EFFECTS OF MATHEMATICS INTEGRATION ON MATHEMATICAL ABILITY AND EFFICACY OF PRESERVICE TEACHERS

By

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To Papa Smith

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LIST OF ABBREVIATIONS

ANCOVA	Analysis of Covariance
AYP	Adequately Yearly Progress
CTE	Career and Technical Education
MANOVA	Multivariate Analysis of Variance
MTE	Mathematics Teaching Efficacy
MTIS	Mathematics Teaching and Integration Strategies
NCLB	No Child Left Behind
NCTM	National Council of Teachers of Mathematics
PME	Personal Mathematics Efficacy
PTE	Personal Teaching Efficacy
STEM	Science, Technology, Engineering, and Mathematics

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EFFECTS OF MATHEMATICS INTEGRATION ON MATHEMATICAL ABILITY AND EFFICACY OF PRESERVICE TEACHERS

By

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The purpose of this study was to determine the effects of mathematics teaching and integration strategies (MTIS) on preservice agricultural teachers' mathematics ability, personal mathematics efficacy, mathematics teaching efficacy, and personal teaching efficacy in a teaching methods course. The independent variable of interest was the MTIS treatment. Dependent variables included mathematics teaching efficacy, personal mathematics efficacy, personal teaching efficacy, and mathematics ability of the preservice teachers. The research was quasi-experimental and utilized a nonequivalent control group design. The sample consisted of preservice teachers enrolled in AEC 4200 *Teaching Methods in Agricultural Education* during the Fall 2011 semester at the University of Florida (n = 19). Data collected were mathematics ability (as measured by the *Mathematics Ability Test),* mathematics teaching efficacy, personal mathematics efficacy, and personal teaching efficacy (as measured by the *Mathematics Enhancement Teaching Efficacy Instrument*).

ANCOVA was used to determine if significant differences existed in mathematics ability based upon the MTIS treatment. The analysis revealed a significant difference in

the mathematics ability of preservice agricultural teachers based upon the MTIS treatment, while controlling pretest mathematics ability scores. Thus, the MTIS treatment had a positive effect on the mathematics ability scores of the preservice teachers.

MANOVAs were used to determine if significant differences existed in mathematics teaching efficacy, personal mathematics efficacy, and personal teaching efficacy based upon the MTIS treatment. The analyses did not reveal a significant difference in the mathematics teaching efficacy, personal mathematics efficacy, and personal teaching efficacy of preservice agricultural teachers based upon the MTIS treatment. Therefore, the MTIS treatment did not have an effect on the mathematics teaching efficacy, personal mathematics efficacy, and personal teaching efficacy of the preservice teachers.

Participants had low to moderate mathematics ability, were moderately efficacious in mathematics teaching efficacy, and efficacious in personal mathematics efficacy and personal teaching efficacy. This study found that a teaching methods course that utilizes the MTIS treatment can improve mathematics ability, but the treatment had no effect on the mathematics teaching efficacy, personal mathematics efficacy, and personal teaching efficacy of the preservice teachers. Based on these findings, recommendations for agricultural teacher educators and researchers were given.

CHAPTER 1
INTRODUCTION

Why are 61% of fourth grade American students, 66% of eighth grade American students (National Center for Educational Statistics, 2009b), and 74% of twelfth grade American students not proficient in mathematics (National Center for Educational Statistics, 2011)? Additionally, why do 35% of college freshmen at two year public institutions and 16% at four year public institutions participate in remedial mathematics courses (National Center for Educational Statistics, 2004)? These statistics are troubling, and a shortage of students educated in the STEM disciplines (science, technology, engineering, and mathematics) will have major economic and national security implications (PTC-MIT Consortium, 2006). With that in mind, educators are part of the answer to improving the mathematics proficiency of the nation's students, but the solution may not just fall on mathematics educators. Agricultural education and, more specifically, preservice agricultural teachers may be an integral part of the solution. Prescott, Rinard, Cockerill, and Baker (1996) stated that academic and vocational subjects should be integrated to maximize learning opportunities. To that end, agricultural education is a ripe academic area with numerous opportunities for contextualization of core academic subjects (Stripling, Ricketts, Roberts, & Harlin, 2008).

Chapter 1 will provide a historical context to the continuing national quest to solve educational deficiencies among American students and focus on the educational initiatives to date designed to correct persistent student deficiency in mathematics. More purposely, Chapter 1 will describe the role of Career and Technical Education in

improving the mathematics content knowledge of secondary students and outline a research response.

