analyzed whether the insertion of "real world" experiences through Academic Service learning helped improve students' motivation to learn mathematics.

Kennedy and Schumacher (2005) designed a three-year intervention program at Bryant University in Rhode Island designed to encourage women and minorities to enroll in advanced mathematics courses at the high school level. Math Accelerated Professionals (MAP) program 'was developed as part of a grant that involved the collaboration of university math professors, business professionals, and high school math

teachers" (Kennedy and Schumacher, 2005, p. 190). The authors investigated whether the program would succeed in increasing the number of underrepresented students who select majors that require advanced mathematics.

The professors involved in the program had to develop teaching lessons that emphasize the importance of mathematics in the day-to-day workings of the business world. The participants who were high school students had to use mathematical modeling to solve word problems that resulted from collecting data from local businesses. University students were paid to tutor and mentor the high school students. In addition, the program had a strong social component in which university faculty, high school faculty, students, tutors, and business professionals gathered together at various times to share their experiences during the program.

The authors collected data from the five high schools that participated in the program; they found that the students were thrilled to see that they were dealing with data from actual companies. Furthermore, the study found that the program successfully increased the number of underrepresented students who enrolled in advanced mathematics courses. More importantly, "almost 100 percent of the students agreed or strongly agreed with the statement: mathematics is important to everyone's life" (Kennedy and Schumacher, 2005, p. 193).

Kennedy and Schumacher (2005) did not report on the effects of the program on the university students who served as mentors and tutors. The current study, however, investigated whether Academic Service Learning projects in which college students served as tutors to 4^{th} and 5^{th} graders had an impact on the college students. In addition, Kennedy and Schumacher's (2005) study informed the current study in that partnerships

were formed with local social agencies. In the current study, the researcher tested the hypothesis that services provided by the participants through partnerships with two local non-profit organizations impacted the students' dispositions towards mathematics learning.

Motivation is a fundamental component in the success or failure of students enrolled in developmental mathematics courses (George, 2010). In addition, Merseth (2011) identified four factors responsible for students' lack of engagement and motivation in developmental mathematics courses. Those factors include: the students' perception of mathematics course content as uninteresting and unimportant, the students' inadequate study skills and habits, the students' lack of confidence in their ability to successfully complete mathematic courses, and the scarcity of interaction among the students as well as between the students and the faculty. "Teachers can use theories of motivation to analyze their interactions with students and to develop patterns of interactions with their students that may enhance their students' willingness to expand effort in achievement-related tasks" (Tollefson, 2000, p. 64). A paradigm shift from a teacher-centered to a learner centered method of teaching may be necessary to increase students' motivation in developmental mathematics courses.

Evans (2007) studied students' attitudes and conceptions about statistics in a large urban university in Northeastern United States. The participants in the study consisted of 115 students enrolled in five different sections of an undergraduate statistics course. The sample was composed of 80 female students and 35 male students from three different departments: sociology, psychology and mathematics. Evans (2007) used five-point Likert scale surveys to collect data on students' attitudes towards statistics before the

courses started and at the end of the semester. In addition, the author conducted interviews with the faculty members who were teaching the courses. The interviews consisted of open-ended questions concerning the actions the instructors had taken throughout the semester to improve students' attitudes towards statistics and improve misconceptions.

Evans (2007) found that "students claimed they would not have taken statistics if it were not required; they did not find statistics very valuable in their programs of study" (Evans, 2007, p. 26). The author recommended that students' conceptions could be improved by giving them the opportunity to experience various careers that use statistics. Similarly, Champion, Parker, Mendoza-Spencer, and Wheeler (2011) examined whether students could make the connections between their future careers and the skills they were learning in a college algebra class. The following research questions guided the study: "(1) what are college algebra students' attitudes about the potential value of mathematical knowledge, data analysis skills, writing, and technology in their career? (2) Do students' attitudes about the value of mathematical knowledge, data analysis skills; writing, and technology, with respect to their future career differ by project involvement, business major, and gender?

Champion et al., (2011) developed an attitudinal survey and collected data from 144 students enrolled in six sections of college algebra at a mid-size doctoral granting university in the western part of the United States. Through chi-square analysis and Analysis of Variance (ANOVA), the study found that students had positive views about the importance of mathematics for their potential careers. Although most of the students consistently saw writing and technology as important for their future careers, 30 percent

of them did not think they would need to write about data in their careers. Further, the study found that there was no difference in attitudes about the value of mathematics between male and female students. However, business majors held more positive views about the importance of mathematics for their potential careers than non- business majors.

Some students held particularly negative views about the importance of mathematics with regard to topics such as graphing data and writing about data analysis. Furthermore, many students expressed negative attitudes with regard to the real-life project they were required to complete. Champion et al., (2011) offered some explanations as to the reasons why the students failed to see the point of completing the project. They include among others, the failure of the project to make the connections to "real world" situations explicit and the tendency of students in American culture to view mathematics as a boring subject with little connection to the "real world". These findings were important for the current study in that the researcher explored whether the insertion of "real world" initiatives through Academic Service Learning, a recommendation of Champion et al., (2011), positively impacted students attitudes towards mathematics, thereby increasing their motivation to learn the subject. Champion et al., (2011) captured in part the objective of Academic Service Learning when they contended that "increasing student motivation may require connecting current learning to the future goals of the students rather than attempting to motivate short-term course goals" (p. 1096).

Atkinson (1965) asserted that students are willing to put forth effort on tasks depending on their belief that they have the ability to successfully perform the tasks and the value they place on the rewards associated with successful realization of the tasks.

"Students who feel confident in their capabilities put forth more effort on tasks, persist longer, and show resilience in the face of obstacles" (Spence and Usher, 2007, p. 269). The researcher of the current study theorized that inserting Academic Service Learning into intermediate algebra courses would motivate the students to expand effort into learning the content because they would desire to gain the respect of the 4^{th} and 5^{th} grade children by projecting competence in the subject matter, thereby increasing the students' likelihood to engage with the course content. Research indicates that self-efficacy is a good predictor of academic achievement especially in the area of mathematics. ASL affords the students the opportunity to increase their motivation by augmenting their self-concept, their ability to set goals, and their desire to work toward achieving them.

In the traditional mathematics classroom, teachers present the materials to the students in the form of a lecture. Then, the students are assigned a set of drill and practice problems to complete (Eggen & Kauchak, 2006). Students who are intrinsically motivated will complete the problems because they have been successful in prior mathematics courses and view the completion of the task as a challenge they must overcome. Extrinsically motivated students will complete the task merely because they are afraid of getting a failing grade for the assignment. Students who have a history of failure and difficulty in mathematics courses will view the assignment as a waste of time and may not complete the assignments at all. A large percentage of the students enrolled in developmental courses at two-year and four-year institutions fit in the latter category.

The Academic Service Learning component of the curriculum provides valuable motivational tools to students in all three categories. The motivation level of the students who are intrinsically motivated may increase because they want to provide valuable

assistance to the children they are tutoring. Similarly, the level of interest of students who are extrinsically motivated may rise because they want to project competence during the tutoring sessions. According to socio-cultural learning theory, the students will be more likely to expand more effort in learning the material so they earn the respect of the respect and admiration of the elementary school children (Kolb, 1976).

Sezer (2010) contended "students not majoring in mathematics and sciences often perceive mathematics as an abstract, rigid field that has little or no application in daily life" (p. 416). Sezer (2010) argued that the lecture method of teaching that assumes that knowledge can be transferred from the teacher to the learner is ineffective at best. Sezer (2010) hypothesized that students would perceive mathematics as valuable, and as a result, be motivated to learn it if they understood the relevance of the concepts in their daily lives. Next gender and race differences in mathematics learning and achievement are explored.

Gender and Race Differences in Mathematics Learning and Achievement

Success in mathematics is linked to students' attitudes toward the subject and their motivation to engage with course contents. This section of the literature investigated whether differences exist between the success rates of male and female students in mathematics. According to Donovan and Wheland (2008), the percentage of female students who successfully completed intermediate algebra is statistically significantly higher than the percentage of male students who succeeded in the course. Other studies confirmed that females outperformed their male counterparts in entry level college mathematics courses (Callas, 1993; Spradlin & Ackerman, 2010). In addition, the graduation rate of female students was higher that of male students at both public and

private not for profit institutions (NCES, n.d.). However, Champion et al., (2011) found no gender difference with regard to students' attitudes towards the value of mathematics in preparing them for their future careers. Taylor (2008) contended that students' performance in mathematics depend on several factors including gender, but found no statistical differences on mathematical achievement based on gender.

Ashby, Sadera, and McNary (2011) reported statistically significant differences in students' performance based on gender regardless of the learning environment: face-to-face, blended, or completely online. Female students are more likely to attribute success to effort and male students are more likely to attribute success to ability (Shores & Smith, 2010). National trends show that although females obtained better grades in introductory algebra courses than their male counterparts; however, female students are less likely to enroll in advanced mathematics courses (Callas, 1993). In 2003, the National Science Foundation (NSF) indicated that only 22.8% of the scientist and engineers in the labor force were women (NSF, 2003). Further, The National Center for Educational Statistics reported that in 2001, 72% of the degrees in Computer and Information Science were awarded to men, and only 28 % to women (NCES, 2001).

Shores and Smith (2010) conducted a literature review that covered attribution studies from 1978 to 2008. They argued that there is a need to examine the factors that affect mathematics achievement of females and minority groups given that historically there have been doubts about the intellectual capabilities of females and certain ethnic groups in mathematics. Mathematics is the gateway to careers in scientific and technical fields such as physics, engineering, technology and the sciences (Adelman, 1999).

According to a report issued in 2003 by the National Science Foundation (NSF), 82.8 % of scientists and engineers in the American labor force were White. The report also stated that 3.4% were black, 3.1% were Hispanic, 0.3% were classified as other, and 10.4% were Asian Pacific Islanders. In addition, in 2001, 9.7% of degrees in Computer and Information Science were awarded to Blacks and 5.1 % to Hispanics. For engineering, Blacks and Hispanics comprised only 10.8% of awarded degrees with each group receiving 5.4% of engineering degrees.

In high school, 26% of White students reported having taken calculus, while 14 % of African American and between 14 and 19% of students from other minority groups reported having taken calculus (College Board, 2002). These statistics indicated to minority groups lagged behind their White counterparts with respect to mathematics achievement. Oswald and Harvey (2000) stated that mathematics proficiency is one of the stumbling blocks preventing students from pursuing careers in science, technology, engineering, or mathematics related fields (STEM). The current study considered whether a difference exists in the success rates of students who participated in ASL and those who elected not to participate in ASL in intermediate algebra. Differences between male and females participants' attitudes and motivation were also explored and differences between White and minority participants' attitudes and motivation were also analyzed.

Conclusion

Mathematics has become increasingly important in today's world. Most institutions of higher education require students to complete a sequence of mathematics courses in order to be eligible for graduation. Furthermore, with the advancement of technology, an increasing number of career choices require the individual to possess a

solid command of basic mathematics concepts. At the same time, the majority of students are entering college unprepared or under-prepared for rigorous work in mathematics.

The literature review suggests that, with the opportunities of drilling and practicing on the computer and receiving instant scores and adapted feedback, some students had gained an interest in doing mathematics, and formed a perception that they became more proficient in problem solving. However, the degree to which the insertion of technology was successful in increasing students' achievement has been varied. Additionally, the attitude improvements were quite different across ethnic and gender groups.

Other studies suggest that students' attitudes toward learning mathematics vary based on characteristics of classroom and instruction, such as types of assessment, topics, and material delivery tools. Some researchers argue that interactive learning environments can improve students' success in mathematics. Many studies have been done to try to uncover the most effective ways to teach mathematical concepts; however there has been no consensus on the best methods to use in the mathematics classroom. The current study evaluated whether the insertion of "real world" activities through Academic Service Learning would resulted in an improvement in students' performance, attitudes and motivation to learn mathematical concepts.

Summary

In Chapter One the author presented the scope of the study, the research questions, definitions of key terms, and the purpose of the study. In Chapter Two a review of the literature was presented. In the next chapter, the subjects, sampling method, procedures, and instrumentation are discussed. Details of the quantitative statistical

methods as well as the qualitative methods used in the study are also provided. In Chapter Four, the results are presented. Finally, in Chapter Five, the results and their implications for educators and other stakeholders are discussed.

Chapter 3. Research Methodology

Introduction

Research suggests that students at all levels of education have difficulty understanding and applying the concepts presented in mathematics classrooms (Burns, 1998; Gallo & Odu, 2009; Taylor 2008; Spradlin & Ackerman 2010; Wheland et al., 2003). Problem solving can be considered to be the real essence of mathematics. Once students have learned to solve a problem, they might only have learned to solve that particular problem, but it is more likely that they have learned to solve a variety of similar problems and perhaps even a variety of problems possessing similar characteristics. Thus, it can be asserted that teaching problem solving is an important goal in educational settings. Many studies have been done to try to uncover the most effective ways to teach mathematical concepts; however, there has been no consensus on the best methods to use in the mathematics classroom.

This mixed method research study investigated whether the insertion of Academic Service Learning projects into an intermediate algebra course resulted in an increase in students' success rate, an improvement in students' attitudes towards mathematics learning, and a change in students' motivation to learn the subject. The following research questions guided this investigation:

1) Does "real world" experience through Academic Service Learning make a difference on college students' mastery of learning objectives in intermediate

algebra compared to students enrolled in the same course who elected not to participate in the ASL program at a public university?

1A) Does the effect of ASL on students' mastery of learning objectives vary by gender in intermediate algebra at a public university?

1B) Does the effect of ASL on students' mastery of learning objectives vary by race in intermediate algebra at a public university?

2) How does the infusion of "real world" experiences through Academic Service Learning affect students' motivation to learn mathematical concepts in an intermediate algebra course at a public university?

2A) Does the effect of ASL on students' motivation to learn mathematics vary by gender in intermediate algebra at a public university?

2B) Does the effect of ASL on students' motivation to learn mathematics vary by race in intermediate algebra at a public university?

3) How does the infusion of "real world" experiences through Academic Service Learning affect students' attitudes towards mathematics learning in intermediate algebra at a public university?

3A) Does the effect of ASL on students' attitudes towards mathematics learning vary by gender in intermediate algebra at a public university?

3B) Does the effect of ASL on students' attitudes towards mathematics learning vary by race in intermediate algebra at a public university?

Intervention

In this study, students in intermediate algebra were asked to go to local social agencies and provide group tutoring or one-on-one tutoring on mathematical concepts

related to the course to 4th and 5th grade children in after care programs. The students were asked to perform up to 20 hours of community service during the semester at one of two local community centers. This equated to an average of at least 2 hours per week for 10 weeks. The community centers provided after school enrichment programs to economically disadvantaged children enrolled in elementary or middle school. The university students were asked to perform at least one hour of service per visit and they were given the choice to perform two hours of service once per week or one hour of service twice a week. Service hours were between 2 PM and 6 PM.

In addition, the students were directed to keep an electronic journal in Microsoft Word that detailed their experiences at the agency for every visit; each journal entry was to consist of at least 2 paragraphs with at least 3 sentences each. The students were asked to send their journal entries to the researcher at the close of each semester. They were directed to address the following prompts in their journals: (1) describe your experience during your visit to the agency and the content you covered with the children; (2) in your view, how did the tutees experience the tutoring session? Were they satisfied? Provide examples; (3) is there anything else you would do differently? Is yes, explain.

The students were informed that in order to participate in the ASL project they would have to attend a two-hour training session that would count as a part of their community service hours. During the first hour of the training, the following topics were covered: learning styles, different models of instruction, how to interact with students with learning disabilities, and how to foster the children's critical thinking without offending or shaming them.

During the second hour of the training a representative of the coordinating office for Service Learning provided training to the students on the use of the NobleHour software to keep track of their hours of service (NobleHour, n.d.). The representative emphasized the need to be punctual and professional. In addition, the students received information regarding the proper way to dress, the need to avoid offensive language, and the importance of avoiding inappropriate physical contact with the children.

At the end of the training sessions, the students were directed to complete two Likert scale type surveys electronically. They were also informed that they would receive an invitation via mail at the close of the semester to participate in an interview, as well as a request to complete the two survey instruments once more. They were informed of their rights to decline to participate in the interview, and they were told that the total time commitment required for the study was approximately 25 hours over a period of 10 weeks. This translated to an average of about 2.5 hours per week, two hours tutoring at the community center and about a half hour for the journal entries. In addition, the researcher explained that participation was completely voluntary and that the participants would not receive community service hours for the time spent writing the journal.

The site of the study was a large public university located in Southeast Florida. To ensure the privacy of the participants the pseudonym South Eastern University (SEU) will be used from this point forward. The population comprises students from a wide range of cultural, ethnic, and economic background. SEU offers bachelors, masters, and doctoral degrees in many fields of studies that prepare students to become professional in their chosen fields.

Subjects

The sample for the study consisted of 34 students (n = 34) enrolled in intermediate algebra courses during the fall of 2015 and spring 2016 semesters. As a subset of the entire student population at the university, the sample was composed of individuals from diverse racial, social and economic backgrounds. The ASL group comprised 15 participants: 7 Caucasian students, 3 African American students, 3 Hispanic students, 1 student identified her ethnicity as biracial, and 1 did not indicate her ethnicity in the questionnaires. The non-ASL group was composed of 19 subjects: 13 Caucasian students, 3 African American students, 1 Hispanic student, and 2 students who either identified their ethnicity as "Other" or failed to answer the question.

A typical intermediate algebra course comprises African American, Latino, Caucasian students and various other minority groups. At the university, the student body is approximately 50% Caucasian, 19% Hispanic, 17% African American, 5% Asian, and 0.3% Native American. Another 3 % are international students who come from various countries around the world. The racial composition of the ASL group was almost 47% Caucasian, 20% African American, 20% Hispanic, and 13 % "Other"; while the non-ASL group consisted of a little over 68% Caucasian, almost 16% African American, close to 5% Hispanic, and over 10 % identified their ethnic background as "Other".

Because of the nature of the study, it was impossible to obtain a random sample as the Academic Service Learning program was being inserted in intermediate algebra for the first time at the university. As a result, a purposeful sampling method was used to address the research questions. To recruit the participants, the researcher visited six sections of intermediate taught by one instructor (See Appendix C for the description of

the recruitment method). At the beginning of the semester, all students enrolled in the course were required to complete an initial assessment using the educational software titled and Learning in Knowledge Spaces (ALEKS). The results of the initial assessment were utilized to ascertain whether the participants included students from varying ability levels.

The sample consisted of 34 students (n=34), 12 males and 22 females; the Academic Service Learning group consisted of 15 students (n =15), 5 males and 10 females and the comparison group consisted of 19 students (n = 19), 6 males and 13 females. Students were not coerced to participate, they had the option to participate in the program if they desired to do so. The rate of participation was low since, at the university, students' enrollment in one section of intermediate algebra varied between 80 and 120; in the fall of 2015 and spring 2016 semesters, attempts were made recruit participants from all six sections of intermediate algebra taught by one instructor. The students who completed all the requirements of the program were awarded up to 20 hours of community service on their transcript. To control for differences in teaching styles and teacher characteristics, attempts were not made to recruit students from intermediate algebra sections taught by other faculty members.

Procedures

The researcher sought the approval of the Institutional Review Board (IRB), the instructor of the course, the mathematics department at SEU, and the coordinating office for Service-Learning. The requests presented the nature of the study, the type of information that would be collected, and the purpose of the study. The records consisted mostly of the data necessary to complete the study: students' test scores, gender, and

ethnicity. Although the data analysis was conducted using the researcher's personal computer, the data collected was kept in a secured location according to SEU's IRB standards.

After receiving approval from the IRB office, the mathematics department, the instructor of the course, and the coordinating office for Service-Learning at SEU; the researcher visited six sections of intermediate algebra taught by one instructor and pitched the program to the students; three in the fall of 2015 and three in the spring of 2016 (See Appendix C for recruitment method). The instructor did not require the students to participate in the ASL program, but encouraged it. After listening to the presentation made by the researcher and the director of the coordinating office for Service-Learning, the students decided whether or not to participate. The students who were interested in participating in the program were provided with the researchers' contact information for more detailed information about the project and were asked to sign up for training and orientation.