Educational Reform in the United States

The pursuit of solutions to correct the enduring problems in public schools became nationally prominent with the help of a publication known as, *A Nation at Risk: The Imperative for Educational Reform* by the 1983 National Commission on Excellence in Education (National Research Council, 1988). According to *A Nation at Risk: The Imperative for Educational Reform*, United States educational achievements had been matched and were being surpassed by other countries (National Commission of Excellence in Education, 1983). This claim was also supported by several other reports that declared that education in the United States was deteriorating (Vinovskis, 2009). As a result, reform of core academic subjects, including mathematics, became a major priority in the 1980s (Phipps, Osborne, Dyer, & Ball, 2008).

Educational Reform in the1980s

The year 1983 was a year of national concern that led to educational reform efforts by federal and state governments, schools, and colleges (U.S. Department of Education, 1984). *A Nation at Risk: The Imperative for Educational Reform* called for increasing graduation rates, higher academic standards, more instructional time, improved teacher education programs, and greater accountability for elected officials (Vinovskis, 2009). The report also found that remedial mathematics courses at four year public colleges had increased by 72% from 1975 to 1980, which represented 25% of all mathematics courses offered at those four year public colleges (National Commission of Excellence in Education, 1983).

The generally accepted theme of the 1980s educational reform movement was "more should be demanded of teachers, students, and administrators, and basic subjects and cognitive skills should be reemphasized" (National Research Council, 1988, p. 60). As a result, teacher education programs placed more emphasis on core academic subjects and field-based experiences (U. S. Department of Education, 1984). According to Vinovskis (2009), the Southern Regional Education Board was a key leader in advocating for data to compare the educational progress of the states. The Southern Regional Education Board's (1981) report, *The Need for Quality*, suggested the need for improving teaching and learning at all levels of education. In 1988, the Southern Regional Education Board released *Goals for Education: Challenge 2000,* which described the following 12 educational goals:

1. All children will be ready for the first grade (p. 10).
2. Student achievement for elementary and secondary students will be at national levels or higher (p. 11).
3. The school dropout rate will be reduced by one-half (p. 13).
4. 90 percent of adults will have a high school diploma or equivalency (p. 14).
5. 4 of every 5 students entering college will be ready to begin college-level work (p. 15).
6. Significant gains will be achieved in the mathematics, science, and communications competencies of vocational education students (p. 16).
7. The percentage of adults who have attended college or earned two-year, four-year, and graduate degrees will be at the national averages or higher (p. 18).
8. The quality and effectiveness of all colleges and universities will be regularly assessed, with particular emphasis on the performance of undergraduate students (p. 19).
9. All institutions that prepare teachers will have effective teacher education programs that place primary emphasis on the knowledge and performance of graduates (p. 20).

10. All states and localities will have schools with improved performance and productivity demonstrated by results (p. 22).

11. Salaries for teachers and faculty will be competitive in the marketplace, will reach important benchmarks, and will be linked to performance measures and standards (p 23).

12. States will maintain or increase the proportion of state tax dollars for schools and colleges, while emphasizing funding aimed at raising quality and productivity (p. 25).

In 1989, several governors led an initiative that developed national educational goals and predicted that by the year 2000 graduating high school students would be achieving high levels of academic success (National Commission on Teaching and America's Future, 1996). History has revealed their prediction did not come to fruition.

Educational Reform in the 1990s

In 1988, a campaigning future president, George H. W. Bush, declared he wanted to be the education president and lead a revitalization of quality in American schools (Walker, 1988). In 1990, President Bush unveiled the following six national goals:

1. By the year 2000, all children in America will start school ready to learn.

2. By the year 2000, we will increase the percentage of students graduating from high school to at least 90 percent.

3. By the year 2000, American students will leave grades four, eight, and twelve having demonstrated competency over challenging subject matter, including English, mathematics, science, history, and geography.

4. By the year 2000, U.S. students will be first in the world in science and mathematics achievement.

5. By the year 2000, every adult American will be literate and possess the knowledge and skills necessary to compete in a global economy and exercise the rights and responsibility of citizenship.

6. By the year 2000, every school in America will be free of drugs and violence and offer a disciplined environment conducive to learning. (Swanson, 1991, pp. 2-4)

However, reports in the early 1990s indicated that the United States was still losing ground to other countries and was ranked near the bottom on international tests in mathematics and science (National Commission on Teaching and America's Future, 1996). In 1990, 88% of fourth grade American students and 87% of eighth grade American students were not proficient in mathematics (National Center for Educational Statistics, 2009a) In 1991, U.S. 13 year olds ranked 13th out of 14 countries on the International Assessment of Educational Progress (National Commission on Teaching and America's Future, 1996).