The researcher served as coordinator of the ASL program. In that capacity, he was responsible for working closely with the course instructor, the agencies, the students, and the coordinating office for Service-Learning to ensure that any issues that arose on the research sites were addressed in a timely manner. The course instructor was not responsible for solving any problems that arose outside of her classroom. To minimize the possibility of confounding, the same instructor taught all the six courses included in the ASL program.

The students who were interested in participating in the program were asked to provide their names and contact information. Then, they were provided with the dates

and times to attend a mandatory orientation. All those who attended the orientation and completed the initial surveys were included in the study. Those who completed at least ten hours of community, provided a journal reflection at the close of the semester, and responded to the surveys at the end of the semester were considered participants. The students who attended orientation, responded to initial surveys, but dropped out of the study before the end of the semester formed the comparison group.

Instrumentation

At the beginning of each semester all prospective participants were asked to complete two Likert-type Scale surveys to ascertain their motivation to learn mathematics and their attitudes towards the subject. Similarly, at the end of the semester, those who completed the requirements stipulated in the agreement were asked to complete the same two surveys initially administered at the beginning of each semester. The two instruments were designed to ascertain whether the students' participation in the Academic Service Learning project made a positive difference on their motivation to learn mathematics as well as their attitudes towards the subject.

The Motivation to Learn Mathematics Instrument (MLMI) and the Mathematics Attitudes Instrument (MAI) are adaptation of two survey instruments developed by Florida Campus Compact which is a nationally recognized leading organization in Service Learning. Permission to use the surveys were not necessary since their authors allow anyone to use them (Baratian, et al., 2007).

Both instruments contained a total of fifty statements with typical Likert-type scale responses ranging from a one signifying strongly disagree to a five signifying strongly agree. The thirty statements in the MAI instrument identified the value the

students placed on mathematics learning with regard to its importance in their future careers as well as their daily lives; and the twenty statements in the MLMI instrument ascertained the subjects' motivation to learn mathematics. Analyses of the responses determined whether there is a difference in students' attitudes towards mathematics and their motivation to learn the subject as a result of participating in the ASL program. Please refer to appendix A for a detailed description of the survey instruments. The study hypothesized that there would be a difference in students' attitudes towards mathematics and their motivation to learn the subject as a result of participating in the Academic Service Learning program. Both surveys were administered using the electronic survey management system called Typeform (Typeform, n.d.). The surveys were sent to the participants via email and the responses were submitted electronically via Typeform. The counsel of content experts in mathematics education and statistics were sought in order to establish whether the instruments can yield valid data. The participants' responses were analyzed to find patterns in students' attitudes towards mathematics learning and their motivation to learn the subject. Cronbach's alpha coefficient was calculated to determine the internal consistency of each of the two instruments. The MAI instrument yielded an alpha coefficient of .51 and the MLMI instrument yielded an alpha coefficient of 0.92. The table below summarizes the research questions, method of data collection, and analysis procedure.

Table 2 Summary of research questions, collection method, and analysis method

Research Question	Data Collection Method	Analysis method
RQ1	Request the students final course grade from the instructor	Descriptive statistics, independent sample t-test, effect size, power analysis
RQ1A and RQ1B	Request the students final grade from the instructor	Descriptive statistics, ANOVA, effect size, power analysis
RQ2 and RQ3	MLMI Survey, journal entries and Interviews	Descriptive statistics, paired sample t-test, effect size, power analysis, qualitative data analysis
RQ2A and RQ2B	MLMI Survey, journal entries, and interviews	Descriptive statistics, ANOVA, effect size, power analysis
RQ3A and RQ3B	MAI Survey, journal entries, and interviews	Descriptive statistics, ANOVA, effect size, power analysis

Assessments

The students were required to complete four written exams during the semester; each exam was designed to assess students' mastery of the learning objectives of the course. The exams accounted for 40% of the students' final grade in the course. In

addition, the students were obligated to complete a mandatory and comprehensive final exam worth 15% of their final course grade. Further, the students had to complete a set of quizzes worth 20% of their final course grade. Finally, the students were assigned homework worth 15% of their final course grade using the educational management software titled Assessment and Learning in Knowledge Spaces (ALEKS). The remaining 10% of the students' final course grade was for satisfactory attendance as defined by the instructor in the syllabus (See Appendix E). The students who volunteered to participate in the Academic Service Learning project were asked to go to local social agencies and provide group tutoring or one-on-one tutoring on mathematical concepts related to the course to 4^{th} and 5^{th} grade children in after care programs. The participants were asked to perform up to 20 hours of community service during the semester. In addition, the participants were asked to keep a journal that details their experiences during the duration of the project as well as reflect on those experiences. The students in both the ASL group and the non-ASL group were assessed and graded in exactly the same manner.

Coding of Variables

The following dependent and predictor variables were used to analyze the data obtained. The response and predictor variables consisted of qualitative data at the ordinal level of measurement.

(1) Final Score: Final Score ASL Group and Final Score non-ASL Group are response variables that referred to the subjects' final average in the course. The researcher obtained the students' final average from the instructor of the course. As stated in the syllabus (See appendix E), a final course average of 65% or better was considered a success and a final average below 65% was considered a failure.

(2) Gender: Gender ASL Group, Gender Non-ASL, ASL MAI Gender, ASL MLMI gender group were categorical independent variables that represented the students' gender. A value of one was assigned to female students and a value of zero was assigned to male students.

(3) Race: Race ASL Group, Race Non-ASL group, ASL MAI Race, and ASL MLMI Race were categorical independent variables that represented the students' race. A value of one was assigned to White students and a value of zero was assigned to non-White students.

(4) ASL MAI Prescore, ASL MAI Postscore, ASL MLMI Prescore, and ASL MLMI Postscore represented dependent variables that refer to the students' total score from the survey instruments. The total score for the MAI survey instrument was calculated and represented the students' overall attitude towards mathematics learning. The total score for the MLMI survey was tabulated and represented students overall level of motivation towards mathematics learning.

Quantitative Analysis

After data collection was completed, the surveys were coded. For positively worded statements, strongly disagree (SD) was assigned a value of 1, disagree (D) was assigned a value of 2, Neutral (N) was assigned a value of 3, agree (A) was assigned a value of 4, and strongly agree (SA) was assigned a value of 5. For negatively worded statements the items were coded in the reverse manner: SA = 1, A = 2, N = 3, D = 4, and SD = 5. The total score for each respondent was calculated. A summary of the results for both the ASL and the non-ASL groups are presented in Chapter Four.

To address hypothesis 1 and determine whether the mean final course grade for the ASL group is equal to the mean final course grade for the non-ASL group, an independent sample t-test was performed. The null hypothesis of equality between the groups was not rejected at the usual significance level of 0.05. Subsequently, a Cohen's d procedure was conducted to complement the test. The effect size allowed the research to ascertain whether the differences between the two means observed in the descriptive statistics had any practical significance. Then, the post hoc power was calculated. The post hoc power and the effect size were used to determine the sample size necessary to achieve a statistically significant difference between the ASL and the non-ASL groups.

To address hypotheses 2 and 3, dependent samples t-tests were conducted to explore whether ASL made a difference on students' motivation to learn mathematics and their attitudes toward the subject. After failing to reject the null hypotheses, effect size and post-hoc power were calculated to determine the sample size required to achieve statistical significance between the mean motivation score pre-ASL and the mean motivation score post-ASL.

To address hypotheses 1A, 1B, 2A, 2B, 3A, and 3B; Factorial Analyses of variance were conducted. Effect sizes and power analyses were conducted to ascertain the practical significance of the differences observed as well as determine the sample sizes necessary to achieve statistical significance in each case. The Statistical Package for Social Sciences (SPSS) was used to perform the quantitative analyses aforementioned. The results are reported in the next chapter.

Qualitative Analysis

A qualitative case study analysis was used to describe how students experienced the Academic Service Learning program in intermediate algebra. This design fits this portion of the analysis as it is "a qualitative approach in which the investigator explored a real life, contemporary bounded system" (Creswell, 2013). The researcher sent an email to the students who completed the Academic Service Learning project to ask for their participation in semi-structured interviews regarding their experiences during the project. The interviews consisted of open ended questions that also addressed the students' motivation and attitudes towards the learning of mathematics.

The interview was optional as required by the internal review board (IRB). Five students (n = 5) volunteered to participate in the interviews: three at the end of the fall 2015 semester, and two at the close of the spring 2016 semester. The participants were also asked to keep a journal that describes their experiences during their participation in the program as well as their feelings about the program. Pseudonyms are used to safeguard the privacy of the participants.

The interviews were approximately thirty minutes long and consisted of ten open ended questions. The researcher met with the students in a place convenient for both the students and the researcher on campus. The interviews were audiotaped and transcribed in order to minimize the possibility of misinterpreting the participants' statements. The transcribed interviews, the journal entries, and the interviewees' survey responses were analyzed. The data obtained was coded and triangulated to look for emergent themes (Please refer to appendix B for interview protocol and interview questions).

To cross-check the results, the surveys responses for each interviewee along with the corresponding statements were rewritten into complete sentences. For example, for the sentence “I have the ability to learn mathematics”, the respondents’ answers were written in one of the following manner: (1) I strongly agree that I do not have the ability to learn mathematics, (2) I agree that I do not have the ability to learn mathematics, (3) I am not sure whether I have the ability to learn mathematics, (4) I agree I have the ability to learn mathematics, (5) I strongly agree I have the ability to learn mathematics. The researcher rewrote each Likert-Scale type item in a similar fashion for both instruments each time the surveys were administered to the five interviewees.

In addition, all participants were asked to keep a journal that describes their experiences during their tutoring sessions, their feelings and emotions while interacting with the children, and their feelings about the ASL program overall.

The software package ATLAS TI was used to analyze the data. The Software package ATLAS TI has been in use for many years and is one of the most powerful qualitative data analysis software package available today. It has the capability of performing many complex functions such as: analyzing data obtained from audio-recorded interviews, videos, written records, and questionnaires. Furthermore, the software is able to process a vast amount of data, code data, keep track of interactions between the coding scheme, and present reports in many formats.

Summary

In Chapter One the author presented the scope of the study, the research questions, the definition of key terms, and the purpose of the study. In Chapter Two a review of the literature was presented. Chapter Three detailed the quantitative statistical

methods as well as the qualitative methods used for the study. In the next chapter, the results are presented. Finally, in Chapter Five, the implications of the results for educators and other stakeholders are discussed.

Chapter 4. Analysis of Results

Introduction

Low success rates in developmental mathematic courses present a challenging problem for educational leaders at tertiary institutions. Predominantly, web-based technologies such as MyMathLab (MML), Assessment and Learning in Knowledge Spaces (ALEKS), and many others have been used when mathematics educators attempt to address this issue. However, the effectiveness of web-based technologies in improving students' success rates in mathematics remains unproven. This study hypothesized that inserting Academic Service Learning into intermediate algebra courses has the potential to positively impact the students' performance, increase their motivation to learn mathematics, and make a positive difference on their attitudes towards the subject. The research questions that follow guided the study.

Question 1: Mastery of learning objectives

Does "real world" experience through Academic Service Learning make a difference on college students' mastery of learning objectives in intermediate algebra compared to students enrolled in the same course who elected not to participate in the ASL program at a public university?

To answer this question, the final course average was obtained for each subject in both the ASL and the non-ASL groups from the instructor of the course. The percentage

who successfully completed the course was calculated and the mean final course average was determined for each group. The results are presented in table 3 and figure 1

Table 3 Percentage passing per group

Group	Percent Passing	Percent Failing
ASL	86.7%	13.3%
Non-ASL	63.2%	36.8%

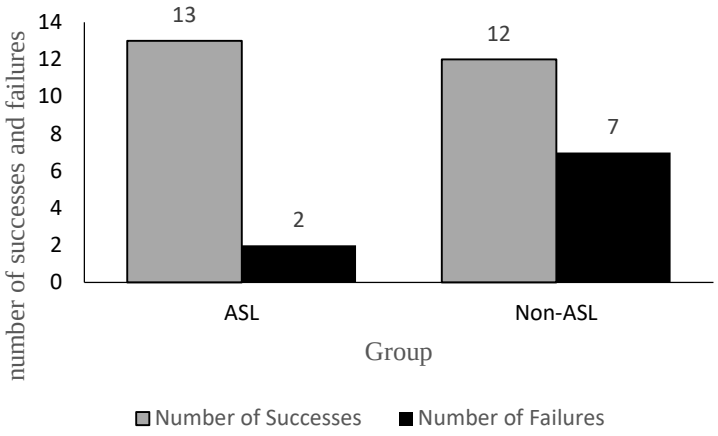

Figure 1. Number of successes and failures per group.

The mean final course average for the ASL group (*M = 76.47*) was not statistically significantly higher than the mean final course average for the non-ASL group (*M = 69.37*), *p > 0.05*. It is worth noting that the standard deviation for the ASL group was lower (*SD =12.17*) than that of the non-ASL group (*SD = 20.47*), as shown in table 4 below, the ASL group displayed less variation and a lower standard error of the mean; suggesting that students' performance in the ASL group was more consistent. A Cohen's d effect size of 0.04 and a post hoc power of 0.21 were obtained. The low power

suggests that a relationship between mastery of learning objectives and participation in the ASL program could be obtained with a larger sample size.

Table 4 Final course grade results per group

Group	N	Mean	Std. Deviation	Std. Error Mean
ASL	15	76.47	12.171	3.142
Non-ASL	19	69.37	20.473	4.697

Question 1A: Effect by gender

Does the effect of ASL on students' mastery of learning objectives vary by gender in intermediate algebra at a public university?

The mean score for males was not statistically significantly lower than the mean scores for females for both the ASL and the non-ASL groups, $p > 0.05$. For the ASL group, a low effect size of .139 and an observed power of .268 were obtained. Similarly, for the comparison group a small effect side ($d = .031$) was observed and the post hoc power was 0.108. It is worth noting the larger effect size and post hoc power in the ASL group.

Table 5 Final course grade results by gender

Group	N	Mean	Std. Deviation	Std. Error Mean
Male ASL	5	69.40	7.057	3.156
Female ASL	10	79.00	13.784	4.359
Male non-ASL	6	64.17	25.317	10.336
Female non-ASL	13	71.77	18.489	5.128

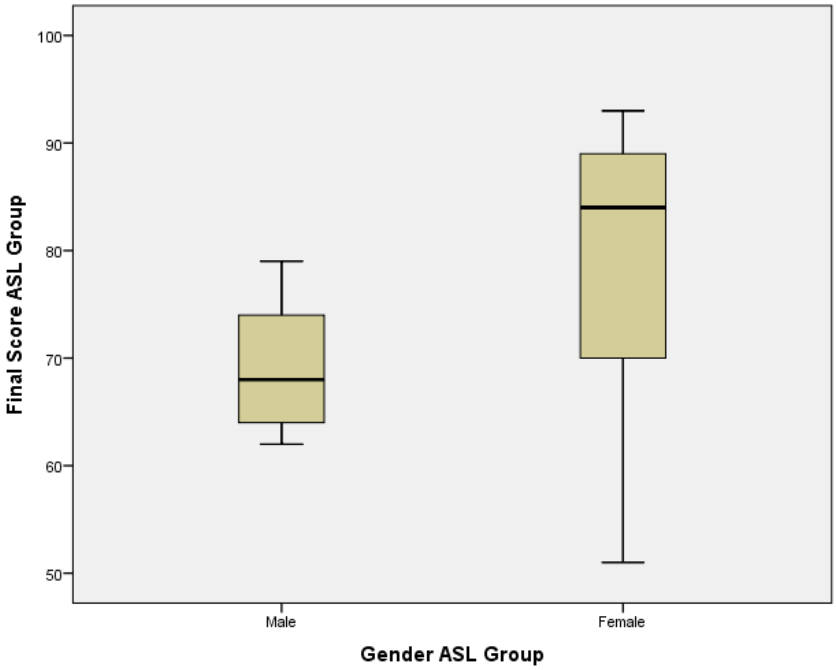

Figure 2. Final course grade results by gender.

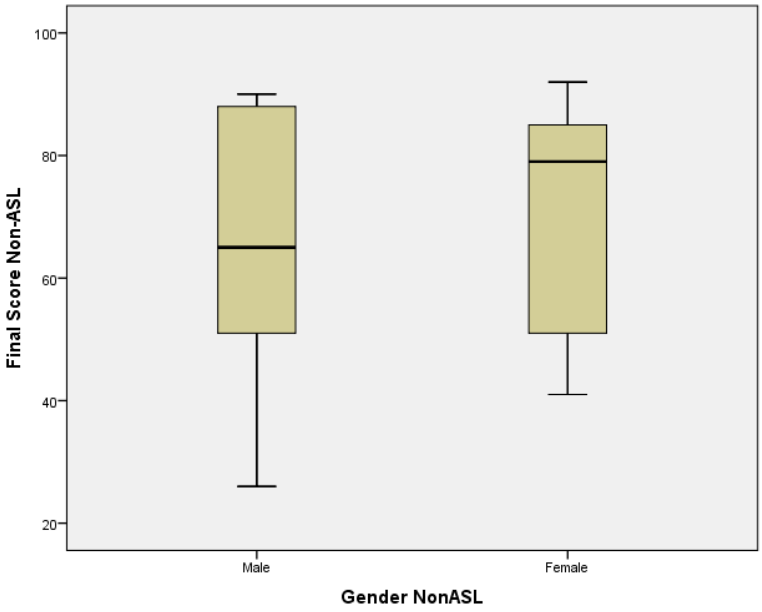

Figure 3. Non-ASL group mean final course grade based on gender.

Question 1B: Effect by race

Does the effect of ASL on students' mastery of learning objectives vary by race in intermediate algebra at a public university?

A factorial analysis of variance was also performed to ascertain whether there was a difference in mastery of learning objectives in intermediate algebra based on race. For the ASL group, the mean of White Participants (*M = 81.71*) was not statistically significantly higher than that of non-White participants (*M = 72*), *p > 0.05*. The associated Cohen's d effect size was .167 and the observed power was .297. In the non-ASL group, the mean of both groups were almost identical (*M = 72*) for non-Whites and (*M = 70.54*) for non-Whites. The effect size was 0.001 and the observed power was 0.052.

Table 6 Final course grade results by race

Group	N	Mean	Std. Deviation	Std. Error Mean
White ASL	7	81.71	8.789	3.322
Non-White ASL	7	72.00	14.071	5.318
White Non-ASL	13	70.54	20.85	5.783
Non-White Non-ASL	5	72.00	19.17	8.573

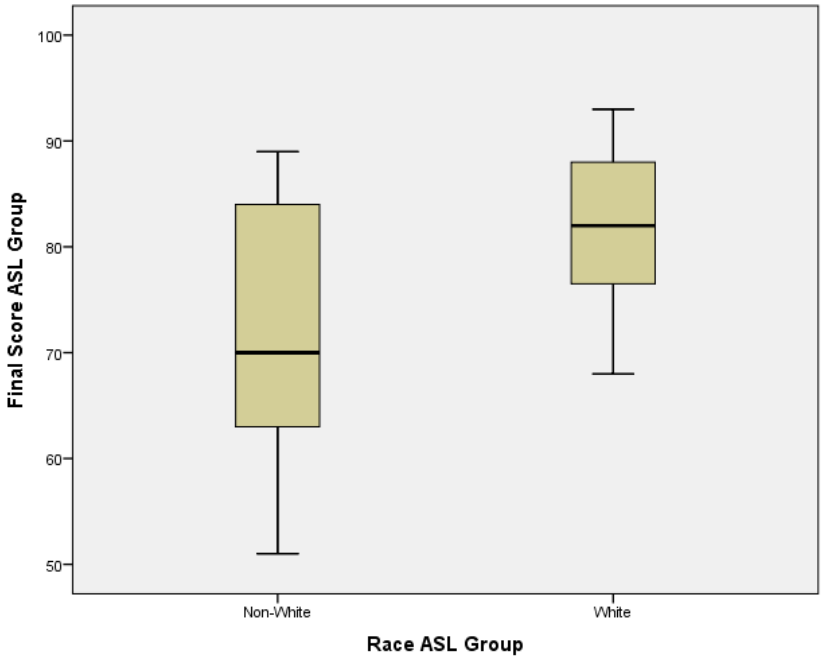

Figure 4. Final course grade results by race.