As a result of continued educational deficiencies among U.S. students, President Clinton signed *Goal 2000: Educate America Act* into law on March 31, 1994. The purpose of the act was

> to improve learning and teaching by providing a national framework for education reform; to promote the research, consensus building, and systemic changes needed to ensure equitable educational opportunities and high levels of educational achievement for all students; to provide a framework for reauthorization of all Federal education programs; [and] to promote the development and adoption of a voluntary national system of skill standards and certifications. (P. L. 103-227, 1994, para. 1)

President Clinton's *Goals 2000: Educate America Act* declared the following eight national goals:

1. By the year 2000, all children in America will start school ready to learn.
2. By the year 2000, the high school graduation rate will increase to at least 90 percent.
3. By the year 2000, all students will leave grades 4, 8, and 12 having demonstrated competency over challenging subject matter including English, mathematics, science, foreign languages, civics and government, economics, arts, history, and geography, and every school in America will ensure that all students learn to use their minds well, so they may be prepared for responsible citizenship, further learning, and productive employment in our Nation's modern economy.

4. By the year 2000, the Nation's teaching force will have access to programs for the continued improvement of their professional skills and the opportunity to acquire the knowledge and skills needed to instruct and prepare all American students for the next century.

5. By the year 2000, United States students will be first in the world in mathematics and science achievement.

6. By the year 2000, every adult American will be literate and will possess the knowledge and skills necessary to compete in a global economy and exercise the rights and responsibilities of citizenship.

7. By the year 2000, every school in the United States will be free of drugs, violence, and the unauthorized presence of firearms and alcohol and will offer a disciplined environment conducive to learning.

8. By the year 2000, every school will promote partnerships that will increase parental involvement and participation in promoting the social, emotional, and academic growth of children. (P.L. 103-227, 1994, section 102)

Concerns over the education of American youth rose to the forefront of American politics in the mid-1990s. A Gallup poll reported the American public believed educational quality of public schools was the most important issue of the 1996 presidential election (USA Today, 1996). The Gallup poll also revealed the American public believed good teachers were vital to improving the academic success and achievement of America's student (USA Today, 1996).

The American public had valid reasons to be concerned. In 1995, U.S. fourth graders were ranked 7th among 16 countries and U.S. eighth graders were ranked 13th among 20 countries on international tests in mathematics (National Center for Educational Statistics, 2009a). Also in 1995, the Third International Mathematics and Science Study (TIMSS) indicated that a U.S. student in the final year of a secondary school scored, "on average, below the average student in 14 other countries and above the average student in two other countries" (National Center for Educational Statistics, 2000a, p. 28). Furthermore, "on the assessments in physics and advanced

mathematics, the United States was among the lowest scoring countries" (National Center for Educational Statistics, 2000a, p. 18). The National Center for Educational Statistics (2000b) reported that in 1996 only 7% of 17 year olds students in the United States could solve mathematics problems requiring several steps, and 80% of fourth grade American students and 77% of eighth grade American students were not proficient in mathematics (National Center for Educational Statistics, 2009a). As a result of continued poor academic performance in the 1990s, the National Commission on Teaching and America's Future (1996) proposed the following three premises were needed for educational reform:

1. What teachers know and can do is the most important influence on what students learn.
2. Recruiting, preparing, and retaining good teachers is the central strategy for improving our schools.
3. School reform cannot succeed unless it focuses on creating the conditions in which teachers can teach, and teach well. (p. 11)

The commission also reported a need for teacher preparation and professional development to be reinvented and organized "around standards for students and teachers" (National Commission on Teaching and America's Future, 1996, p. 11) and for teacher education programs to defragment the practice of teaching subject matter in isolation of teaching methodology.

On March 26, 1996, President Clinton's administration, the nation's governors, business leaders, and educators convened for the National Education Summit and committed

> to achieving higher academic standards for America's schools and students. The governors pledged to develop internationally competitive academic standards and assessments in each state within the next two years and to reallocate funds to provide the professional development,

> infrastructure, and new technologies needed to meet these goals. (The National Commission on Teaching and America's Future, 1996, p.3)

Also in 1996, The National Commission on Teaching and America's Future (1996) posited that when students do not succeed in school, they are less likely to be employed and be contributing members of society as compared to students 20 years ago. The commission also posited that the failure of American education would have national consequences in a global economy, and that unlike any time in our nation's history the success of the nation depended on its ability to teach. Furthermore, the commission purported that "every teacher must know how to teach students in ways that help them reach high levels of intellectual and social competence,…[and] new courses, tests, and curriculum reforms… are meaningless if teachers cannot use them productively" (National Commission on Teaching and America's Future, 1996, pp. 3-5).