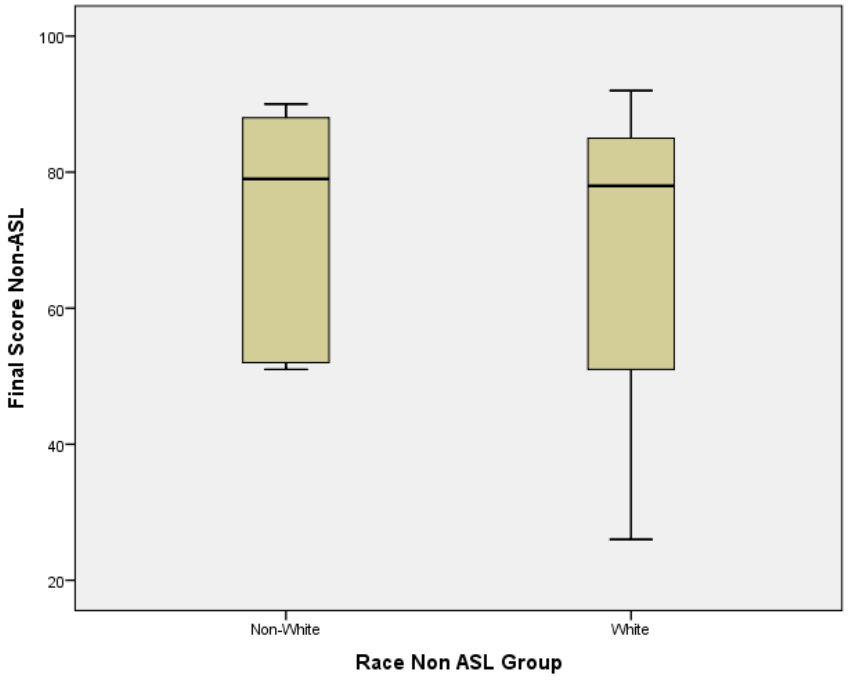

Figure 5. Final exam score for non-ASL group by race.

Question 2: Motivation for mathematics learning

How does the infusion of "real world" experiences through Academic Service Learning affect students' motivation for mathematics learning in intermediate algebra at a public university?

The mean score for motivation before participation in ASL (*M= 67.60*) was almost identical to the mean motivation score after Participation in ASL (*M = 66.40*), *p > 0.05*. The standard deviation for the post-score (*SD = 11.36*) was lower than the standard deviation for the pre-score (*SD = 13.02*), indicating less variation in the students' answers after participation in the ASL program. The effect size was .003 and the power was 0.06.

Question 2A: Effect by gender

Does the effect of ASL on students' motivation for mathematics learning vary by gender in intermediate algebra at a public university?

To ascertain whether the ASL program made a difference on students' motivation based on gender a factorial ANOVA was performed. The associated effect size was 0.213 and the post hoc power was 0.411 before participation in the ASL program; the mean motivation score for male students (*M= 75.80*) was not statistically significantly higher than the mean motivation for female students (*M = 63.50*), *p > 0.05*. After participating in ASL, the mean motivation score for male students (*M= 70.40*) was still not statistically significantly higher than the mean motivation for female students (*M = 64.40*), *p > 0.05*. A smaller effect size of 0.066 and a smaller post hoc power of .145 were obtained.

Table 7 Motivation score results by gender

Group	N	Mean	Std. Deviation	Std. Error
Male Pre-ASL	5	75.80	5.89	2.63
Female Pre-ASL	10	63.50	13.86	4.38
Male Post-ASL	5	70.40	12.68	5.67
Female Post-ASL	10	64.40	10.77	3.41

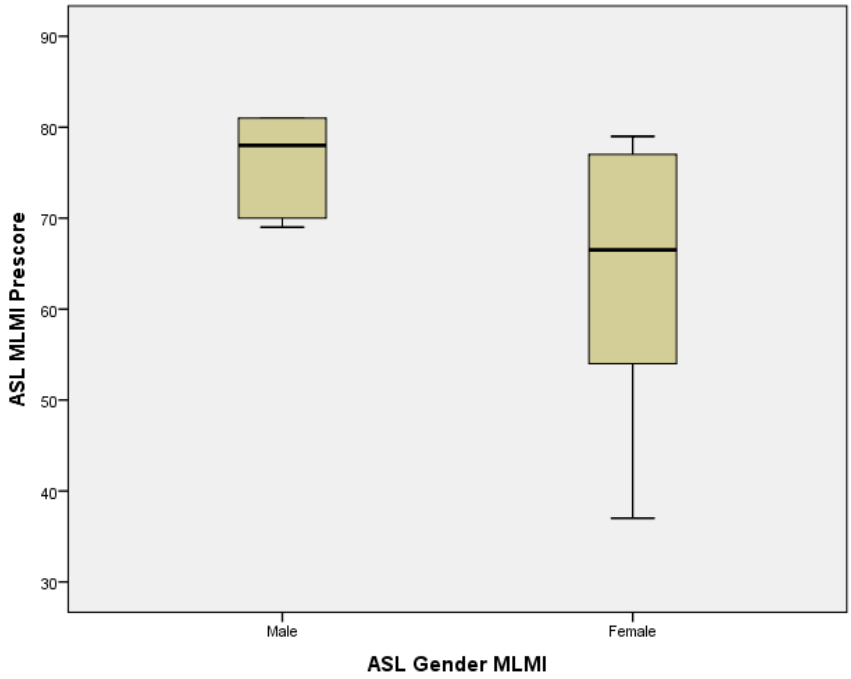

Figure 6. Motivation score for ASL group by gender before ASL participation.

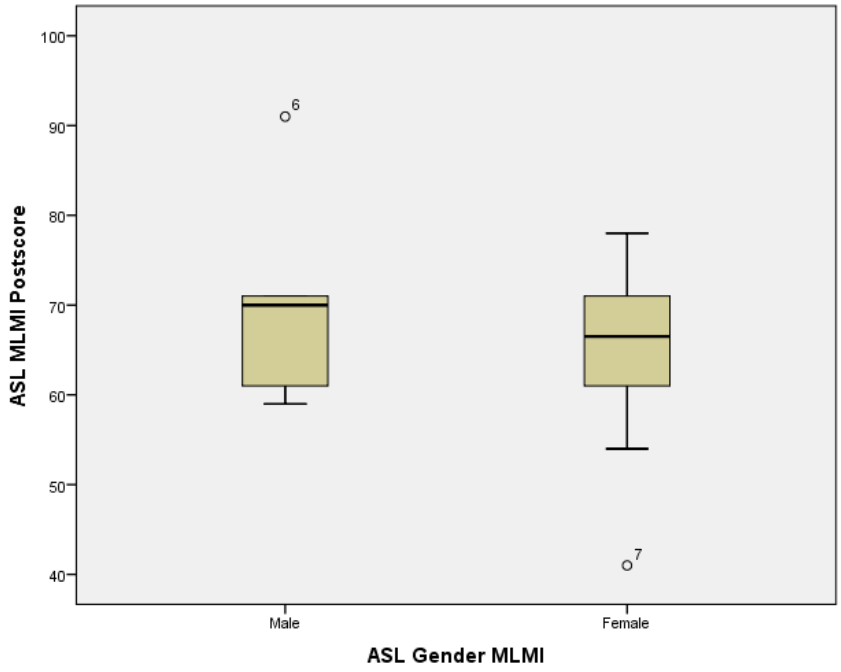

Figure 7. Motivation score for ASL group by gender after ASL participation.

Question 2B: Effect by race

Does the effect of ASL on students' motivation for mathematics learning vary by race in intermediate algebra at a public university?

Prior to ASL participation, white students had statistically significantly higher mean motivation score (*M = 75.86*) than non-white students (*M = 60.38*); *F(1, 13) = 7.88, p = .015*. The associated Cohen's effect size was 0.38, the observed power was 0.74. After ASL participation, the difference between the mean motivation score of white students (*M = 66.00*) and the mean motivation score of non-white students (*M = 66.75*) was statistically non-significant *(p > 0.05).* The effect size was .001, the observed power was 0.05. These results suggested that ASL may be able to provide a solution to the gap in motivation to learn mathematics between minority and non-minority students in intermediate algebra.

Table 8 Motivation score results by race.

Group	N	Mean	Std. Deviation	Std. Error
White Pre-ASL	7	75.86	5.18	1.96
Non-White Pre-ASL	8	60.38	13.71	4.85
White Post-ASL	7	66.00	5.97	2.26
Non-White Post-ASL	8	66.75	15.08	5.33

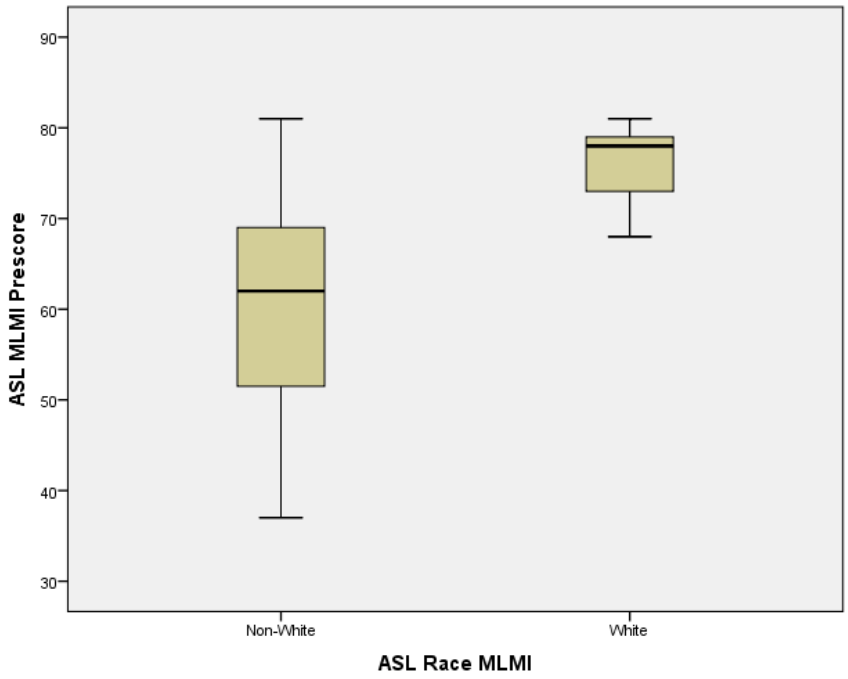

Figure 8. Motivation score for ASL group by race before ASL participation.

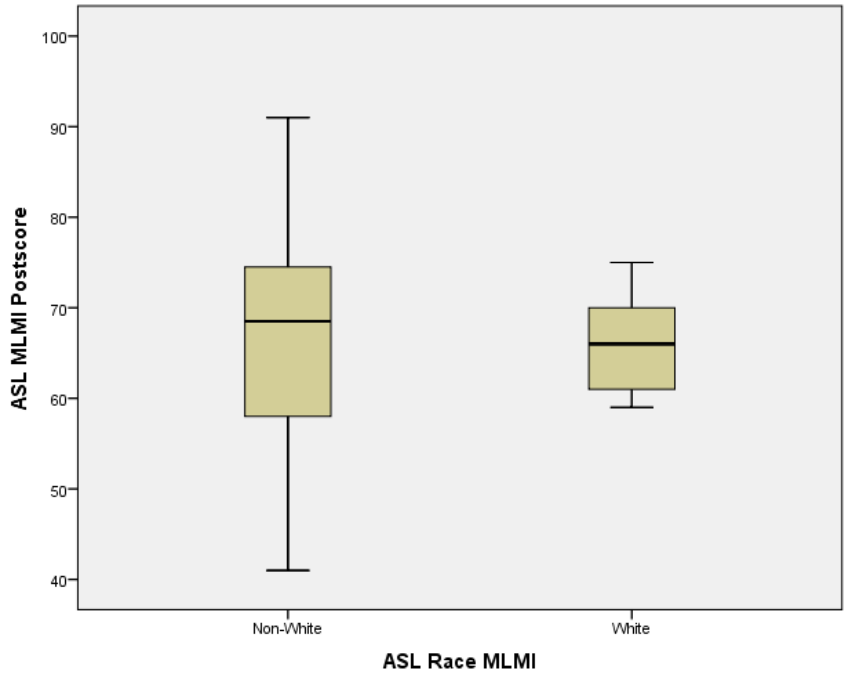

Figure 9. Motivation score for ASL group by race after ASL participation.

Question 3: **Attitudes toward mathematics learning**

How does the infusion of "real world" experiences through Academic Service Learning affect students' attitudes towards learning mathematical concepts in an Intermediate Algebra course at a public university?

The results of the dependent samples t-test revealed that students' attitudes towards mathematics did not change towards mathematics learning as a result of participating in ASL $t(12) = 1.30$, $p = .217$. The mean attitude score prior to participating in ASL was not statistically significantly higher ($M = 95.08$) than the mean score after completion of the program ($M = 88.80$). The standard deviation before participation in the program ($SD = 22.50$) was higher than the standard deviation after completion of the program ($SD = 16.98$), suggesting that the participants' responses were more consistent after participating in the ASL program. The effect size was 0.026, the observed power was 0.128.

Question 3A: Effect by gender

Does the effect of ASL on students' attitudes towards learning mathematics vary by gender in intermediate algebra at a public university?

Prior to participating in the ASL project, the mean attitude score for males (M = 100.50) was not statistically significantly higher than the mean attitude score female participants (*M = 92.67*), *F(1, 11) = .316, p = .585*. The effect size was 0.028 and the power was 0.081. After participating in the ASL project the mean attitude score for female students (*M = 89.60*) was not statistically significantly higher than the mean attitude score for male students (*M = 87.20*), *F(1, 13) = .062, p = .807*. The effect size was 0.005 and the achieved power was 0.056.

Table 9 Attitude score results by gender

Group	N	Mean	Std. Deviation	Std. Error Mean
Male Pre-ASL	4	100.50	14.271	7.136
Female Pre-ASL	9	92.67	25.729	8.576
Male Post-ASL	5	87.20	18.727	8.375
Female Post-ASL	10	89.60	17.044	5.390

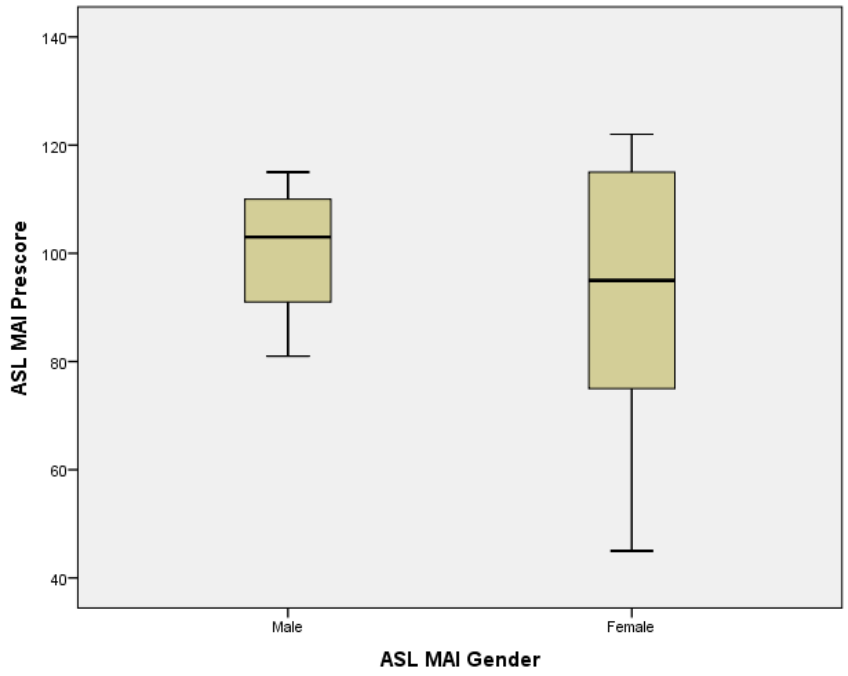

Figure 10. Attitude score for ASL group by gender before ASL participation.

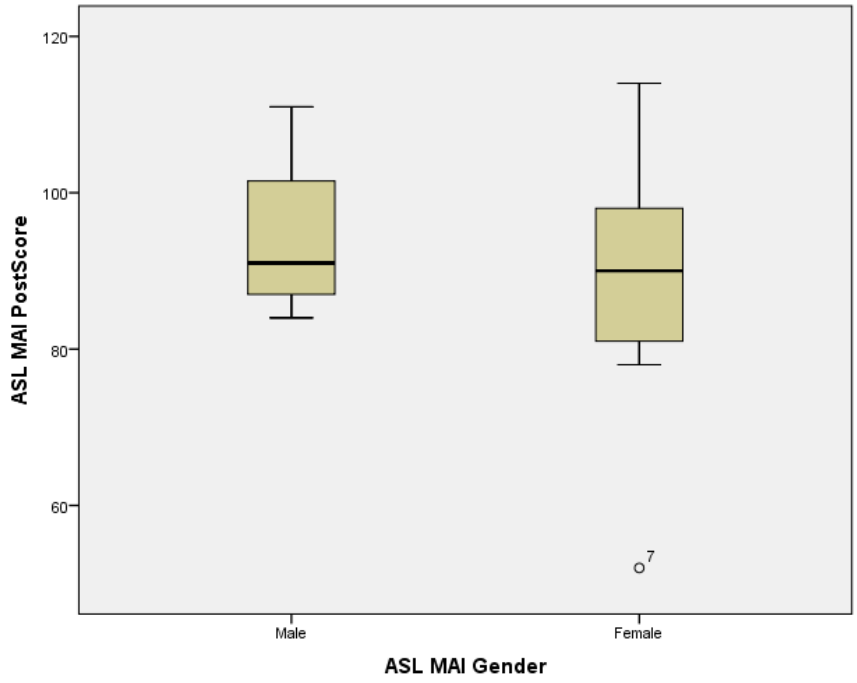

Figure 11. Attitude score for ASL group by gender after ASL participation.

Question 3B: Effect by race

Does the effect of ASL on students' attitudes towards learning mathematics vary by race in intermediate algebra at a public university?

Before participating in the ASL project, the mean attitude score was not statistically significantly higher for the white group ($M = 104.83$) than the non-white participants ($M = 86.71$), $F(1, 11) = 2.33$, $p = .155$. The effect size was 0.18 and the achieved power was 0.29. After participating in the ASL project, the mean attitude score of the white students ($M = 90.14$) was not statistically significantly higher than the mean attitude score of the non-white students ($M = 87.63$), $F(1, 13) = .077$, $p = .786$. The effect size was 0.006 and the observed power was 0.058. These results suggest that ASL had no statistically significant effect on students' attitudes towards mathematics learning regardless of their race.

Table 10 Attitude score results by race

Group	N	Mean	Std. Deviation	Std. Error
White Pre-ASL	6	104.83	17.23	7.04
Non-White Pre-ASL	7	86.71	24.26	9.17
White Post-ASL	7	90.14	5.97	18.07
Non-White Post-ASL	8	87.63	17.13	6.06

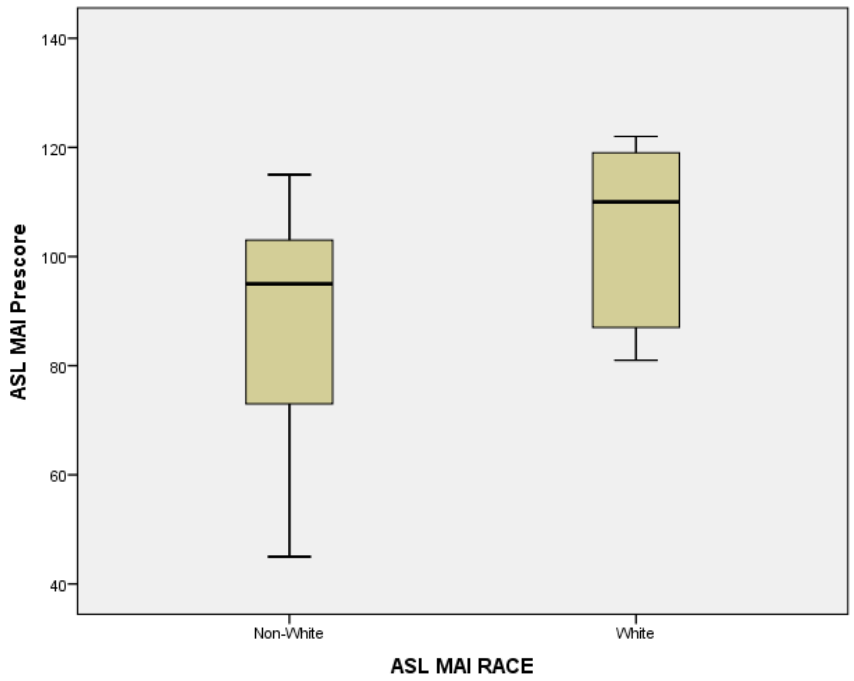

Figure 12. Attitude score for ASL group by race before ASL participation.