As described above, competencies of teachers were held in high regard by the participants of the commission and their report provided the following about the proficiency of teaching:

> Expert teachers use knowledge about children and their learning to fashion lessons that connect ideas to students' experiences. They create a wide variety of learning opportunities that make subject matter come alive for young people who learn in very different ways. They know how to support students' continuing development and motivation to achieve while creating incremental steps that help students progress toward more complicated ideas and performances. They know how to diagnose sources of problems in students' learning and how to identify strengths on which to build. These skills make the difference between teaching that creates learning and teaching that just marks time. Needless to say, this kind of teaching requires high levels of knowledge and skill. To be effective, teachers must know their subject matter so thoroughly that they can present it in a challenging, clear, and compelling way. They must also know how their students learn and how to make ideas accessible so that they can construct successful "teachable moments." Research confirms that teacher knowledge of subject matter, student learning, and teaching methods are all important elements of teacher effectiveness. Furthermore, studies show

> that teacher expertise is the most important factor in student achievement. (National Commission on Teaching & America's Future, 1996, p.6)

Teaching is more than delivering information, testing, and grading (National Commission on Teaching and America's Future, 1996). Qualified teachers of mathematics need a deeper understanding of their subject matter, a better understanding of how students learn, the expertise to create learning experiences, and an understanding of how to motivate learners (National Commission on Teaching and America's Future, 1996). Thus, a national goal was proposed by the commission that in 2006 all American students would have "access to competent, caring, qualified teaching in schools organized for success" (National Commission on Teaching and America's Future, 1996, p. 10).

Reform in the 1990s established national goals, called attention to the need for competent teachers, and spurred the creation of content and performance standards. As a result, progress was made in establishing content and performance standards for K-12 education. According to data released by the U.S. Department of Education before the *Goals 2000: Educate America Act*, only 19 states had content standards, and none had performance standards (Vinovskis, 2009). In 1997, 42 states had content standards, and 8 states had performance standards, but by the end of 2000, all states had content standards, and 28 states had performance standards.

Educational Reform in the 2000s to the Present

As mentioned earlier, an initiative by the nation's governors did not deliver on their prediction that graduating high school students would be achieving high levels of academic success by the year 2000, and the national goals of President Bush and President Clinton did not come to fruition.

In 2000, 77% of fourth and 75% eighth grade American students were not proficient in mathematics (National Center for Educational Statistics, 2009a). As a result, most postsecondary institutions offered at least one remedial mathematics course (Parr, Edwards, & Leising, 2006). In 2003, the National Center for Educational Statistics

> determined that 71% of all Title IV, degree granting, two- and four-year institutions that admit freshmen were offering at least one remedial mathematics course. Even though two-year public schools were the most likely institutions to provide remedial courses (98% reported that they did so), public four year universities were close behind with 80% reporting that they offered at least one such course. (Parr, Edwards, & Leising, 2006, p. 81)

In 2007, the mathematics woes of American students continued to persist. On an international test in mathematics, U.S. fourth graders were ranked 11th among 36 countries, and U.S. eighth graders were ranked 9th among 40 countries (National Center for Educational Statistics, 2009a). The *Nation's Report Card: Mathematics 2009*, a published report by the National Center for Educational Statistics (2009b), reported that 61% of fourth grade students and 66% of eighth grade students were not proficient in the National Assessment of Educational Progress mathematics.

Before It's Too Late, a report by the National Commission on Mathematics and Science Teaching for the 21st Century (2000) emphasized the need for qualified mathematics and science teachers and called for "an ongoing system to improve the quality of mathematics and science teaching in grades K-12" (p. 5). This report was similar to other calls for reform issued in the 1980s and 1990s. The National Commission on Mathematics and Science Teaching for the 21st Century also claimed that the nation and its people are dependent on the American education system, its effectiveness, and more specifically the mathematics and science education of

American students. The following denotes the stance of the National Commission on Mathematics and Science Teaching for the 21st century (2000):

> Mathematics and science will also supply the core forms of knowledge that the next generation of innovators, producers, and workers in every country will need if they are to solve the unforeseen problems and dream the dreams that will define America's future. (p. 4)

The report by the National Commission on Mathematics and Science Teaching for the 21st Century proposed four reasons signifying the need for competencies in mathematics and science among American students:

1. The rapid pace of change in both the increasingly interdependent global economy and in the American workplace demands widespread mathematics- and science-related knowledge and abilities.

2. Our citizens need both mathematics and science for their everyday decision-making.

3. Mathematics and science are inextricably linked to the nation's security interests.

4. The deeper, intrinsic value of mathematical and scientific knowledge shapes and defines our common life, history, and culture. (p. 7)

Before It's Too Late also proposed two major messages: "American students must improve their performance in mathematics and science… [and] the most direct route to improving mathematics and science achievement is better mathematics and science teaching" (National Commission on Mathematics and Science Teaching for the 21st Century, 2000, p. 7).