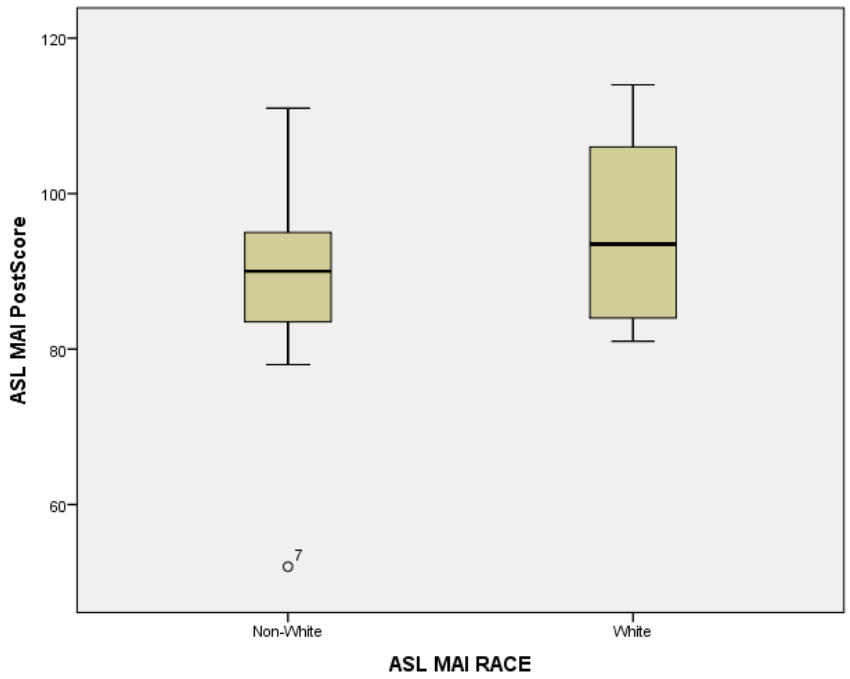

Figure 13. Attitude score for ASL group by race after ASL participation.

Summary of Quantitative Results

The results showed that the proportion of students in the ASL group who successfully completed the course was higher than the proportion of students in the non-ASL group who successfully completed the course. However, the mean final course grade was not statistically significantly higher in the ASL group. Similarly, no statistically significant difference was found between male and female students in the ASL group. The differences in performance based on race were also statistically non-significant.

Students' motivation to learn mathematics and their attitudes towards the subject did not change as a result of participating in the program. Male students displayed higher motivation than female students, but the motivation of females increased while the motivation of males decreased. The motivation of Caucasian students was not statistically significantly higher than the motivation of non- white students pre and post ASL. While the motivation of the non-white participants improved, the motivation of whites decreased; and at the end of the ASL project, the difference between the means of the two groups was no longer statistically significant. These results suggest that ASL has the potential to raise the motivation level of minority students and may provide a solution to the gap between the motivation level of White and non-White students in intermediate algebra.

Qualitative Results

The results of the qualitative portion of the study described how students experienced the Academic Service Learning program in intermediate algebra. Five individual cases of students who agreed to grant an interview and share their experiences

during the ASL program are presented. In addition, thirteen of the fifteen participants submitted a journal at the close of the semesters that detailed their experiences during their participation in the ASL project. To safeguard the privacy of the participants, pseudonyms are used.

Case study of Angela.

Angela is eighteen years of age and bi-racial. She indicated that her initial interest in the course was moderate and that the course was required for her major. Her overall average was 70%. Angela participated in the ASL program in the fall of 2015; her career aspiration is to become a social worker. The two tables that follow summarize her responses to the two survey instruments.

Angela's attitude toward mathematics learning.

Table 11 Angela's responses to the items in the Mathematics Attitude Instruments (MAI)

SA = Strongly Agree A = Agree	N = Neutral	D = Disagree SD = Strongly Disagree

Question #	Question	Response Before	Response After
1	Mathematics is an easy subject to learn for me.	N	D
2	Thinking about math makes me anxious	D	N
3	I enjoy mathematics.	N	N

Table 11 Angela's responses to the items in the Mathematics Attitude Instruments (MAI) (Continued)

Question #	Question	Response Before	Response After
4	I can perform the computations in class, but I really do not understand why they work.	D	N
6	I feel confident when I think about math.	N	D
7	I can perform the computations in class, but I do not understand what those numbers are telling me.	N	N
8	Learning math is difficult for me.	N	N
9	I would enjoy taking another mathematics course in the future.	N	D
10	Men are generally better at math than are women.	SD	D
11	Math is one of those subjects in which a person has to place too much effort.	N	N

Table 11 Angela's responses to the items in the Mathematics Attitude Instruments (MAI) (Continued)

Question #	Question	Response Before	Response After
12	Math is too complicated for me to study.	N	N
13	No matter how hard I try I just cannot do well in mathematics.	D	N
14	I would take mathematics even if it were not required for my program.	D	D
15	Math will be useful for me in my future career.	A	N
16	I can see many useful applications for mathematics in the “real world”.	SA	N
17	I will not use math again once I finish school.	SD	D
18	Math is one of the most valuable subjects for me in my program of study.	D	D
19	All people would benefit from a course in mathematics.	A	N

Table 11 Angela's responses to the items in the Mathematics Attitude Instruments (MAI) (Continued)

Question #	Question	Response Before	Response After
20	I will be better able to make intelligent decisions from taking mathematics.	A	N
21	Mathematics is not very useful for everyday life.	SD	D
22	Mathematical thinking will one day be as necessary for efficient citizenship as the ability to read and write.	N	N
23	Most professions use Mathematics to some extent.	N	A
24	Mathematics is directly related to my field of study.	D	N
25	Mathematics is not really very useful because it tells us what we already know anyway.	D	D
26	Mathematics is best left to the "experts" and should not be a part of most professionals' jobs.	D	D

Table 11 Angela's responses to the items in the Mathematics Attitude Instruments (MAI) (Continued)

Question #	Question	Response Before	Response After
27	Mathematics is needed for important fields such as science and medicine.	SA	A
28	Mathematics will improve my ability to research.	A	N
29	I will be better in my field by having knowledge of Mathematics.	N	N
30	Mathematics helps me develop critical thinking skills.	A	A

A close analysis at Angela's answers revealed that: (1) she perceived the course as more difficult at the closing of the semester, her anxiety level slightly decreased, and her enjoyment of mathematics remained the same; (2) her understanding of the computations slightly decreased, her willingness to take mathematics in the future remained the same, and her confidence slightly diminished; (3) her ability to interpret numerical results remained unchanged, her perception of the difficulty to learn mathematics remained intact, and her willingness to enroll in a math course in the future slightly decreased, (4) her perception that men are better at math than women slightly increased, her perception that mathematics learning requires too much effort and her understanding of meaning of computations remained the same.

In addition, (5) Angela's self confidence in her ability to do well in math slightly decreased, her belief that math is useful in her career decreased, and her ability to see useful applications for mathematics in the "real world" dramatically decreased; (6) her perception that she will use math after finishing school slightly decreased, her perception of the value of mathematics in her program of study and the benefit people receive from taking a math course remained the same; (7) her belief that mathematics helps with decision making decreased, her viewpoint that most professions use mathematics increased, and her discernment that mathematics should be left to experts remained the same; (8) her understanding that knowledge of mathematics will help her be better in her chosen field and that mathematics will help her develop critical thinking skills remained unchanged. Overall, at the end of the semester, Angela's average attitude score decreased from 3.5 to 3.0.

Angela's motivation to learn mathematics.

Table 12 Angela's responses to the items in the Motivations to Learn Mathematics Instruments (MLMI)

SA = Strongly Agree A = Agree	N = Neutral	D = Disagree SD = Strongly Disagree	
Question #	Question	Response Before	Response After
1	I find mathematics interesting.	D	N
2	I have a good foundation of mathematical knowledge.	N	A
3	I have the ability to learn mathematics.	A	A
4	I have to work hard to learn mathematics.	A	A

Table 12 Angela's responses to the items in the Motivations to Learn Mathematics Instruments (MLMI) (Continued)

Question #	Question	Response Before	Response After
5	Mathematics makes sense to me in applied examples.	A	N
6	I am aware of the many applications of mathematics in everyday life.	A	A
7	I believe applications of mathematics relate directly to my life.	N	N
8	I am aware of the applications of specific mathematics topics in business and society.	N	N
9	I believe applications of mathematics relate directly to major/career choice.	N	N
10	I would like to learn more about applications of mathematics in the world.	D	D
11	I would like to learn more about mathematics.	D	D

Table 12 Angela's responses to the items in the Motivations to Learn Mathematics Instruments (MLMI) (Continued)

Question #	Question	Response Before	Response After
12	The ability to reason and problem-solve is mathematical skill.	A	A
13	For mathematics learning to occur students must spend time beyond class hours pursuing course content.	A	A
14	A college education should include mathematics courses to develop well-rounded students.	A	N
15	As a result of taking this course, I would like to learn more about mathematics.	D	D
16	The ability to reason and problem-solve is important in everyday life.	A	A
17	Having to take mathematics courses is a waste of time.	D	D

Table 12 Angela's responses to the items in the Motivations to Learn Mathematics Instruments (MLMI) (Continued)

Question #	Question	Response Before	Response After
18	Only a few majors should be required to take mathematics courses.	D	N
19	Learning mathematics will not make me an effective problem solver.	D	D
20	I am effective in solving problems.	A	A

(1) Angela found mathematics slightly more interesting and felt that she had a good foundation of mathematical knowledge; (2) her belief in her ability to learn mathematics and that she has to work hard at it remained unchanged; (3) her viewpoint about mathematics making sense in real life examples slightly decreased, her awareness of applications of mathematics in everyday life remained unchanged; (4) her awareness of applications of mathematics in her life, business and society, and her career choice stayed the same.

In addition, (5) Angela's desire to learn more about applications of mathematics in the "real world" and to learn about mathematics in general did not change; (6) her discernment that reasoning and problem solving is a mathematical skill and that students must spend more time outside the classroom in order to learn mathematics remained unchanged; (8) her opinion that mathematics is necessary to develop well rounded students decreased, her judgment that taking mathematics courses is a waste of time and

that mathematics will not make her an effective problem solver remained unchanged. Overall, Angela's motivation score increased slightly.

During the interview, Angela said that the experience was very interesting and was related to the material covered in the classroom. She emphasized "it was really a satisfying thing to do." When pressed to explain why she feels the way she does about the experience, she added "well, I am not a great person on math, let's start there, it was interesting to see that we were able to help them with a subject that I am not very strong in and they were happy about it". She also added that her participation in the ASL program gave her the impetus she needed to seek help. "I have too much pride I guess, but I was willing to accept help. It was the first time I went to the math lab and it was great, I was just great. "The ASL project opened my perception a little more when it came to accepting help". She said that she went to the math lab several times during the semester and plans to continue doing so in the future. She came back the following semester and asked to go back to the social agency and continue to tutor the children. She said that the experience was so gratifying that she was willing to continue doing it without receiving any community service hours on her transcript. Angela's average motivation score remained virtually the same after her participation in the ASL project.

Case study of Modanel.

Modanel is a twenty-year old African American male who aspires to be a lawyer. He indicated that he decided to participate he the ASL program because he wanted to help the elementary school children in mathematics and that his initial interest in the course was very high. Modanel said this course was required for his major; his overall average in the course was a 62 %. Modanel took the course in the spring semester of

2016. He is one of the two ASL participants who did not successfully complete the course and the only male interviewee. A summary of his responses are presented in the two tables that follow.

Modanel's attitude toward mathematics learning.

Table 13 Modanel's responses to the items in the Mathematics Attitude Instrument (MAI)

SA = Strongly Agree A = Agree	N = Neutral	D = Disagree SD = Strongly Disagree	
Question #	Question	Response Before	Response After
1	Mathematics is an easy subject to learn for me.	A	A
2	Thinking about math makes me anxious	A	A
3	I enjoy mathematics.	A	A
4	I can perform the computations in class, but I really do not understand why they work.	N	N
5	I would rather not be taking mathematics.	D	D
6	I feel confident when I think about math.	A	A

Table 13 Modanel's responses to the items in the Mathematics Attitude Instrument (MAI) (Continued)

Question #	Question	Response Before	Response After
7	I can perform the computations in class, but I do not understand what those numbers are telling me.	D	N
8	Learning math is difficult for me.	D	N
9	I would enjoy taking another mathematics course in the future.	A	A
10	Men are generally better at math than are women.	D	N
11	Math is one of those subjects in which a person has to place too much effort.	D	N
12	Math is too complicated for me to study.	D	N
13	No matter how hard I try I just cannot do well in mathematics.	D	D
14	I would take mathematics even if it were not required for my program.	A	D

Table 13 Modanel's responses to the items in the Mathematics Attitude Instrument (MAI) (Continued)

Question #	Question	Response Before	Response After
15	Math will be useful for me in my future career.	A	A
16	I can see many useful applications for mathematics in the "real world".	A	A
17	I will not use math again once I finish school.	D	SD
18	Math is one of the most valuable subjects for me in my program of study.	A	A
19	All people would benefit from a course in mathematics.	A	A
20	I will be better able to make intelligent decisions from taking mathematics.	A	A
21	Mathematics is not very useful for everyday life.	N	SD

Table 13 Modanel's responses to the items in the Mathematics Attitude Instrument (MAI) (Continued)

Question #	Question	Response Before	Response After
22	Mathematical thinking will one day be as necessary for efficient citizenship as the ability to read and write.	A	A
23	Most professions use Mathematics to some extent.	A	SD
24	Mathematics is directly related to my field of study.	A	A
25	Mathematics is not really very useful because it tells us what we already know anyway.	N	SD
26	Mathematics is best left to the "experts" and should not be a part of most professionals' jobs.	D	SD
27	Mathematics is needed for important fields such as science and medicine.	A	A
28	Mathematics will improve my ability to research.	A	A

Table 13 Modanel's responses to the items in the Mathematics Attitude Instrument (MAI) (Continued)

Question #	Question	Response Before	Response After
29	I will be better in my field by having knowledge of Mathematics.	A	A
30	Mathematics helps me develop critical thinking skills.	A	A

Modanel had a positive attitude toward mathematics learning at the beginning of the semester. At the end of the semester, his attitude remained almost the same at the end of the course and the majority of his responses to the MAI questionnaire did not change. However, a closer examination of his responses revealed that Modanel may have been overconfident about his mathematical abilities at the beginning of the semester. Prior to the beginning of the semester, he felt confident about his understanding of the mathematical computations, but he was neutral at the end of the semester; he disagreed that math was difficult for him at the beginning of the semester, but was neutral at the end; his attitude also changed slightly regarding the statement that men are better at math than women.

His perception of the difficulty of mathematics as well as the amount of effort required to study mathematics slightly increased, and he no longer wished to take a mathematics class as an elective. His belief that he will be using mathematics after completing his degree and his perception of the usefulness of mathematics in everyday life increased. Contrastingly, his belief that mathematics is used in most professions dramatically decreased even though he disagreed that mathematics should be left to the

experts and should not be part of most professional jobs. Modanel' average attitude score decreased from 3.83 at the beginning of the semester to 2.96 at the close of the semester.

Modanel's motivation to learn mathematics.

Table 14 Modanel's responses to the items in the Motivation to Learn Mathematics Instruments (MLMI)

SA = Strongly Agree A = Agree	N = Neutral	D = Disagree SD = Strongly Disagree	
Question #	Question	Response Before	Response After
1	I find mathematics interesting.	SA	SA
2	I have a good foundation of mathematical knowledge.	A	SA
3	I have the ability to learn mathematics.	A	SA
4	I have to work hard to learn mathematics.	A	SA
5	Mathematics makes sense to me in applied examples.	A	SA
6	I am aware of the many applications of mathematics in everyday life.	A	SA
7	I believe applications of mathematics relate directly to my life.	A	SA

Table 14 Modanel's responses to the items in the Motivation to Learn Mathematics Instruments (MLMI) (Continued)

Question #	Question	Response Before	Response After
8	I am aware of the applications of specific mathematics topics in business and society.	A	-
9	I believe applications of mathematics relate directly to major/career choice.	A	A
10	I would like to learn more about applications of mathematics in the world.	A	SA
11	I would like to learn more about mathematics.	A	A
12	The ability to reason and problem-solve is mathematical skill.	A	SA
13	For mathematics learning to occur students must spend time beyond class hours pursuing course content.	A	A

Table 14 Modanel's responses to the items in the Motivation to Learn Mathematics Instruments (MLMI) (Continued)

Question #	Question	Response Before	Response After
14	A college education should include mathematics courses to develop well-rounded students.	A	SA
15	As a result of taking this course, I would like to learn more about mathematics.	A	A
16	The ability to reason and problem-solve is important in everyday life.	A	SA
17	Having to take mathematics courses is a waste of time.	D	SD
18	Only a few majors should be required to take mathematics courses.	D	SD
19	Learning mathematics will not make me an effective problem solver.	D	SD
20	I am effective in solving problems.	A	SA

Modanel's answers both at the beginning and at the end of the course suggest that he was motivated to learn mathematics prior to enrolling in the course and his motivation increased after participating in ASL. However, Modanel's final course grade did not reflect his motivation towards mathematics learning and his attitude toward the subject. George (2010) found that highly motivated students have better outcomes than students who lack motivation. One possible explanation of the dichotomy between Modanel's answers and his outcome in the course may be that male students tend to overestimate their abilities in mathematics (Mura, 1987).

During the interview Modanel stressed the importance of mathematics learning "I knew that mathematics learning is really important, but also that the ASL experience increased my view of that. Because mathematics teaches everyone to think in a more constructive way. Mathematics is important for all of us, and without it, it's very difficult to reach your goals." He also reported being excited about his participation in the program, "When you go out there and when you do the Service Learning, you forget about grades and you forget about everything, you only think of the children that are there. The fact that you actually increase the children being able to be better at math is what makes it exciting."

Modanel also reported that he focused more on the material as soon as he knew he had to complete the project. "I was like trying to pay more attention to the work in case someone else asks me to do something. I would be like, yes, you do this, and you do that and that. Before the project I was not thinking this way; I would be like I don't know." Modanel stated that he learned other things as a result of participating in the ASL program, not just to solve math problems. As the only male interviewee, his failure to

successfully complete the course suggest that he probably underestimate the course's difficulty level and overestimated his abilities.

Case study of Asuka.

Azuka, an eighteen-year old Caucasian female; she stated that her initial interest in the course was moderate and took it as an elective. Her overall average was 82%. Asuka participated in the program in the fall semester of 2015; she indicated that she is majoring in law, was interested in volunteer opportunity, and wanted to gain a deeper understanding of the course material and extend the mathematics studied in class. Asuka said decided to participate in the ASL program because she has always wanted to help others. The two tables that follow highlight her responses to the two survey instruments.

Asuka's attitude toward mathematics learning.