On January 8, 2002, President George W. Bush signed into law the Elementary and Secondary Education Act of 2001, known as the No Child Left Behind Act. Major initiatives of the legislation were to improve the academic success of American students, prepare and recruit highly qualified teachers, and establish national accountability for American schools (U. S. Department of Education, 2002). No Child

Left Behind established periodic assessments in mathematics and reading and demanded highly qualified teachers. More specifically, No Child Left Behind sought to increase elementary and secondary students' mathematics achievement and increase the "subject matter knowledge and teaching skills" (U. S. Department of Education, 2002, p. 69) of mathematics teachers. Thus, this legislation supported the calls for better teaching of the 1980s and 1990s (National Commission on Mathematics and Science Teaching for the 21st Century, 2000; National Commission on Teaching and America's Future, 1996; National Research Council, 1983) and the national goal proposed by the National Commission on Teaching and America's Future in 1996 of providing all American students with qualified teachers.

In an effort to "turn our schools around" (para. 1), the National Governors Association Center for Best Practices and the Council of Chief State School Officers (2010) released their Common Core State Standards for K-12 education (Association of Public and Land-Grand Universities, 2010). According to the National Governors Association and the Council of Chief State School Officers (2010),

> the Common Core State Standards provide a consistent, clear understanding of what students are expected to learn, so teachers and parents know what they need to do to help them. The standards are designed to be robust and relevant to the real world, reflecting the knowledge and skills that our young people need for success in college and careers. With American students fully prepared for the future, our communities will be best positioned to compete successfully in the global economy. (Mission statement, para 1)

The new Common Core Standards place an "increasingly high level of demand that our teachers have a more sophisticated and deeper understanding of mathematics" (Michigan State University Center for Research in Mathematics and Science Education, 2010, p. 19).

In 2007, the National Governors Association called for K-12 teachers that were qualified in the STEM (science, technology, engineering, and mathematics) disciplines to aid in "developing innovative goods, services, and processes that can be sold in the national and international marketplace" (p. 3). The report by the National Governors Association (2007) also called for accountability among STEM teacher preparation programs and suggested the following accountability measures:

1. Greater impact of teacher preparation program graduates on public school student achievement.
2. Higher teacher program graduate scores on exit and/or licensure exams.
3. Higher teacher satisfaction with their preparation programs.
4. Higher principal satisfaction with recent hires from preparation programs. (p. 12)

The National Governors Association (2007) also posited that "state postsecondary systems often lack clear, well-articulated expectations for individual institutions, including how they are to relate to one another and to industry, communities, and K-12 education" (p. 3). The report also stated that postsecondary institutions are now obligated to provide more remedial math and English courses, which signifies a lack of college readiness among high school graduates.

A report by Michigan State University Center for Research in Mathematics and Science Education (2010) reported that preservice teachers in the United States receive weak preparation in mathematics and are ill-prepared to teach a demanding mathematics curriculum that is severely needed to compete internationally. The Michigan State University Center professed that teacher education programs must educate preservice teachers not only in formal mathematics but also in the practical teaching of mathematics. The Center also described the mathematics deficiency

among teachers as moving from a gathering storm to a perfect storm because of the adoption of more challenging and rigorous mathematics standards in which teachers do not possess the necessary competencies to teach. The report also indicated, "not surprisingly," (Michigan State University Center for Research in Mathematics and Science Education, 2010, p. 15) that U. S. preservice teachers' international performance was consistent with the uninspiring U. S. students' international performance. For that reason, a charge was given to

> break the vicious cycle in which we find ourselves – where the weak K-12 mathematics curriculum taught by teachers with an inadequate mathematics background produces high school graduates who are similarly weak. Some of them then become future teachers who are not given a strong preparation in mathematics, and then they teach and the cycle continues. (Michigan State University Center for Research in Mathematics and Science Education, 2010, p. 3)

According to National Research Council (2009),

> few academic institutions provide explicit training in critical thinking and analysis, and few classroom experiences challenge students in this regard. Moreover, mathematical analysis is often not incorporated into the classes beyond a very basic level, and students have few opportunities to engage in quantitative reasoning. For example, students are rarely presented with real data or asked to suggest a strategy when the data do not point to a single 'correct' answer. Textbook examples often downplay confounding data and simplify scenarios. Even laboratory and field experiences may involve some means of data cleaning so that students will be able to draw the 'correct' inferences. The natural environment can make pedagogical activities more difficult, but it is vital that students have the opportunity to engage with real-world systems and to be forced to evaluate disparate data; they should be asked to make decisions on the basis of these data and to explain and defend their choices. (pp. 41-42)

"Today the states have become partners with federal governments in developing and implementing NCLB [No Child Left Behind], and states are allowed to set their own student academic content and performance standards as well as define what constitutes highly qualified teachers" (Vinovskis, 2009, pp. 1-2). According to Vinovskis

(2009), financial support for K-12 education has increased significantly due to various educational reform efforts, but America has “failed to meet the promised bipartisan targets under Goal 2000 and NCLB” (p. 207) of delivering quality education for America’s children.