Table 15 Asuka's responses to the items in the Mathematics Attitude Instrument (MAI)

SA = Strongly Agree A = Agree	N = Neutral	D = Disagree SD = Strongly Disagree	
Question #	Question	Response Before	Response After
1	Mathematics is an easy subject to learn for me.	N	D
2	Thinking about math makes me anxious	N	A
3	I enjoy mathematics.	N	D

Table 15 Asuka's responses to the items in the Mathematics Attitude Instrument (MAI) (Continued)

Question #	Question	Response Before	Response After
4	I can perform the computations in class, but I really do not understand why they work.	A	A
5	I would rather not be taking mathematics.	A	A
6	I feel confident when I think about math.	D	D
7	I can perform the computations in class, but I do not understand what those numbers are telling me.	N	A
8	Learning math is difficult for me.	N	N
9	I would enjoy taking another mathematics course in the future.	D	N
10	Men are generally better at math than are women.	SD	SD

Table 15 Asuka's responses to the items in the Mathematics Attitude Instrument (MAI) (Continued)

Question #	Question	Response Before	Response After
11	Math is one of those subjects in which a person has to place too much effort.	D	N
12	Math is too complicated for me to study.	D	D
13	No matter how hard I try I just cannot do well in mathematics.	D	D
14	I would take mathematics even if it were not required for my program.	D	D
15	Math will be useful for me in my future career.	D	D
16	I can see many useful applications for mathematics in the "real world".	N	N
17	I will not use math again once I finish school.	N	N
18	Math is one of the most valuable subjects for me in my program of study.	D	D

Table 15 Asuka's responses to the items in the Mathematics Attitude Instrument (MAI) (Continued)

Question #	Question	Response Before	Response After
19	All people would benefit from a course in mathematics.	A	D
20	I will be better able to make intelligent decisions from taking mathematics.	N	N
21	Mathematics is not very useful for everyday life.	D	N
22	Mathematical thinking will one day be as necessary for efficient citizenship as the ability to read and write.	D	D
23	Most professions use Mathematics to some extent.	N	D
24	Mathematics is directly related to my field of study.	SD	D
25	Mathematics is not really very useful because it tells us what we already know anyway.	D	A

Table 15 Asuka's responses to the items in the Mathematics Attitude Instrument (MAI) (Continued)

Question #	Question	Response Before	Response After
26	Mathematics is best left to the "experts" and should not be a part of most professionals' jobs.	D	N
27	Mathematics is needed for important fields such as science and medicine.	SD	SA
28	Mathematics will improve my ability to research.	N	N
29	I will be better in my field by having knowledge of Mathematics.	D	D
30	Mathematics helps me develop critical thinking skills.	A	N

Asuka's answers suggested that at the closing of the semester: (1) she perceived mathematics as a difficult subject, was more anxious about the subject, and did not enjoy it; (2) she was able to perform the computations, but did not understand them or their meaning; she did not feel confident about mathematics and would rather not be taking the course; (3) she did not agree nor disagree that math is difficult for her, her belief that she would enjoy taking another math course in the future slightly improved, and she strongly disagreed that men are better than women in mathematics; (4) she also disagreed that

math is one of those subjects in which a person has to place too much effort, that math is too complicated for her to study, and that she cannot do well in mathematics no matter how hard she tries; (5) she indicated that she would not take mathematics if it were not required for her program, did not believe that mathematics will be useful in her future career, and did not think that mathematics is one of the most valuable subjects for her in her program of study.

Furthermore, (6) Asuka neither agreed nor disagreed that she sees many useful applications of mathematics in the "real world" or that she will use math again once she completes school; (7) she disagreed that all people would benefit from taking a mathematics course, felt neutral that mathematics helps make intelligent decisions and that mathematics is not very useful in everyday life; (8) she disagreed that mathematical thinking will one day be as necessary as the ability to read and write, that most professions use mathematics to some extent, and that mathematics is directly related to her field of study; (9) she agreed that mathematics is not very useful because it tells what we already know anyway, felt neutral that mathematics is best left to the experts and should not be part of most professional jobs, but strongly agreed that mathematics is needed for important fields such as science and medicine; (10) she did not agree nor disagree that mathematics will improve her ability to do research and that mathematics helped her develop her critical thinking skills; she disagreed that she will be better in her field by having knowledge of mathematics. Azuka's average attitude score decrease from a 2.9 at the beginning of the semester to a 2.7 at the close of the semester.

Asuka's motivation to learn mathematics.

Table 16 Asuka's responses to the items in the Motivation to Learn Mathematics Instruments (MLMI)

SA = Strongly Agree A = Agree	N = Neutral	D = Disagree SD = Strongly Disagree	
Question #	Question	Response Before	Response After
1	I find mathematics interesting.	D	D
2	I have a good foundation of mathematical knowledge.	N	N
3	I have the ability to learn mathematics.	SA	A
4	I have to work hard to learn mathematics.	N	A
5	Mathematics makes sense to me in applied examples.	A	N
6	I am aware of the many applications of mathematics in everyday life.	SA	D
7	I believe applications of mathematics relate directly to my life.	N	D
8	I am aware of the applications of specific mathematics topics in business and society.	A	D

Table 16 Asuka's responses to the items in the Motivation to Learn Mathematics Instruments (MLMI) (Continued)

Question #	Question	Response Before	Response After
9	I believe applications of mathematics relate directly to major/career choice.	N	D
10	I would like to learn more about applications of mathematics in the world.	D	N
11	I would like to learn more about mathematics.	D	N
12	The ability to reason and problem-solve is mathematical skill.	N	N
13	For mathematics learning to occur students must spend time beyond class hours pursuing course content.	A	N
14	A college education should include mathematics courses to develop well-rounded students.	A	A

Table 16 Asuka's responses to the items in the Motivation to Learn Mathematics Instruments (MLMI) (Continued)

Question #	Question	Response Before	Response After
15	As a result of taking this course, I would like to learn more about mathematics.	D	N
16	The ability to reason and problem-solve is important in everyday life.	A	A
17	Having to take mathematics courses is a waste of time.	D	D
18	Only a few majors should be required to take mathematics courses.	D	D
19	Learning mathematics will not make me an effective problem solver.	D	N
20	I am effective in solving problems.	N	N

At the end of the course, Asuka did not find mathematics interesting; she felt neutral about her foundation of mathematical knowledge; she agreed that she has the ability to learn mathematics but must work hard to do so; did not agree nor disagree that mathematics makes sense to her in applied example. Unlike her initial answer, she no longer believed that applications of mathematics relate directly to her life or her career

choice; she was not aware of specific applications of mathematics in business and society; and she did not want to learn more about applications of mathematics in the world.

In addition, Asuka felt neutral that the ability to reason and solve problems is a mathematical skill and that for learning to occur students must spend time beyond class hours pursuing course content. However, Asuka agreed that a college education should include mathematics courses to develop well-rounded students and that the ability to reason and problem-solve was important in everyday life. Asuka's feelings about learning more about mathematics slightly improved at the end of the semester; it went from disagree to neutral. She disagreed that only a few majors should take mathematics and that taking mathematics is a waste of time for most students. Finally, she felt neutral about being an effective problem solver and that mathematics learning can make her an effective problem solver.

During her interview, Asuka asserted that ASL was a great opportunity for her because it helped her complete her mathematics class and gave her a sense of community affinity. "What I enjoyed the most was to interact with the kids." She reported that her intrinsic motivation to learn mathematics increased as a result of participating in the ASL program and that her participation in the program helped her become a more rounded person.

Azuka said she would encourage all of her friends to participate in an ASL because not only did she develop her math skills, but also it made her more rounded. "You learn more other things too. Not just solving math problems." She felt that the ASL program motivated her to put more time and effort in the course. She said that seeing how

the children enjoyed receiving her help made her realize that there is support available to her as well. Asuka's average motivation score fell from a 3.4 at the beginning of the semester to a 3.05 at the end of the semester.

Case study of Amy.

Amy is another Caucasian eighteen year-old who recently graduated from high school. Her interest in the course was moderate and she indicated she was taking the course as an elective. Her overall average was a 93%. She enrolled in the course in the fall semester of 2015 and wanted to participate in the ASL program because she was interested in volunteer opportunity and desired to develop her communication and group interaction skills. Amy's career plan is to become a forensic specialist or a detective. Her responses to the two survey instruments are detailed below.

Amy's attitude toward mathematics learning.

Table 17 Amy's responses to the items in the Mathematics Attitude Instrument (MAI)

SA = Strongly Agree A = Agree	N = Neutral	D = Disagree SD = Strongly Disagree

Question #	Question	Response Before	Response After
1	Mathematics is an easy subject to learn for me.	A	A
2	Thinking about math makes me anxious	N	D
3	I enjoy mathematics.	A	A

Table 17 Amy's responses to the items in the Mathematics Attitude Instrument (MAI) (Continued)

Question #	Question	Response Before	Response After
4	I can perform the computations in class, but I really do not understand why they work.	D	D
5	I would rather not be taking mathematics.	D	D
6	I feel confident when I think about math.	A	A
7	I can perform the computations in class, but I do not understand what those numbers are telling me.	D	D
8	Learning math is difficult for me.	N	D
9	I would enjoy taking another mathematics course in the future.	A	A
10	Men are generally better at math than are women.	D	A

Table 17 Amy's responses to the items in the Mathematics Attitude Instrument (MAI) (Continued)

Question #	Question	Response Before	Response After
11	Math is one of those subjects in which a person has to place too much effort.	N	A
12	Math is too complicated for me to study.	N	D
13	No matter how hard I try I just cannot do well in mathematics.	D	D
14	I would take mathematics even if it were not required for my program.	D	D
15	Math will be useful for me in my future career.	A	A
16	I can see many useful applications for mathematics in the "real world".	A	A
17	I will not use math again once I finish school.	SD	D
18	Math is one of the most valuable subjects for me in my program of study.	A	A

Table 17 Amy's responses to the items in the Mathematics Attitude Instrument (MAI) (Continued)

Question #	Question	Response Before	Response After
19	All people would benefit from a course in mathematics.	A	A
20	I will be better able to make intelligent decisions from taking mathematics.	A	A
21	Mathematics is not very useful for everyday life.	SD	D
22	Mathematical thinking will one day be as necessary for efficient citizenship as the ability to read and write.	SA	A
23	Most professions use Mathematics to some extent.	SA	A
24	Mathematics is directly related to my field of study.	A	A
25	Mathematics is not really very useful because it tells us what we already know anyway.	D	D

Table 17 Amy's responses to the items in the Mathematics Attitude Instrument (MAI) (Continued)

Question #	Question	Response Before	Response After
26	Mathematics is best left to the "experts" and should not be a part of most professionals' jobs.	D	D
27	Mathematics is needed for important fields such as science and medicine.	SA	A
28	Mathematics will improve my ability to research.	SA	A
29	I will be better in my field by having knowledge of Mathematics.	SA	A
30	Mathematics helps me develop critical thinking skills.	SA	A

(1) Amy felt that mathematics is an easy subject for her, she did not believe that thinking about mathematics made her anxious, and she enjoyed mathematics; (2) she thought she could perform the computations in class, she felt confident when she thought about math, and she understood what the numbers were telling her; (3) she did not think of mathematics as a difficult subject, she knows she will enjoy mathematics in the future; (4) contrary to her initial response, at the end of the semester, she agreed that men are generally better at math, and that mathematics is one of those subjects in which a person

has to place too much effort; (5) contrastingly, she disagreed that math is too complicated for her to study, that she cannot do well in mathematics, and would take mathematics even if it were not required for her program.

In addition, (6) Amy perceived mathematics as useful for her career, she could see many useful applications for mathematics in the “real world”, and she understood that she will be using math after finishing school; (7) she indicated that math is one of the most valuable subjects in her program of study, she felt that all people would benefit from taking a course in mathematics, and that she will be better able to make intelligent decisions from taking mathematics; (8) she believed that mathematics is useful in everyday life, agreed that mathematical thinking will one day be as necessary as the ability to read and write, believed that most professions use mathematics to some extent, and that it is directly related to her field of study; (8) she understood that mathematics should be a part of most professional jobs, that the subject is needed for science and medicine, and that mathematics will improve her ability to conduct research; (10) she agreed that having knowledge of mathematics will enable her to be better in her field, and that mathematics can help her develop her critical thinking skills. Amy’s average attitude score decreased from 4.06 at the semester’s beginning to a 3.80 at its end.

Amy's motivation to learn mathematics.

Table 18 Amy's responses to the items in the Motivation to Learn Mathematics Instruments (MLMI)

SA = Strongly Agree
A = Agree
N = Neutral
D = Disagree
SD = Strongly Disagree

Question #	Question	Response before	Response After
1	I find mathematics interesting.	A	A
2	I have a good foundation of mathematical knowledge.	A	A
3	I have the ability to learn mathematics.	A	A
4	I have to work hard to learn mathematics.	N	N
5	Mathematics makes sense to me in applied examples.	A	SD
6	I am aware of the many applications of mathematics in everyday life.	A	A
7	I believe applications of mathematics relate directly to my life.	A	A
8	I am aware of the applications of specific mathematics topics in business and society.	A	A

Table 18 Amy's responses to the items in the Motivation to Learn Mathematics Instruments (MLMI) (Continued)

Question #	Question	Response before	Response After
9	I believe applications of mathematics relate directly to major/career choice.	A	A
10	I would like to learn more about applications of mathematics in the world.	A	A
11	I would like to learn more about mathematics.	A	A
12	The ability to reason and problem-solve is mathematical skill.	A	A
13	For mathematics learning to occur students must spend time beyond class hours pursuing course content.	A	A
14	A college education should include mathematics courses to develop well-rounded students.	A	A

Table 18 Amy's responses to the items in the Motivation to Learn Mathematics Instruments (MLMI) (Continued)

Question #	Question	Response before	Response After
15	As a result of taking this course, I would like to learn more about mathematics.	N	A
16	The ability to reason and problem-solve is important in everyday life.	A	N
17	Having to take mathematics courses is a waste of time.	D	A
18	Only a few majors should be required to take mathematics courses.	D	A
19	Learning mathematics will not make me an effective problem solver.	D	A
20	I am effective in solving problems.	A	A

Amy found mathematics interesting, felt that she has a good foundation of mathematical knowledge and has the ability to learn mathematics. She did not agree nor disagree that she has to work hard to learn mathematics. However, in contrast to her initial response, she strongly disagreed that mathematics makes sense to her in applied examples even though she agreed that she is aware of many applications of mathematics

in everyday life, business, and society; and she believed that applications of mathematics relate directly to her life and her future career. Amy said she would like to learn more about applications of mathematics in the ""real world"."

Furthermore, she concurred that the ability to reason is a mathematical skill, that for mathematics learning to occur students must spend time beyond class hours pursuing course content and that a college education should include mathematics courses to develop well-rounded students. Amy also agreed that as a result of taking this course she would like to learn more about mathematics, but felt neutral that the ability to reason and problem solve is important in everyday life. Surprisingly, Amy agreed that taking mathematics is a waste of time; that only a few majors should be required to take mathematics; and that learning mathematics will not make her an effective problem solver. Amy felt that she is already an effective problem solver.

Amy's responses to some of the items in the questionnaires seem contradictory. Overall she had a positive attitude towards mathematics learning and was motivated to learn mathematics. Her grade in the course supports this assertion. She felt that the ASL program was a great opportunity because not only did it help her improve her skills in math, but also, it made her feel like she was a part of the community. Amy said that the program was well structured and that she appreciated the presence of the agency staff to lend a helping hand whenever necessary. She said the part of the program she enjoyed the most was helping the children, especially the ones who spoke little English. "Some of the students spoke very little English, so that part, to be interactive, I really enjoyed the most."

Amy said the program made a huge impact on her and affected her educational goals to some extent. “The program made me realize that I am comfortable assisting others, such as small children, and that maybe I have some gift in that field.” She is considering changing her major to education. She also stated that, although she knew mathematics was important, her participation in the ASL program reinforced that view somewhat. “It’s important for all of us and without it, it is very difficult to reach your goal and to succeed in life”. However, some of the responses she provided to the surveys contradict this statement. Amy’s average motivation score decreased from 3.95 at the opening of the semester to a 3.45 at the closing of the semester.

Case study of Daniela.

Daniela is eighteen years-old and of African American descent. Her initial interest in the course was moderate even though she indicated that the course is required for her major. Her overall average was an 89%. She enrolled in the course in the fall of 2015 and was interested in the ASL program because she wanted to gain a deeper understanding of the mathematics studied in class and develop her organizational, communication, and critical thinking skills. Daniela said she wanted to become a nurse. Her responses to the two survey instruments are provided below.

Daniela's attitude toward mathematics.

Table 19 Daniela's responses to the items in the Mathematics Attitude Instrument (MAI)

SA = Strongly Agree
A = Agree
N = Neutral
D = Disagree
SD = Strongly Disagree

Question #	Question	Response Before	Response After
1	Mathematics is an easy subject to learn for me.	D	D
2	Thinking about math makes me anxious	N	A
3	I enjoy mathematics.	D	D
4	I can perform the computations in class, but I really do not understand why they work.	N	N
5	I would rather not be taking mathematics.	A	A
6	I feel confident when I think about math.	D	D
7	I can perform the computations in class, but I do not understand what those numbers are telling me.	D	N

Table 19 Daniela's responses to the items in the Mathematics Attitude Instrument (MAI) (Continued)

Question #	Question	Response Before	Response After
8	Learning math is difficult for me.	A	A
9	I would enjoy taking another mathematics course in the future.	D	N
10	Men are generally better at math than are women.	A	D
11	Math is one of those subjects in which a person has to place too much effort.	A	A
12	Math is too complicated for me to study.	A	N
13	No matter how hard I try I just cannot do well in mathematics.	N	D
14	I would take mathematics even if it were not required for my program.	D	N
15	Math will be useful for me in my future career.	D	N

Table 19 Daniela's responses to the items in the Mathematics Attitude Instrument (MAI) (Continued)

Question #	Question	Response Before	Response After
16	I can see many useful applications for mathematics in the "real world".	D	D
17	I will not use math again once I finish school.	N	D
18	Math is one of the most valuable subjects for me in my program of study.	D	D
19	All people would benefit from a course in mathematics.	D	D
20	I will be better able to make intelligent decisions from taking mathematics.	D	D
21	Mathematics is not very useful for everyday life.	A	N
22	Mathematical thinking will one day be as necessary for efficient citizenship as the ability to read and write.	D	D

Table 19 Daniela's responses to the items in the Mathematics Attitude Instrument (MAI) (Continued)

Question #	Question	Response Before	Response After
23	Most professions use Mathematics to some extent.	A	N
24	Mathematics is directly related to my field of study.	D	D
25	Mathematics is not really very useful because it tells us what we already know anyway.	N	D
26	Mathematics is best left to the "experts" and should not be a part of most professionals' jobs.	A	A
27	Mathematics is needed for important fields such as science and medicine.	N	N
28	Mathematics will improve my ability to research.	D	N
29	I will be better in my field by having knowledge of Mathematics.	N	N
30	Mathematics helps me develop critical thinking skills.	D	D

Prior to the beginning of the semester, Daniela did not have a positive attitude towards mathematics learning. Her views toward mathematics learning did not markedly improve at the closing of the semester. (1) She viewed mathematics as a difficult subject, thought that mathematics made her anxious, and did not enjoy mathematics; (2) she did not agree nor disagree about understanding the computations, why they work, or what the numbers are telling her; she did not feel confident when thinking about mathematics and would rather not be taking mathematics; (3) she felt that math was difficult for her, that math was one of those subjects in which a person has to place too much effort, and could not see many applications for mathematics in the "real world"; (4) she did not agree nor disagree that mathematics is too complicated for her, that she would take mathematics even if it were not required for her program, or that math will be useful in her future career.

In addition, (5) Daniela disagreed that she cannot do well in mathematics no matter how hard she tries, that she will not use mathematics again once she finishes school, or that math is one of most valuable subject in her program of study; (6) she did not feel that all people would benefit from taking a math course, that she would be able to make intelligent decisions from taking mathematics, or that mathematical thinking will be one day as necessary as the ability to read or write; (7) she felt neutral about the usefulness of mathematics for everyday life, about the use of mathematics for most professions, about the importance of mathematics in science and medicine, about mathematics knowledge improving her ability to do research or improving her competence in her field; (8) she did not agree that mathematics is not very useful because it tells us what we know anyway, but agreed that mathematics is best left to the experts

and should not be a part of most professional jobs and she did not think that mathematics would help her develop critical thinking skills. Daniela started the semester with a negative attitude towards mathematics learning. Her average MAI score increased from a 2.37 to a 2.60 at the end of the semester.

Daniela's motivation to learn mathematics.

Table 20 Daniela's responses to the items in the Motivation to Learn Mathematics Instruments (MLMI)

SA = Strongly Agree
A = Agree
N = Neutral
D = Disagree
SD = Strongly Disagree

Question #	Question	Response Before	Response After
1	I find mathematics interesting.	D	D
2	I have a good foundation of mathematical knowledge.	D	N
3	I have the ability to learn mathematics.	A	A
4	I have to work hard to learn mathematics.	A	A
5	Mathematics makes sense to me in applied examples.	A	A
6	I am aware of the many applications of mathematics in everyday life.	D	D

Table 20 Daniela's responses to the items in the Motivation to Learn Mathematics Instruments (MLMI) (Continued)

Question #	Question	Response Before	Response After
7	I believe applications of mathematics relate directly to my life.	D	D
8	I am aware of the applications of specific mathematics topics in business and society.	D	N
9	I believe applications of mathematics relate directly to major/career choice.	D	N
10	I would like to learn more about applications of mathematics in the world.	D	D
11	I would like to learn more about mathematics.	D	D
12	The ability to reason and problem-solve is mathematical skill.	N	D

Table 20 Daniela's responses to the items in the Motivation to Learn Mathematics Instruments (MLMI) (Continued)

Question #	Question	Response Before	Response After
13	For mathematics learning to occur students must spend time beyond class hours pursuing course content.	A	A
14	A college education should include mathematics courses to develop well-rounded students.	N	N
15	As a result of taking this course, I would like to learn more about mathematics.	A	D
16	The ability to reason and problem-solve is important in everyday life.	D	N
17	Having to take mathematics courses is a waste of time.	A	A
18	Only a few majors should be required to take mathematics courses.	A	A

Table 20 Daniela's responses to the items in the Motivation to Learn Mathematics Instruments (MLMI) (Continued)

Question #	Question	Response Before	Response After
19	Learning mathematics will not make me an effective problem solver.	N	A
20	I am effective in solving problems.	N	N

Daniela's motivation to learn mathematics was as low as her attitude toward the subject. She did not find mathematics interesting, did not feel she had a good foundation of mathematics knowledge. She felt she had the ability to learn the subject, but must work hard at it. She agreed that mathematics makes sense to her in applied examples, but did not feel that she was aware of the many applications of mathematics in everyday life, business, or society. She did not think that applications of mathematics relate directly to her life or her career choice, nor would she like to learn more about applications of mathematics in the world.

Further, Daniela would not like to learn more about mathematics, did not feel that the ability to reason and problem-solve is a mathematical skill, but for mathematics learning to occur students must spend time beyond class hours pursuing course content. Daniela did not think that a college education should include mathematics courses to develop well rounded students, or that the ability to reason and problem solve is important in everyday life. She expressed that having to take mathematics courses is a waste of time; she felt that only a few majors should be required to take mathematics, or

that learning mathematics would make her an effective problem solver. Finally, she did not think she was an effective problem solver.

Despite Daniela's low motivation level to learn mathematics and her negative attitude toward the subject, she successfully completed the course and said she loved every minute of the ASL program. She asserted that she enjoyed helping the children, but felt that she received more than she gave. "It actually helped me more because some of the things they were going over, we were actually going over in class. So it just helped reinforced what I learned." She said the ASL program helped her with patience and her understanding of how other people think and react in situations.

She also stated that she would advise her friends to participate in ASL because as she puts it "once you teach someone else, you are actually learning more about yourself and about the subject." She felt that the ASL program motivated her to learn because she did not want to go tutor the children and provide wrong answers. She expressed that ASL should be implemented at all levels of education and in a broad spectrum of subjects. When asked if she thought the university should offer more math classes with ASL, she replied: "yes, definitely and it should be for other students, too. In middle school, high school so you can help them out more and help ourselves out more, too". Daniela's average motivation score was below the mean and remained unchanged at the close of the semester.

Summary of qualitative results

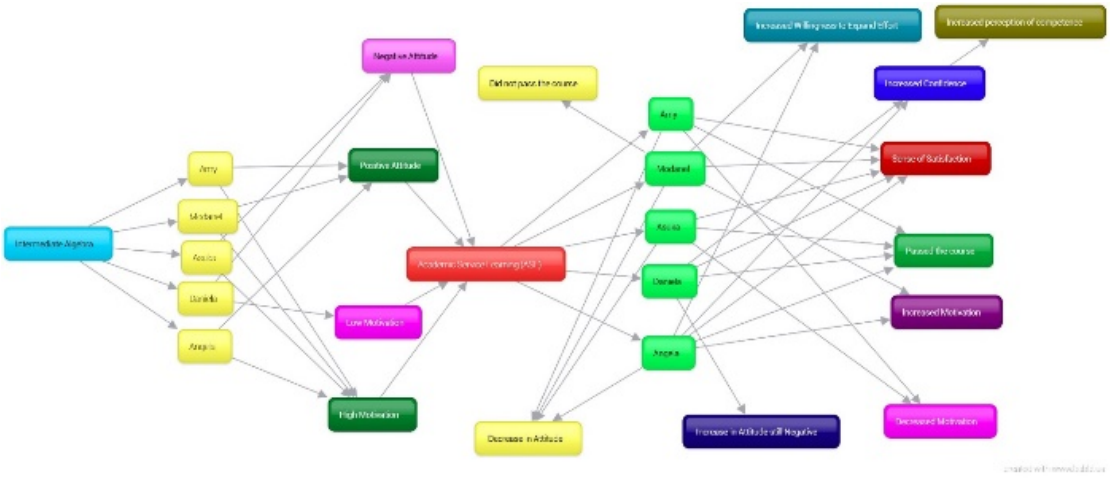

Figure 14. Summary of qualitative results.

The ASL program provided the participants with a sense of satisfaction.

Overwhelmingly the participants stated that they enjoyed the Academic Service Learning experience. Daniela said she enjoyed the experience not only because she "got to use her little math skills," but also because she loves being with the kids and helping them out. She also enjoyed the experience because she felt that the little kids were looking up to her and that they enjoyed interacting with her. Modanel echoed Daniela's sentiments; he expressed that the fact that he had to be away from the campus to be with the little kids was a welcome change. All of the interviewees said that experience was very interesting and the experience was related to the material covered in the classroom. They emphasized having a sense of satisfaction both during and after their participation in Academic Service Learning.

Increased motivation to learn mathematics as result of the Academic Service Learning experience.

Two of the interviewees reported an increased motivation to learn mathematics as a result of participating in the ASL program. The other three interviewees reported that

although their motivation to learn mathematics did not increase, the ASL program caused them to put forth more effort in the course. Unlike Angela who reported an increased level of motivation and putting forth more efforts in the course as a result of the ASL experience, Amy and Daniela made it very clear that they still did not care much for mathematics learning. Daniella stated that "math is generally not enjoyable, but if I had to do it again in another math course, I would look forward to helping the kids again, but math is still math".

Angela reported that not only the ASL program affected her in positive way regarding mathematics learning and motivated her to put forth more efforts in the course, it also gave her the impetus to seek help. Both Angela and Modanel reported that their intrinsic motivation to learn mathematics increased as a result of participating in the ASL program.

No change in attitudes towards mathematics learning.

Although all of the participants indicated that their attitudes towards mathematics did not change as a result of participating in the ASL project, they all indicated that they were highly likely to enroll in a mathematics course with ASL and that they would recommend mathematics with ASL to their friends. One major theme that emerged was that the ASL component of the course took the grind out of doing mathematics. Daniela said: "I would recommend mathematics with ASL to my friends because I am sure it would change their whole outlook." Angela said: "I definitely would. It gave me the opportunity to think outside of the box and to interact with others." Modanel said: "Teaching math to other people made me more flexible and made think of different ways of solving problems on my feet." Angela said: "because it was outside of college, there

was a different appeal to the experience, but I was really enthusiastic about doing word problems; something that I generally do not enjoy. It made me realize that if I set myself up to accomplish something, I can achieve it. I actually started believing in my own abilities." Although the participants did not directly state that their attitudes had changed towards mathematics learning, a change in the participants' outlook can be discerned. One can reasonably conclude that there was a positive change toward the participants' attitude toward mathematics learning when embedded in ASL, but not a change towards their perception of the usefulness of mathematics in everyday life or their future careers.

Increased perception of competence as a result of the ASL program.

The participants reporting feeling more confident regarding their mathematical abilities as a result of participating in the ASL program. Angela said that when she was solving word problems with the children, the fact that they looked up to her made her feel better about herself. "They really looked up to me and actually made me feel better about my mathematics." Similarly, Daniela felt a sense of competence as a result of participating in the ASL program. "I enjoyed it because I got to use my little math skills a bit."

Chapter 5. Discussion, Conclusions, Recommendations, and Future Research

Introduction

In this mixed method research study, the researcher sought to ascertain whether the insertion of Academic Service Learning in an intermediate algebra class resulted in an improvement in the students' success rates, motivation to learn mathematics, and their attitude towards the subject. The quantitative portion of the study compared students who participated in the ASL program to students who showed an initial interest, but withdrew from the program in the early stages. In addition, participants in the program were surveyed before and after their participation in the program to ascertain whether a change in motivation and attitude resulted from their involvement in the ASL project.

The qualitative portion of the study involved (1) the analysis of journal entries provided by the participants that described their thoughts and feelings throughout the duration of the project, (2) the study of responses provided by five students who volunteered to participate in semi-structured interviews that queried them about their motivation and attitude towards mathematics learning after participating in the ASL project, (3) qualitative dissection of responses to Likert scale type surveys. The following is a summary of the findings that emerged from the results obtained in the previous chapter in light of the research questions. Limitations, implications for educational stakeholders, and recommendations for future research are also included.

Summary of Findings

Question 1: Mastery of learning objectives

Does "real world" experience through Academic Service Learning make a difference on college students' mastery of learning objectives in intermediate algebra compared to students enrolled in the same course who elected not to participate in the ASL program at a public university?

The descriptive statistics show that the proportion of students who obtained a passing grade in the course was higher in the ASL group than in the non-ASL group, 86.7% and 63.2% respectively. The mean final score for the course was also calculated, and the mean score for the ASL group (*M = 76.47*) was greater than the mean score of the non-ASL group (*M = 69.37*). It was also found that the ASL group performed with better consistency (*SD =12.17*) than the non-ASL group (*SD =20.47*). Cohen's d effect size indicated that 11% of the difference between the mean of the two groups could be explained by the students' participation in ASL.

Although these results did not reach statistical significance, they are in line with several prior studies that tested the effectiveness of ASL in raising students' success rates in various subjects. Duffy et al., (2011) reported that the majority of the students who enrolled in engineering programs indicated that ASL played a major role in their abilities to complete their programs. Similarly, Zang et al., (2000) found that a student enrolled in a finite mathematics course who elected to tutor at-risk youth at a local organization, increased her mastery of college level mathematics and saw a decrease in her level of mathematics anxiety. Further, Hilosky et al., (1999) asserted that Academic Service

Learning has the potential to increase retention and provides a learning atmosphere conducive to student centered strategies.

Question 1A: Effect by gender

Does the effect of ASL on students' mastery of learning objectives vary by gender in intermediate algebra at a public university?

As reported in previous research, female students performed better than male students in both the ASL and the non-ASL groups (Spradlin & Ackerman, 2010). The male participants outperformed the male non-participants; similarly, the female participants outperformed the female non-participants. However, the results were not statistically significant. These results accorded with those of Taylor (2008) who found no statistical differences in mathematical achievement by gender.

These results also agreed with those reported by Callas (1993) who found that female outperformed their male counterparts in entry level college mathematics courses. One possible explanation is that male students tend to overestimate their mathematical abilities more female students (Mura, 1987). Another plausible explanation is that female students may have benefited more from their participation in the ASL project as they may have perceived themselves as providers of a valuable service to the community and the children to a higher degree than their male counterparts. One consistent finding of the qualitative analysis was that the participants enjoyed their interaction with the children. This finding is interesting given that the majority of the participants was female.

Question 1B: Effect by race

Does the effect of ASL on students' mastery of learning objectives vary by race in intermediate algebra at a public university?

Two categories of race were considered: White and non-White. The results showed that there was no statistically significant differences in performance between White and non-White in both the ASL and the non-ASL groups. In the ASL group, the achieved power was .297.The results suggest that non-White participants may have gained more from participating in the ASL program than the White subjects. These results indicated that ASL may increase the number of underrepresented students who successfully complete intermediate algebra (Hilosky et al., 1999; Kennedy & Schumaker, 2005).

Question 2: Motivation for mathematics learning

How does the infusion of "real world" experiences through Academic Service Learning affect students' motivation for mathematics learning in intermediate algebra at a public university?

The Motivation to Learn mathematics Instruments (MLMI) was administered to the participants both at the beginning and at the end of each semester. The instrument consisted of Likert-Scale type items ranging from a one signifying strongly disagree to a five signifying strongly for positively worded items; and a one representing strongly agree to a five representing strongly disagree for negatively worded items. The participants' responses were tabulated and the results showed that the mean motivation score was virtually the same both at the beginning and at the end of the semesters. These results contradict the findings of (Sherman & MacDonald, 2009; Duffy et al., 2011) who

reported a statistically significant increase in students' motivation after participating in ASL projects. The resulting low power suggested that the null hypothesis of no difference in motivation between the two groups could possibly be rejected with a sufficient sample size.

Similarly, the qualitative analyses showed that two of the participants who volunteered to be interviewed reported an increase in their motivation to learn mathematics. Two other interviewees stated that, although their motivation did not increase, the program inspired them to expand more effort in the course. The majority of the participants said that they focused more on the course content as a result of having to tutor the elementary school children because they wanted to minimize the chances of providing wrong answers to their tutees.

Question 2A: Effect by gender

Does the effect of ASL on students' motivation for mathematics learning vary by gender in intermediate algebra at a public university?

The results showed that, both before and after their participation in the ASL project, male participants were more motivated than female participants. However, the results were not statistically significant. It is interesting to note that at the end of the project, the motivation level of the female students slightly increased while the motivation of the male subjects slightly decreased. The qualitative data analysis indicated that both male and female reported either an increase in motivation or an increased willingness to expand more effort in the course.

In question 1b, it was found that female participants outperformed their male counterparts. The findings of question 2b contradict those 1b in that highly motivated

students should have better outcomes than students who lack motivation (George, 2010). In this study, although females outperformed males, the male students displayed a higher level of motivation than the female students. However, the difference in motivation between male and females was smaller in the ASL group, suggesting that the ASL project had some effect in narrowing the gap between male and female students' motivation. It is worth noting that the ASL project had a small negative effect of the motivation of male students.

Question 2B: Effect by race

Does the effect of ASL on students' motivation for mathematics learning vary by race in intermediate algebra at a public university?

The ANOVA results revealed that prior to ASL, the difference in motivation between Whites and non-Whites was statistically significant. Contrastingly, this difference was statistically insignificant after participation in ASL. Concurrently, in the qualitative portion of the study, some of the participants reported that the ASL project motivated them to engage with the course content; and others reported that ASL inspired them to put forth more effort in the course. Based on the qualitative data, it can be reasonably concluded that, regardless of race, the motivation level of most of the participants increased as a result of participating in the ASL project. Therefore, the qualitative data support the assertion that Academic Service Learning has the potential to increase students' motivation to learn (Sherman & MacDonald, 2009; Hofmann & Hunter, 2003; Duffy et. al., 2011).

Question 3: Attitudes toward mathematics learning

How does the infusion of "real world" experiences through Academic Service Learning affect students' attitudes towards learning mathematical concepts in an Intermediate Algebra course at a public university?

The Mathematics Attitudes Instrument (MAI) was administered to the participants at the opening and closing of each semester. The mean attitude score prior to participating in ASL was slightly higher than the mean attitude score after participating in ASL. The numerical results were statistically non-significant and show that the ASL program had no impact on the participants' attitudes towards mathematics learning.

Similarly, the results of the qualitative portion of the study revealed that students' attitudes towards mathematics learning remained unchanged after participating in ASL. Students who display a positive attitude towards mathematics tend to perform better and high performing students tend to display a positive attitude towards mathematics (Evans, 2007; Shores & Smith, 2010). Even though the participants in this study did not report a direct change in attitude, their enjoyment of the ASL experience may have contributed to their successful completion of the course.

Question 3A: Effect by gender

Does the effect of ASL on students' attitudes towards learning mathematics vary by gender in intermediate algebra at a public university?

Prior to their experiences with ASL the mean attitude score for the male subjects was higher than the mean attitude score for female students. The attitude score for both genders slightly dropped after their participation in the ASL project. The difference in attitude score between the groups remained virtually unchanged after their participation

in the program. Similarly, the qualitative results showed that, regardless of gender, the students' attitudes towards mathematics learning remained the same after the ASL experience.

Champion et al., (2011) found no gender difference with regard to students' attitudes towards the value of mathematics in preparing them for their future careers. One possible reason why the ASL experience did not affect the students' attitudes towards mathematics is the lack of opportunity this ASL program provided to the students to make tangible connections between the "real world" and the mathematical world. Students are weak at making connections between these two worlds and need more opportunities to be able to make such connections (Crouch & Haines, 2004). Students may have perceived tutoring the children as confined within a classroom with no connection to their everyday lives or their future careers.

Question 3B: Effect by race

Does the effect of ASL on students' attitudes towards learning mathematics vary by race in intermediate algebra at a public university?

The numerical results revealed that the ASL experience did not statistically significantly affect the students' attitudes towards mathematics learning when the participants' were divided among racial lines. Both before and after participating in ASL, the results yielded similar patterns. The qualitative data confirmed these findings. The majority of the participants did not report any change in attitude after their participation in ASL.

Although the participants reported a sense of satisfaction while helping the children solve word problems, the experience did not seem to affect their attitudes

towards mathematics learning. The results of this study conflict with those reported by Hoffmann and Hunter (2003) who stated that teaching traditional algebra topics with problem solving improved students' attitudes towards beginning algebra. In solving word problems, students often call on their knowledge of how to solve other word problems, but do not necessarily see the relevance of the word problems in "real world" situations (Le Roux, 2008).

Summary

The quantitative analyses showed that ASL may provide a solution to the problem of students' underperformance in intermediate algebra since the students who participated in the ASL did perform better than the students who expressed interest but did not participate in the program. Concurrently, the results of the qualitative analysis unequivocally showed that the students were enthusiastic about their participation in the program and felt that ASL raised their motivation level or their willingness to expand effort in the course. On the other hand, both qualitative and quantitative results agreed that the ASL program did not have an effect on students' attitudes towards mathematics learning.

Several factors may explained why the program did not affect the students' attitudes. (1) the MAI instrument yielded a low reliability coefficient of .51, (2) the students may have perceived the program as confined within the four walls of a classroom with no connections to their everyday lives of future careers (Sezer, 2010), (3) most of the participants perceived intermediate algebra as difficult and boring, (4) ASL was inserted into a course using the traditional lecture method with no adjustments made for the extra work required for participating in the ASL project, and (5) most of the

participants may have lacked the prerequisite skills necessary for the course which increased their perception of mathematics as a difficult subject.

Implications

These results suggest that ASL may be able to improve students' performance in intermediate algebra as well as increase their motivation to learn the subject. One possible explanation for the failure of Academic Service Learning to affect students' attitudes towards mathematics learning is the way this particular ASL program was structured. Even though it provided "real world" experiences, it did not provide the students the opportunity to use mathematics to solve "real world" problems outside of the classroom (Sherman & MacDonald, 2009). The results confirmed the hypothesis that having to tutor the elementary school children would motivate the college the students to put forth more effort in the course.