Educational Reform: Career and Technical Education

In 1996, the National Association of Secondary School Principals called for an integrated curriculum and suggested that teaching content in isolation distorts knowledge. The National Association of Secondary School Principals also stated that curricula should allow students to apply their knowledge to real-life scenarios or authentic experiences, thus aiding students in linking their educational experiences to future use. Similarly, the National Research Council (1988) stated that for agricultural education to continue to produce highly qualified graduates there must be an emphasis on traditional academic skills through an integrated curriculum.

Mathematics educators have also seen the need for an integrated curriculum and have called for contextualized learning activities (Shinn et al., 2003). Swartz (2003) professed,

> there is a great deal of qualitative and anecdotal evidence from school classrooms that infusion [or contextualized] lessons both improve student thinking and enhance content learning. Teachers report that student interest in their learning improves, their understanding of the content they are learning deepens, many students do better on content-area tests, and many students begin using the thinking strategies introduced in these lessons…. When using infusion [or contextualization] as an approach to teaching thinking and enhancing learning, the learning students engender will prepare them to enter an increasingly complex and technological world with skills that they will need to use information meaningfully, to make sound judgments, and to develop confidence in themselves as thoughtful people. (pp. 247-249)

Bailey (1998) suggested that broad based occupational areas such as agriculture can provide a meaningful context for mathematics. Taylor and Mulhall (1997) stated that agriculture could act as a unifying theme of curricula and provide real world meaning. Shinn et al. (2003) proclaimed that “secondary agricultural education, through the use of relevant curriculum delivered from a student-centered perspective by skillful teachers, has high potential for engaging students in active, hands-on/minds-on learning environments rich with opportunities for learning mathematics” (p. 23). Shinn et al. also called for the agricultural education profession to embrace the role of improving mathematics achievement of secondary students.

Before Shinn et al.’s call the National Research Council (1988) called for secondary agricultural education to become more than vocational agriculture, to prepare students for careers that require competencies in science and mathematics, and to help students to effectively use new technologies. The National Research Council also posited that “teacher preparation and in-service education programs must be revised and expanded to develop more competent teachers” (pp. 6-7) of agriculture to make the fundamental shift described above.

In the 1990s, “mathematics education researchers (Parnell, 1995; Romberg & Kaput, 1999)… [emphasized that] the current direction of math education is toward a more practical or meaningful and ‘connected’ form of teaching and learning” (Shinn et al., 2003, p.14). In 2003, Shinn et al. purported that “contextual relationships have the potential to strengthen linkages among the learning environments of school, home, and community and add meaning to mathematics for students” (p. 5). A report published by the National Council for Agricultural Education in 2003, outlined 12 promising practices

that teachers should implement in an attempt to increase student achievement in mathematics, and stated that the key to obtaining "higher student achievement in math is dependent on the interaction of contextually rich curriculum and inquiry-based instructional strategies supported by effective teacher preparation and professional development activities" (Shinn et al., 2003, p. 29). According to Myers and Thompson (2009),

> professional development is paramount to moving the profession forward in integrating academics into agricultural education programs. Instruction in integrating math, science, and reading at the preservice and inservice levels are professional growth functions that should be embraced at the national, regional, state, university, and local levels. (p. 83)

In 2006, Stone et al. posited that career and technical education provides a context for using an integrated curriculum to teach mathematics and facilitates the transferability of skills. Research has shown that teaching mathematics concepts found within career and technical education coursework improved "students' performance on standardized measures of mathematics" (Stone et al., 2006, p. 69). Nonetheless, "CTE [Career and Technical Education] educators are not trained to teach math, however, explicit math content, such as algebraic formulas, rarely makes it onto the blackboard" (Stone et al., 2006, p. 4). To that regard, Stone et al. (2006) emphasized the following five core principles that will be discussed further in Chapter 2 for enhancing mathematics in Career and Technical Education:

1. Develop and sustain a community of practice among the teachers.
2. Begin with the CTE curriculum and not the math curriculum.
3. Understand that math is an essential workplace skill.
4. Maximize the math in the CTE curriculum.