However, the students still had to solve problems in the idealized sphere of a classroom. As a result, the students were not exposed to problems that needed solutions in their everyday lives or their future careers. To address the problem of students' perception of the uselessness of mathematics in the "real world", ASL programs in mathematics should be designed so that students are placed in organizations where they experience solving problems related to their future careers in business, industry, or community centers. One student whose aspiration is to become an elementary school teacher reported receiving significant benefits out the program. She requested to continue volunteering at the agency the following semester without receiving community service hours on her transcript.

Future Research

Several studies reported that ASL has the potential to increase retention and provides a learning atmosphere conducive to student-centered strategies (Duffy et al., 2011; Sherman & MacDonald, 2009; Hilosky et al., 1999). In addition, Le Roux (2008) indicated that students do not necessarily see the relevance of word problems to "real world" situations. The current study could be replicated with larger sample sizes and with the following adjustments: (1) to address the problem of students perceiving mathematics as irrelevant, they could be placed with organizations where the service is related to their personal interests or their future careers; (2) mathematics courses could be paired with science courses such as biology and chemistry where students' projects would consist of projects that provide tangible connections between concepts covered in the classroom and the "real world" of business or industry (Sherman & MacDonald, 2009); (3) students in college level courses could be asked to tutor intermediate algebra students; (4) intermediate algebra students could be asked to tutor young adults preparing to take the mathematics portion of the General Education Development (GED) test; (4) high school students could tutor middle and elementary school children; (5) intermediate algebra students could be asked to tutor students enrolled in vocational and professional programs.

In addition, the effect of ASL on the 4^{th} and 5^{th} grade children could be studied. It would be interesting to determine whether the children's interactions with college students made an impact on their current mathematics achievement during the current school year, as well as their performance as they progress to higher grade levels. Also, research on the effect of ASL on social agencies, business, and industry could be

undertaken. Finally, the effect of ASL on the teaching faculty as well as how ASL impacts interactions between students and faculty could be studied.

Conclusions

Many intervention programs have attempted to address the problem of students' failure in developmental mathematics courses by providing students the opportunity to engage with the course content outside of the classroom with web-based technologies (Kodippili and Senaratne 2008; Taylor 2008, Stillson and Alsup 2003; Spradlin and Ackerman 2010; Zerr 2007; Meagher 2012; Stephens and Konvalina 1999; Burch and Kuo 2010). However, the design of these technologies target cognitive outcomes and fail to consider the role of the affective domains in mathematics teaching and learning (Eggen & Kauchak, 2006).

Inserting ASL projects into mathematics courses may be able to not only address the objectives in the cognitive domains, but also provide solutions to issues in the affective domains. The affective domains are linked to beliefs, motivations, and attitudes toward a subject (Liljedahl, 2005). Most teachers of mathematics focus on cognition and make little deliberate attempt to address the affective elements. This study found that the majority of the participants perceived mathematics as difficult, dull, and irrelevant to their everyday lives or future careers.

At the same time, the qualitative data revealed that the participants reported (1) a sense of satisfaction after their involvement with ASL, (2) an increase in motivation or willingness to expand effort in mathematics as result of participating in the ASL project, (3) an improvement in confidence because of participating in ASL, and (4) a willingness to recommend the ASL program to their friends. This research study contributed to, if not

initiated, the conversation on the role of the affective domains in developmental mathematics teaching and learning.

Carr (2002) highlighted many barriers that prevent mathematics faculty from implementing ASL projects in their courses. These include: the time it would take to design and coordinate the project, concern about rigor and academic integrity, and support from the college or university. The results of this study suggest that an ASL program, if fully implemented, as recommended by Florida Campus Compact, has the potential to address the problem of low success rates in developmental mathematics courses. To increase students' success, improve their motivation to learn mathematics, and positively impact their attitudes towards the subject, an ASL program in developmental mathematics should at a minimum: (1) be a non-trivial percentage of the students' final course grade, (2) provide students with the opportunity to perform the service in an organization related to their career aspirations or personal interests, and (3) enable students to solve "real world" problems, preferably in a field they are interested in (Hoffman & Hunter, 2003).

Limitations

This study has several limitations that impede the generalizability of the findings. The subjects were not randomly assigned to the two groups, the sample was collected at a single location, and the sample size was relatively low. Another limitation is the difficulty to determine the difference between the characteristics of the subjects who dropped out of the ASL program and those who completed it. One explanation may be that the students who dropped out no longer wanted to make the time commitment required after learning about it during the orientation and training. Another explanation

may be that they lacked confidence in their mathematical abilities and feared the prospect of tutoring the elementary school children.

Summary

This study found that ASL may be able to alleviate the problem of students' disengagement in developmental mathematics courses. However, to implement a successful ASL program in developmental mathematics, a continuing institutional commitment is necessary; interdepartmental cooperation as well as resources are needed (Serow, et al., 1996). If educational stakeholders are serious about increasing students' success in mathematics, they need to take a serious look at students' attitudes and motivation. The results of this study suggest that Academic Service Learning may be able to provide some solutions to students' low motivation and lack of interest in mathematics (Hilosky et al., 1999). Serious consideration should be given to implementing Academic Service Learning in developmental mathematics courses. Further research is therefore warranted on this topic.

Appendices

Appendix A. Mathematics Attitude Instrument (MAI)

Please complete the following background information by placing a check in the appropriate space provided. Please only check one selection for each item.

1) Gender: Female_____ Male_____

   Student ID_____

2) Ethnic background:

   Asian/Pacific Islander___ lack (non-Hispanic)___ Hispanic___

   Native American___ White (non-Hispanic)___ Other____

3) Age (Specify)_____

4) Initial course Interest: High__ Moderate__

5) Is this course a required or elective course? Required__ Elective__

Please complete the following attitudes toward mathematics information by reading each question carefully and circling the choice that best represents your opinion.

SA = Strongly Agree

A = Agree

N = Neutral

D = Disagree

SD = Strongly Disagree

#	Question					
1	Mathematics is an easy subject to learn for me.	SA	A	N	D	SD
2	Thinking about math makes me anxious	SA	A	N	D	SD
3	I enjoy mathematics.	SA	A	N	D	SD
4	I can perform the computations in class, but I really do not understand why they work.	SA	A	N	D	SD

5	I would rather not be taking mathematics.	SA	A	N	D	SD
6	I feel confident when I think about math.	SA	A	N	D	SD
7	I can perform the computations in class, but I do not understand what those numbers are telling me.	SA	A	N	D	SD
8	Learning math is difficult for me.	SA	A	N	D	SD
9	I would enjoy taking another mathematics course in the future.	SA	A	N	D	SD
10	Men are generally better at math than are women.	SA	A	N	D	SD
11	Math is one of those subjects in which a person has to place too much effort.	SA	A	N	D	SD
12	Math is too complicated for me to study.	SA	A	N	D	SD
13	No matter how hard I try I just cannot do well in mathematics.	SA	A	N	D	SD
14	I would take mathematics even if it were not required for my program.	SA	A	N	D	SD
15	Math will be useful for me in my future career.	SA	A	N	D	SD
16	I can see many useful applications for mathematics in the “real world”.	SA	A	N	D	SD
17	I will not use math again once I finish school.	SA	A	N	D	SD
18	Math is one of the most valuable subjects for me in my program of study.	SA	A	N	D	SD
19	All people would benefit from a course in mathematics.	SA	A	N	D	SD

20	I will be better able to make intelligent decisions from taking mathematics.	SA	A	N	D	SD
21	Mathematics is not very useful for everyday life.	SA	A	N	D	SD
22	Mathematical thinking will one day be as necessary for efficient citizenship as the ability to read and write.	SA	A	N	D	SD
23	Most professions use Mathematics to some extent.	SA	A	N	D	SD
24	Mathematics is directly related to my field of study.	SA	A	N	D	SD
25	Mathematics is not really very useful because it tells us what we already know anyway.	SA	A	N	D	SD
26	Mathematics is best left to the "experts" and should not be a part of most professionals' jobs.	SA	A	N	D	SD
27	Mathematics is needed for important fields such as science and medicine.	SA	A	N	D	SD
28	Mathematics will improve my ability to research.	SA	A	N	D	SD
29	I will be better in my field by having knowledge of Mathematics.	SA	A	N	D	SD
30	Mathematics helps me develop critical thinking skills.	SA	A	N	D	SD

Appendix B. Motivation to Learn Mathematics Instrument (MLMI)

Please complete the following background information by placing a check in the appropriate space provided. Please only check one selection for each item.

1) Gender: Female_____ Male_____

   Student ID_____

2) Ethnic background:

   Asian/pacific islander___ Black (non-Hispanic)___ Hispanic___

   Native American___ White (non-Hispanic)___ Other____

3) Age (Specify)_____

4) Career plans/position desired:_____

5) Reason for project participation (Check all that apply):

   Interest in volunteer opportunity _____

   Other (please specify) _____

6) Learning expectations (Check all that apply):

   Gain a deeper understanding of mathematics studied in class _____

   Extend and further the mathematics studied in class ____

   Develop problem solving and organizational skills _____

   Develop communications or group interactions skills _____

   Other (please specify)

   _____

Please read each question carefully before responding. Rate each statement according to the following scale; circle the most fitting choice.

SA = Strongly Agree

A = Agree

N = Neutral

D = Disagree

SD = Strongly Disagree

#	Question	SA	A	N	D	SD
1	I find mathematics interesting.	SA	A	N	D	SD
2	I have a good foundation of mathematical knowledge.	SA	A	N	D	SD
3	I have the ability to learn mathematics.	SA	A	N	D	SD
4	I have to work hard to learn mathematics.	SA	A	N	D	SD
5	Mathematics makes sense to me in applied examples.	SA	A	N	D	SD
6	I am aware of the many applications of mathematics in everyday life.	SA	A	N	D	SD
7	I believe applications of mathematics relate directly to my life.	SA	A	N	D	SD
8	I am aware of the applications of specific mathematics topics in business and society.	SA	A	N	D	SD
9	I believe applications of mathematics relate directly to major/career choice.	SA	A	N	D	SD
10	I would like to learn more about applications of mathematics in the world.	SA	A	N	D	SD

11	I would like to learn more about mathematics.	SA	A	N	D	SD
12	The ability to reason and problem-solve is mathematical skill.	SA	A	N	D	SD
13	For mathematics learning to occur students must spend time beyond class hours pursuing course content.	SA	A	N	D	SD
14	A college education should include mathematics courses to develop well-rounded students.	SA	A	N	D	SD
15	As a result of taking this course, I would like to learn more about mathematics.	SA	A	N	D	SD
16	The ability to reason and problem-solve is important in everyday life.	SA	A	N	D	SD
17	Having to take mathematics courses is a waste of time.	SA	A	N	D	SD
18	Only a few majors should be required to take mathematics courses.	SA	A	N	D	SD
19	Learning mathematics will not make me an effective problem solver.	SA	A	N	D	SD
20	I am effective in solving problems.	SA	A	N	D	SD

Appendix C. Interview Protocol

Name of Interviewer

Mario Toussaint

Description of Interviewees

Five students who completed the course and participated in the Academic Service Learning project were interviewed. The students volunteered to participate in the interviews after receiving an email from the researcher.

Place and Time

The interviews took place either in the researcher's office, over SKYPE, or at another location on campus convenient for both the researcher and the students towards the end of the semester.

Introduction

Good morning and thank you so very much for assisting me with this interview. I value and appreciate your time. When I initially contacted you, I explained to you that I am a graduate student within the Department of Curriculum, Culture, and Educational Inquiry at Florida Atlantic University (FAU). Specifically, I am a doctoral student conducting a research study on the effectiveness of Academic Service Learning as a part of the requirements for obtaining my doctoral degree. I chose to conduct a research project that includes students who completed an Academic Service Learning project in Intermediate Algebra. Just to reiterate a portion of our conversation, please be reminded that the purpose of the interview is to gather data regarding student perceptions of the Academic Service Learning program. Any information gathered will be held in the strictest confidence, and your name will not be used in any publication, or any other

venue. Because this interview will be utilized for the study, I will need to ask you to give your written consent to be a part of this process; and I will need to tape record our interview session. Will you consent to allow for the tape recording of our session? The interview will take approximately 45 minutes.

Interview Questions

1. How do you feel about the Academic Service Learning program you participated in?
2. Which task(s) did you particularly enjoy during the Service learning project?
3. Describe any impact that the Academic Service Learning project had on your overall experience of the course.
4. Has the Academic Service Learning project affected your educational plans? If so, in what ways.
5. Have there been any changes in your views regarding mathematics learning? If yes, please describe those changes.
6. Would you advise your friends to take mathematics courses with Academic Service Learning? If yes, why? If not, why not?
7. Did the Academic Service Learning project motivate you to put more time and effort into the course? If so, in what ways and why?
8. Would you take another mathematics course with an Academic Service Learning component? If yes Why? If not, why not?
9. Do you think the college should offer more mathematics courses with an Academic Service Learning component? Why or why not?
10. How can the Academic Service Learning program be improved?

Closing

Thank you very much for your contribution to my research project. Time is an extremely valuable commodity; and I thank you for allowing me to use yours. Your contribution to my project is immeasurable, and I cannot thank you enough for your assistance. If you have any questions, or concerns, I will be amendable to address them; at this time, or at a later date and time. And, on the other hand, if I have any questions, or concerns, I will contact you. Again, thank you for all that you have done.

Appendix D. Recruitment Script

Good morning/afternoon/evening:

My name is Mario Toussaint and I am doctoral candidate with the college of education. Specifically, I am a conducting a research study on the effectiveness of Academic Service Learning in intermediate algebra as a part of the requirements for obtaining my doctoral degree. The title of the study is: "The Impact of "Real World" Experiences through Academic Service Learning on Students' Success Rate, Attitudes, and Motivation in Intermediate Algebra at a Public University."

Academic Service Learning (ASL) is a teaching and learning strategy that integrates meaningful community service with instruction to enhance students' learning experiences and teach civic responsibility. The project involves tutoring elementary, middle, high school, or GED students in math for at least 20 hours during the semester. You will receive community service hours on your transcript for participating in the project.

I am here to request your participation in the project. Your information will be kept in strict confidence and your name will not be used in any publication. If you are interested in participating, please pick up the consent form, read it, sign it, and return it to me within 5 calendar days. I have placed my contact information on the board. Also, if you have any questions or concerns, please feel free to contact me.

Mario Toussaint

Email: Phone:

Appendix E. Support Letters

Mathematics Department Support Letter

February 16, 2015

Mario Toussaint
Department of Curriculum, Culture, and Educational Inquiry
Florida Atlantic University
College of Education

Dear doctoral student,

After reviewing your research proposal, the mathematics department agrees that your research project has the potential to positively impact the students enrolled in intermediate algebra at the university. As a result, the department grants you permission to advertise the program to students enrolled in the course and to administer your IRB-approved instruments. In addition, the department will provide access to the necessary records.

Sincerely,

Name, Title	Name, Title

Appendix E. Course Syllabus

Syllabus

Intermediate Algebra (MAT 1033 - 001) 3 credits

CRN 24985

Lab Sections:

- **Section 002 CRN 24986**
- **Section 003 CRN 24988**

Fall 2015

Mathematical Sciences Department

Prerequisite:

None

Instructor: Dr. Ana Escuder	Sections: 001, 002, 003
ASL coordinator: Mario Toussaint	CRN 24985, 24986, 24988
Office Hours: SE 204	Lecture: MW 10:00 -10:50, GS 120
T 1:00 pm – 3:00 pm	Lab: SE 314 - T R 10:00 – 11:50
R 1:00 pm – 3:00 pm	Open Lab: M 9:00–12:00; W 10:00-4:00; F 4:00 – 6:00
E-mail Address:	Software: ALEKS 360
Office Phone number:	

Description:

This course prepares students for MAC 1105, College Algebra. Topics include sets, properties of real numbers, exponents and radicals, factoring of polynomial expressions, algebraic fractions, linear, and radical equations and their applications.

This course does not satisfy GORDON RULE mathematics graduation requirement but is a necessary prerequisite for GORDON RULE math courses. This course counts as elective credit only.

Course Objectives:

Upon successful completion of this course, you will have the knowledge and skills pertaining to the following topics:

1. Sets
2. Properties of real numbers;
3. Exponents and radicals;
4. Factoring of polynomial expressions;
5. Algebraic fractions;
6. Linear, and radical equations and their applications.

IFP General Education Outcomes:

1. Knowledge in several different disciplines;
2. The ability to think critically;
3. The ability to communicate effectively;

4. An appreciation for how knowledge is discovered, challenged, and transformed as it advances;

5. An understanding of ethics and ethical behavior.

Information available at

http://www.fau.edu/deanugstudies/NewGeneralEdCurriculum.php

Software:

Students must purchase access to a web-based learning artificially intelligent assessment and learning system called ALEKS 360 (**A**ssessment and **L**earning in **K**nowledge **S**paces). This can be purchased at the bookstore or directly on the ALEKS.com website – more information available in the Lab sections. You will also need access to Blackboard *https://bb.fau.edu*. If you are not familiar with Blackboard, visit http://www.fau.edu/irm/blackboard/bb9_student.php for Blackboard Tutorial for Students. All homework, quizzes and exams will be completed online using the ALEKS system. Students not registered in ALEKS after the third week of the semester may be dropped from the course.

Course Website:

All information pertaining to Intermediate Algebra will be posted on Blackboard; grades will be posted in the ALEKS gradebook. Students should check Blackboard regularly for updated information. Ignorance of posted information is NOT a valid excuse for missing assignments, quizzes, or exams. Questions not answered in the syllabus should be directed via e-mail to the instructor.

Required Materials and Technologies:

- A notebook
- A computer (you can use computers available on campus)
- You do not need to purchase a hard copy of the book. You will have access to the e-book Intermediate Algebra, 4th Ed., by Miller, O'Neill, and Hyde, through ALEKS.
- Students are required to bring blank paper, writing materials, and a valid picture ID (FAU owl cards, US passport or Florida Driver's license) to the lab sessions.
- It is **strongly recommended** that students keep a notebook for their lecture notes and ALEKS homework so that they can readily review their work prior to a quiz or exam.

Lectures and Lab Sessions:

- Sections require two 50-minute lecture sessions plus a 110-minute session in SE 314 each week.
- The lecture sessions are the main presentation of the course material. Once the lecture has begun all cell phones and other electronic devices (other than calculators) must be turned off.
- **Attendance to lectures and lab sessions is mandatory**. A student may have at most 5 unexcused absences. A TOTAL OF 6 OR MORE UNEXCUSED ABSENCES WILL RECEIVE A GRADE OF "F" IN THE COURSE. Attendance means arriving on time and staying until dismissed by the instructor. Roll will be taken in lectures and in lab sessions (bring your Owl card). Absences from the computer lab must be made up by attending an open lab session.

- A valid FAU student ID card is required for access to the Intermediate Algebra Lab - SE 314
- The scheduled 110-minute laboratory session in SE 314 each week is used for both supervised online homework and testing. These weekly 110-minute lab sessions consist of either (1) a 30-minute quiz, followed by 80 minutes of online ALEKS work; or (2) 30 minutes of online ALEKS work, followed by a longer 80-minute test. These tests will be given at approximately 3-week intervals (see the course Calendar/Outline).
- Instructors and "Peer Tutors" (PTs) will be available to provide students with personalized help. Students are strongly encouraged to interact with them in order to get individualized, immediate answers to their questions.
- Students are expected to follow the posted rules and regulations in the SE 314 Lab. Chronic violators may be ejected from the lab.
- Students are expected to be on time for the lab session. Most of the important information will be given at the beginning of the lab session.

Grading:

ALEKS Homework (20%): Homework must be completed by the posted due dates. Give yourself ample time to complete assignments well before the posted due date. Lapses in Internet access, faulty computer, power outages, or scheduled maintenances are NOT valid excuses for missed or incomplete assignments.

Quizzes (25%): A 30-minute quiz will be given during lab times except on exam day. Quizzes will be done using the ALEKS system, however written work will be expected

and collected for grading. Bring paper and pencil. Make-ups will only be given during open lab session and with instructor's permission.

Exams (40%): A total of four written midterm exams will be administered. Each midterm exam will count in towards student's final grade and no midterm exam grade will be dropped. Any grading errors or problems will have to be discussed with the instructor within a week you received your exam. Exams will not be reviewed at the end of the semester. Exams will be done using the ALEKS system, however written work will be expected and collected for grading. Bring paper and pencil.

Comprehensive Final Exam (15%): Final exam will take in the computer lab. More information on dates and times will be posted in blackboard. You must take the final exam to receive a passing grade.

****Grades below 65% (D):** students earning grades below 65 on quizzes or tests in any given week will be required to attend and document 2 hours of extra help for that week. The extra help can be received either in the math-tutoring center, or attending instructor's office hours.

Course Grade:

The course grade will be calculated from ALEKS homework, quizzes, and five exams. Check your grades regularly to make sure that they correctly reflect your scores in the course. Any discrepancies must be notified to instructor via email.

Component	**Weight**
Homework	20%
Quizzes	25%
Midterm Exams (4)	40%
Final Exam	15%

Grading Scale:

Percentage	93%-	90%-	87%-	83%-	80%-	75%-	65%-	60%-	55%-	0%-
Score:	100%	92%	89%	86%	82%	79%	74%	64%	59%	54%
Grade:	**A**	**A-**	**B+**	**B**	**B-**	**C+**	**C**	**D**	**D-**	**F**

Make-up Policy:

There is no makeup for any missed exams (except in cases of severe illness, in which case a written evidence from the hospital or a physician should be submitted, if possible in advance of the scheduled exam, otherwise, your absence will result in 0 points on the exam.)

Academic Service-Learning (ASL)

Due to the nature of the course content, this course is designated as an "academic service-learning" course. The assistance you provide to the agency/organization during your academic service-learning experience is a service to the community and will allow you to apply knowledge from the course to local, national, and/or global social issues. Throughout this course you will be participating in academic service-learning activities while demonstrating civic engagement at campus, local, national, and/or global

community levels. You will also reflect on your academic service-learning experience and the impact on the community as well as your professional development.

Project description

Students in the Academic Service Learning group will be asked to go to local social agencies and provide group tutoring or one-on-one tutoring on mathematical concepts related to the course to 4th and 5th grade children in after care programs. The students will be asked to perform at least 20 hours of community service during the semester. You will receive community service hours on your transcript if you decide to participate in the Academic Service Learning (ASL) project. You must notify the ASL coordinator by the second week of class if you wish to participate in the ASL project.

Relevant and meaningful service in the community

The children who will receive tutoring from the college students will also benefit from the program as they usually come from families with modest economic means who are unable to afford the cost of private tutoring. This program has the potential to make a positive difference in the children or the young adults' mathematics learning. Successful completion of mathematics courses may open doors to career options that would have been inaccessible without the completion of those math courses. Access to careers in Science Technology, Engineering, and Mathematics (STEM) may give the tutees the ability to earn higher wages in the future. Society benefits when more people are able to provide themselves and their families instead of relying on government handouts.

Community service hours

To receive academic service-learning notation of hours on your transcript, your hours must be logged electronically through NobleHour, www.noblehour.com, while completing your academic service-learning project. Also, pre-assessment and post-assessment surveys are required to be taken by academic service-learning students. Please visit the Weppner Center for Service-Learning & Civic Responsibility website, www.fau.edu/volunteer, for instructions on how to log hours through NobleHour and the links for the surveys. Once your hours have been approved and both surveys have been completed, you will receive an academic service-learning notation on your transcript.

Reflection

Two surveys will be administered to the students at the beginning and at the end of the semester to ascertain whether their participation in the Service Learning project made a positive difference on their motivation to learn mathematics as well as their attitudes towards the subject. In addition, the students will be required to keep a journal that details their experiences during the duration of the project as well as reflect on those experiences. For each visit, the students will be required to reflect on their experiences by responding to the following prompts in a few sentences:

- Describe your experience during your visit to the agency and the content you covered with the children or young adults.
- How is this session related to one or more of the course objectives?

- In your view, how did the tutees experience the tutoring session? Were they satisfied? Provide examples.
- How has this session impacted you personally or professionally?
- Is there anything you would do differently? Explain.

Purposeful civic learning

As high school graduates, the researchers assume that the students have already been exposed to the topics they will be tutoring. As a result, it is highly likely that they have a working knowledge of the topics they will be tutoring. In addition, these topics are closely related to the topics that will be taught in the classroom. Furthermore, the FAU students will receive an orientation on how to tutor by both the researcher and staff members of the agency. The ASL coordinator has over 15 years of experience in tutoring mathematics as well as mathematics teaching experience.

Tutoring:

If you are having difficulties and need help in this course beyond the scope of what an instructor can provide or if you would just like some information on how to improve your studies, your university has resources available for you.

- SE 314 will hold Open Lab hours for additional tutoring and free help on Wednesdays from 10 am to 4 pm.
- SE 350 will hold open Lab hours on Mondays from 9 am to 12 pm and Fridays from 4 pm to 6 pm.

- The campus has tutoring available in the Math Learning Center (MLC), room GS 211. Please see the MLC homepage at http://math.fau.edu/MLC/
- The Center for Learning and Student Success (CLASS) can help students find tutoring, improve study skills and much more. For more information visit the CLASS website at http://wise.fau.edu/CLASS/index.php or call (---) --------.

Technical Problem Resolution:

In the online environment, there is always a possibility of technical issues (e.g. lost connection, hardware or software failure). Many of these problems can be resolved relatively quickly, but if students wait to the last minute before due dates, the chances of these glitches affecting their success are greatly increased. Please plan ahead of time. If problems occur, it is essential that students take immediate action to document the issue. Please follow these steps should a problem occur:

1. All students can access computers in any of the FAU campuses.
2. Contact the ALEKS customer service by phone, email, or online chat.
3. Complete a Help Desk ticket at http://www.fau.edu/helpdesk. Make sure the form is filled completely and provide a full description of the problem.
4. If students do not hear back from customer service, or the Help Desk in a timely manner (48 hours), it is the student's responsibility to follow up with the appropriate person until a resolution is obtained.

Netiquette (Internet Etiquette)

Consult http://www.fau.edu/irm/about/netiquette.php for the conventions of politeness pertaining to e-mail and technology use.

By remaining enrolled in this course, you are agreeing to:

1. Uphold the Code of Academic Integrity of Florida Atlantic University, and
2. Accept accountability for the course requirements, the course expectations, and the participation policy stated in this document, and:
    a. Attend class regularly, lectures and lab sessions.
    b. Complete homework assignments as soon as possible.
    c. Attempt to do more problems other than those assign.
    d. Regularly review your notes and use supplemental materials to master concepts etc.
    e. Seek help immediately when necessary.

Communication Policy

1. Announcements: You are responsible for reading all announcements posted by the instructor. Check the announcements each time you login to be sure you have read all of them since your last login session.
2. Course-related Questions: Read the syllabus first and check the Blackboard announcements. If your question is not answered in the syllabus or in the posted announcements, e-mail your question to the instructor or PT.

3. Email Policy: email is the preferred method to contact your instructor. Except for Saturdays, Sundays, and holidays, instructors will respond to messages generally within 24 hours.

Academic Honesty:

Florida Atlantic University expects you to be honest in all of your university class work. By registering for this course, you agree to follow the academic guidelines stated in the university catalog. Instances of academic dishonesty will be prosecuted to the fullest possible extent.

Honor Code:

Students at Florida Atlantic University are expected to maintain the highest ethical standards. Academic dishonesty, including cheating and plagiarism, is considered a serious breach of these standards, because it interferes with the University mission to provide a high quality education in which no student enjoys an unfair advantage over any other. Academic dishonesty is also destructive of the University community, which is grounded in a system of mutual trust and places high value on personal integrity and individual responsibility. Harsh penalties are associated with academic dishonesty. For more information, see www.fau.edu/regulations/chapter4/4.001_Honor_Code.pdf.

Incomplete Grade Policy Statement:

A student who is passing a course, but has not completed all work due to exceptional circumstances, may, with consent of the instructor, temporarily receive a grade of

incomplete ("I"). The assignment of the "I" grade is at the discretion of the instructor, but is allowed only if the student is passing the course. The specific time required to make up an incomplete grade is at the discretion of the instructor. However, the College of Science policy on the resolution of incomplete grades requires that all work required to satisfy an incomplete ("I") grade must be completed within a period of time not exceeding one calendar year from the assignment of the incomplete grade. After one calendar year, the incomplete grade automatically becomes a failing ("F") grade.

Disability Policy Statement:

In compliance with the Americans with Disabilities Act (ADA), students who require special accommodation due to a disability to properly execute coursework must register with the Office for Students with Disabilities (OSD) – in Boca Raton, SU 133, (561) 297-3880; in Davie, MOD 1, (954) 236-1222; in Jupiter, SR 117, (561) 799-8585; or, at the Treasure Coast, CO 128, (772) 873-3305 – and follow all OSD procedures. For more information on OSD you may visit their website at http://osd.fau.edu/

Religious Accommodation Policy Statement

In accordance with rules of the Florida Board of Education and Florida law, students have the right to reasonable accommodations from the University in order to observe religious practices and beliefs with regard to admissions, registration, class attendance and the scheduling of examinations and work assignments. For further information, please see Academic Policies and Regulations at http://www.fau.edu/academic/registrar/catalog/academics.php

A word of Advice:

This is a challenging course, but one that can be easily done IF students plan their time wisely. Do not fall behind on the assignments. It there are any questions, contact the instructor immediately…Don't wait!

If any student has math anxiety or worry about being successful in the course the student is strongly suggested to read the article: Coping with Math Anxiety.

This syllabus is subject to reasonable changes at the discretion of the instructor.

Appendix G. Detailed Learning Outcomes

Prerequisite Learning Objectives for MAT-1033

1. Integers: Operations and Applications

2. Fractions and Mixed Numbers: Operations and Applications

3. Algebraic Expressions and Linear Equations in One Variable

4. Ratios, Rates, Proportions, and Percentages

Module 1 Integers: Operations and Applications

Learning Objectives

- Graph integers on a number line.
- Define the term “absolute value.”
- Evaluate the absolute value of numbers and of numerical expressions.
- Compare two integers using inequality symbols.
- Translate words and phrases involving integers into algebraic expressions
- Add, subtract, multiply, divide, and exponentiate integers
- Simplify numerical expressions involving integers using the order of operations
- Solve application problems requiring integer operations

Module 2 Rational numbers: Operations and Applications

Learning Outcomes

- Select the numerator and denominator of fractions, and identify what each represents
- Represent fractions pictorially, and determine the fraction represented by a figure
- Identify when a fraction is undefined.

- Classify fractions as proper or improper.
- Transform improper fractions into mixed numbers, and vice versa.
- Graph fractions and mixed numbers on a number line.
- Determine equivalent representations of integers, fractions and mixed numbers.
- Reduce fractions and mixed numbers to lowest terms.
- Calculate the least common denominator between two fractions.
- Compare two fractions/mixed numbers using inequality symbols.
- Determine the reciprocal of integers, fractions.
- Add, Subtract, multiply, divide, and exponentiate fractions and mixed numbers.
- Translate words and phrases involving rational numbers into algebraic expressions
- Simplify rational expressions using the order of operations, including those with absolute value.
- Solve application problems requiring operations with rational numbers

Module 3 Algebraic Expressions and Linear Equations in One Variable

Learning Objectives

- Evaluate Algebraic expressions for given values of the variable
- Simplify algebraic expressions involving one or more variables
- Determine if a given variable value is a solution to an equation in one variable
- Solve one-step linear equations in one variable using the addition property of equality

- Solve one-step linear equations in one variable requiring the multiplication property of equality
- Solve multi-step linear equations in one variable requiring both the addition and multiplication properties of equality
- Solve linear equations in one variable with variables on both sides of the equal sign
- Solve linear equations in one variable requiring the distributive property
- Solve application problems modeled by linear equations
- Solve literal equations
- Graph an inequality on a number line.

Module 4 Ratios, Rates, Proportions, and Percentages

Learning Objectives

- Define ratio, rate, and proportion
- Write ratios using reduced-fraction notation
- Write rates using reduced-fraction notation
- Determine if two rational numbers are proportional
- Set up and solve proportions
- Set up and solve application problems using ratios, rates, and proportions
- Define the term “percent.”
- Transform a percent number to a decimal number and vice versa
- Transform a percent number to a rational number and vice versa
- Solve application problems involving percentages

Module 5 the rectangular coordinate system

- Definition The rectangular coordinate system
- Plotting points on the rectangular coordinate system
- Determine if a given ordered pair is a solution of a linear equation in two variables
- graphing linear equations in two variables
- Equations of vertical and horizontal lines
- Definition and meaning of the slope of a line
- Applications of the rectangular coordinate system
- Applications of slope

Course Learning Objectives for Mat-1033

1. Simplify and evaluate algebraic expressions
2. Solve algebraic equations and inequalities involving multiple steps
3. The rectangular coordinate system and graphing linear equations in two variables, slope
4. Polynomials, quadratic expressions, and quadratic equations
5. Rational expressions and rational equations
6. Radical expressions and radical equations

Module 1: Simplify and evaluate algebraic expressions

Learning Objectives

- Evaluate the numerical values of expressions given the values of the variables.
- Identify the properties of real numbers and the distributive property
- Define the terms “variable” and “coefficient.”
- Identify like terms
- Simplify algebraic expressions using the distributive property and/or combining like terms
- Solve application problems involving algebraic expressions

Module 2: Solve algebraic equations and inequalities involving multiple steps

Learning Objectives

- Explain what it means to be a solution to an equation in one variable and write
- Determine if a given variable value is a solution to an equation
- Solve multi-step linear equations in one variable. Include equations that involve fractions and decimals
- Identify linear equations in one variable as conditional, a contradiction, or an identity and identify the solutions as a real number, the empty set, or all real numbers.
- Solve multi-step linear inequalities in one variable
- Solving application problems by setting up linear equations or inequalities

Module 3: Polynomials

Learning Objectives

- Identify polynomial expressions.

- Identify the leading term and the degree of polynomials.
- Classify polynomials as a monomial, binomial, or trinomial.
- Evaluate the numerical value of polynomial expressions given the value of the variable.
- Add, subtract, and multiply polynomials.
- Divide polynomials by monomials, binomials, and polynomials
- Factor out the GCF of polynomials' terms.
- Factor polynomial expressions by grouping, and the "AC" method
- Factor binomial expressions that are differences of perfect squares
- Factor non-prime quadratic trinomials, including perfect square trinomials.
- Solve non-prime polynomial equations in one variable by factoring.
- Solve application problems that involve setting up and solving quadratic equations

Module 4: Rational Expressions and Equations

Learning Objectives

- Determine value(s) of the variable for which rational expressions are undefined
- Simplify rational expressions by canceling common monomial and binomial factors of the numerator and denominator
- Multiply rational expressions
- Divide rational expressions
- Add and subtract rational expressions with like denominators

Module 5: Radical Expressions and Equations (Square roots only)

Learning Objectives

- Define the terms “square root,” “radical,” and “radicand.”
- Simplify square root numerical expressions.
- Identify the square root of a negative number as not real.
- Simplify square root variable expressions.
- Add and subtract square root expressions.
- Multiply square roots.
- Solve appropriate word problems using the Pythagorean Theorem.
- Rationalize the denominator (monomial denominators only).

Appendix H. Adult Consent Form

1) Title of Research Study: The Impact of "Real World" Experiences through Academic Service Learning on Students' Success Rate, Attitudes, and Motivation in Intermediate Algebra at a Public University.

2) Investigator(s)

Faculty advisor: Dr. Joseph Furner
Investigator: Mario Toussaint

3) Purpose:

The purpose of this research study is to determine whether the infusion of "real world" experiences through Academic Service Learning into an Intermediate Algebra course will have a significant impact on students' mathematics achievement, their motivation to learn mathematical concepts, and their attitudes towards mathematics learning.

4) Procedures:

- You have elected to participate in the Academic Service Learning (ASL) project for this course. Your participation in this project is completely voluntary.
- You will be asked to perform at least 20 hours of community service during the semester. This translates to an average of at least 2 hours per week for 10 weeks. The community service consists of providing math tutoring to elementary, middle, high school, or GED students. Depending on the agency you choose, you will be asked to provide at least one hour of service per visit.
- You will be asked to keep an electronic journal in Microsoft Word that details your experiences at the agency for every visit. Each journal entry should take approximately 15 minutes and will consist of at least 2 paragraph with at least 3 sentences each. It would be very helpful if you write your thoughts clearly without spelling or grammatical errors. You will be asked to upload your journal on blackboard at the end of the semester. Please address the following prompts in the journal: (1) describe your experience during your visit to the agency and the content you covered with the children or young adults, (2) in your view, how did the tutees experience the tutoring session? Were they satisfied? Provide examples, (3) is there anything else you would do differently? If yes, explain.
- You will be asked to choose one agency from the list provided and attend an orientation provided by the agency. The orientation time will be counted as a part of the number of service hours you complete.
- You will be asked to participate in a one hour training session that covers the following topics: learning styles, different models of instruction, how to interact

with students with learning disabilities, and how to foster students' critical thinking. In addition, you will be asked to go to the agency of your choice for a one-hour orientation. Those two hours will be counted as a part of your community service hours.

- You will be asked to complete two Likert scale surveys electronically, one at the beginning and one at the end of the semester. Each survey will take between 15 and 30 minutes to complete.
- No audio- or videotaping will be used unless you are chosen for an in-person interview. The interview will last for approximately 45 minutes. You have the right to decline to participate in an interview. If you agree to participate in an interview, you are giving your consent herein to be audiotaped. Interviews are not mandatory and you have the right to refuse to participate in an interview without any negative consequences. Pseudonyms will be used and your name will not be used in any publication or any other venue.
- The total time commitment required for the study is approximately 25 hours over a period of 10 weeks. This translates to an average of about 2.5 hours per week.
- The researchers contact information will be provided and you may contact them at any time if you have any concerns or issues.
- You may withdraw from the project at any time without penalty.

Initials _____

5) <u>Risks:</u>

There are no foreseeable risks associated with participating in this project; except those associated with normal daily activities such as driving a car or using public transportation. Pseudonyms will be used in all publications and your name or any other identifiable information will not be used in any publication and the data obtained by the researchers will be kept in a secure location. In addition, randomly generated numbers will replace the student identification numbers. The data will be kept in the researchers' personal computers and the files containing any data to can be used to identify you will be secured by protecting the computer and the files with passwords.

6) <u>Benefits:</u>

The potential benefits to you are:

- You will receive community services hours on your transcript.
- You will enhance your resume with community service hours.
- You will develop better understanding of course content.
- You will be involved in the community.
- You may experience personal satisfaction for helping others.

7) <u>Data Collection & Storage:</u>

You will be asked to complete two Likert Scale surveys. Each survey will take between 15 and 30 minutes to complete. The surveys will be posted on Blackboard. Blackboard is a secure educational management software that is used for the majority of course at the

university. Since most students use Blackboard anyway, there are no additional security risks associated with completing the surveys. Also, you may be asked to participate in an audio-recorded interview. The interview will last for about 45 minutes.

Any information collected about you will be kept confidential and secure. Only the researchers and the instructor of the course will have access to the data, unless required by law. The data will be kept in a password-protected computer and the files containing the information will be protected with a password. After 5 years the electronic data will be deleted. We may publish what we learn from this study. If we do, we will not let anyone know your name or identity unless you give us permission.

8) Contact Information:

- If you have questions about the study, you should call or email the principal investigator(s), Dr. Joseph Furner at (561) 799-8517 or jfurner@fau.edu; or Mario Toussaint at 954-253-8845 or mtoussai@fau.edu.
- If you have questions or concerns about your rights as a research participant, contact the Florida Atlantic University Division of Research at (561) 297-0777 or send an email to fau.research@fau.edu.

9) Consent Statement:

*I have read or had read to me the preceding information describing this study. All my questions have been answered to my satisfaction. I am 18 years of age or older and freely consent to participate. I understand that I am free to withdraw from the study at any time without penalty. I have received a copy of this consent form.

I agree ____ I do not agree ___ be audiotaped/videotaped.

Signature of Participant:_____Date:_____

Printed Name of Participant:_____

Signature of Investigator:_____Date:_____

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