5. Recognize that CTE teachers are teachers of math-in-CTE, and not math teachers. (p. 69)

Stone et al. also called for the Math-in-CTE model, which contributed to the increase in mathematics performance on standardized measures reported above, to be utilized by teacher education programs as a means of teaching future educators how to teach contextualized mathematics.

The federal Carl D. Perkins Career and Technical Education Improvement Act of 2006 required career and technical courses to contain academic content and "*provides states with unprecedented latitude and funding* that may be used to align CT [career technical] studies with broader high school reform" (Bottoms & Young, 2008, p. ii). According to a report published in 2008 by the Southern Regional Education Board,

> education chiefs, CTE [Career and Technical Education] leaders and other decision-makers from 12 states… explore[d] more deeply the significant contributions career/technical education can make to high school reform. The conference…marked a decisive first step in crafting a new vision for high school success — one that calls on states and school systems to break free of long-held beliefs about the sharp division between academic and career/technical education and weld the strongest elements of both into a powerful engine of reform. (Bottoms & Young, 2008, p. ii)

The Educational leaders mentioned above issued the following challenges for state educators and policy makers:

Challenge 1: Align new and existing career/technical curricula with essential college- and career-readiness standards.

Challenge 2: Create a flexible system of optional career pathways in high schools to better prepare all students for college and careers.

Challenge 3: Create a policy framework that keeps students' future options open by developing career/technical and academic programs that: (1) link high school to postsecondary studies and work, (2) blend academic and technical studies, and (3) connect students to a goal.

Challenge 4: Assess the contributions career/technical education can make to improving academic and technical achievement.

Challenge 5: Prepare and enable career/technical teachers to teach essential academic skills through application in authentic activities, projects and problems. (Bottoms & Young, 2008, p. iii)

"For too long, states have overlooked the contributions that high quality CTE can make in solving the persistent problem of high school underachievement" (Bottoms & Young, 2008, p. iii).

> Research shows that good CTE programs can reduce high school dropout rates and increase the earning power of high school graduates. More students stay in school when they can concentrate on career and technical studies. Students who struggle to learn specific academic skills in a traditional classroom environment are often better served through the project-based learning and problem-solving strategies that are hallmarks of today's best CT courses. (Bottoms & Young, 2008, p. i)

In view of that, Parnell (1996) stated,

> no longer can the debate over the importance of vocational or academic programs be allowed to degenerate into an either/or argument. The basis for good teaching is combining an information rich subject matter content with an experience rich context of application. (p. 1)

Statement of the Problem

Mathematic deficiencies of elementary, secondary, and postsecondary students continue to persist almost thirty years after the published report, *A Nation at Risk: The Imperative for Educational Reform* (National Commission of Excellence in Education, 1983). The lack of mathematics proficiency among U. S. students is well documented (Michigan State University Center for Research in Mathematics and Science Education, 2010; National Center for Educational Statistics, 2000a, 2000b, 2004, 2009a, 2009b, 2010, 2011; National Commission of Excellence in Education, 1983; U.S. Department of Education, 2002), and large scale reform efforts have failed to significantly improve K-12 education (Vinovskis, 2009). Furthermore, many preservice teachers, who will be charged with improving the mathematical ability of American students, are not proficient

in mathematics; this has created a troubling cycle in which teachers that are not proficient in mathematics are producing students with mathematical deficiencies, who then become the next generation of mathematics deficient teachers (Michigan State University Center for Research in Mathematics and Science Education, 2010).

As a result, there have been numerous calls for all subject areas to contribute to the learning of academic content, but preservice agricultural teachers are ill-prepared to make a meaningful contribution (Stripling & Roberts, in press). Therefore, the fundamental problem this study addressed is the lack of mathematics proficiency among the nation's preservice agricultural education teachers.

Purpose of the Study

The purpose of this study was to determine the effects of mathematics teaching and integration strategies (MTIS) on preservice agricultural teachers' mathematics ability, personal mathematics efficacy, mathematics teaching efficacy, and personal teaching efficacy in a teaching methods course.

Statement of Objectives

The following objectives framed this study:

1. Determine the effects of mathematics teaching and integration strategies in the teaching methods course on mathematics ability.
2. Determine the effects of mathematics teaching and integration strategies in the teaching methods course on personal mathematics efficacy.
3. Determine the effects of mathematics teaching and integration strategies in the teaching methods course on mathematics teaching efficacy.
4. Determine the effects of mathematics teaching and integration strategies in the teaching methods course on personal teaching efficacy.

Statement of Hypotheses

The research questions were framed as null hypotheses for statistical analysis, and the significance level of .05 was determined a priori.

H_{01} – There is no significant difference in the mathematics ability of preservice agricultural education teachers based upon the mathematics teaching and integration strategies treatment.

H_{02} – There is no significant difference in the personal mathematics efficacy of preservice agricultural education teachers based upon the mathematics teaching and integration strategies treatment.

H_{03} – There is no significant difference in the mathematics teaching efficacy of preservice agricultural education teachers based upon the mathematics teaching and integration strategies treatment.

H_{04} – There is no significant difference in the personal teaching efficacy of preservice agricultural education teachers based upon the mathematics teaching and integration strategies treatment.

Significance of the Study

This study seeks to add to the limited knowledge of preservice agricultural education teachers' mathematics ability, personal mathematics efficacy, mathematics teaching efficacy, and personal teaching efficacy. In addition, this study provides information on the effectiveness of math teaching and integration in preservice teacher education programs, and this information will be significant to agricultural teacher educators. The results of this study could provide valuable insight into improving the mathematics teaching of future secondary agricultural educators, thus improving the mathematics content knowledge of secondary students (Hill, Rowan, & Ball, 2005; National Commission on Mathematics and Science Teaching for the 21st Century, 2000; National Commission on Teaching and America's Future, 1996; Sikula, Buttery & Guyton, 1996). This information will be significant to secondary students, because

“students have a competitive advantage when they are able to draw upon meaningful scientific knowledge and functional mathematical skills” (Shinn et al., 2003, p.6)

Information on effective ways to improve mathematics content knowledge of secondary students will also be meaningful and significant for national, regional, state, university, and local educational leaders seeking to improve mathematics proficiency and prepare American students for careers in the STEM (science, technology, engineering, and mathematics) disciplines – projections show a 22% increase in job opening by 2014 (Terrell, 2004). This information will also aid secondary schools in meeting Adequately Yearly Progress (AYP)/benchmarks established by the No Child Left Behind Act. Improved content knowledge of American students will assist the United States in maintaining food safety and security, sustainable natural resources (Shinn et al., 2003), and avert major economic and national security disasters (PTC-MIT Consortium, 2006).

This research will answer the call of the National Research Agenda for Agricultural Education and Communication by adding literature to the following priority areas:

Priority 3: Sufficient scientific and professional workforce that addresses the challenges of the 21st century

Priority 4: Meaningful, engaged learning in all environments

Priority 5: Programs of demonstratable efficiency and effectiveness. (Doerfert, 2011, pp. 9-10)

Based on the aforementioned research priority areas and the information presented above, literature regarding improved mathematics proficiency among American students would be significant to postsecondary agricultural educators, preservice teachers, secondary students, industry leaders, national economic and security leaders, and national, regional, state, university, and local educational leaders.

Definition of Terms

The following terms have been operationally defined for the objectives of this study:

1. *Math-enhanced lesson* is an agricultural lesson that incorporates Stone, Alfeld, Pearson, Lewis, and Jensen's (2006) seven components of a math-enhanced lesson.

2. *Mathematics ability* is defined by the students' scores on the 26 items that are contained on the *Mathematics Ability Test*, which is a researcher developed instrument.

3. *Mathematics teaching efficacy* is a person's self-belief about their capabilities to teach mathematics. In this study, mathematics teaching efficacy was defined as the student's score on 13 items contained in the *Mathematics Enhancement Teaching Efficacy Instrument* by Jansen (2007).

4. *Personal mathematics efficacy* is a person's self-belief about their capabilities to solve mathematics problems. In this study, personal mathematics efficacy was defined as the student's score on 8 items contained in the *Mathematics Enhancement Teaching Efficacy Instrument* by Jansen (2007).

5. *Personal teaching efficacy* is a person's self-belief about their capabilities to teach. In this study, personal teaching efficacy was defined as the student's score on 12 items contained in the *Mathematics Enhancement Teaching Efficacy Instrument* by Jansen (2007).

6. *Preservice agricultural teachers* are agricultural education majors in their final year of a teacher preparation program.

7. *Teaching methods course* is the instructional methodology course that "focuses on the selection and use of teaching strategies, methods/approaches, and techniques; evaluating learning; and managing learning environments for teaching agricultural subjects in formal educational settings" (Roberts, 2009, p. 1).

8. *Mathematics teaching and integration strategies* is the incorporation of the following three elements into a teaching methods course: (a) a lecture on the seven components of a math-enhanced lesson, (b) random assignment of the National Council of Teachers of Mathematics sub-standards among the preservice teachers, and (c) requiring two of the micro-teaching lessons to be math-enhanced.

Limitations of the Study

The results of this study are subject to the following limitations:

A random sample of preservice teachers was not selected due to the fact that the preservice teachers self-registered for a teaching methods lab section that best fit their schedule of classes, thus the preservice teachers were not randomly assigned to their teaching methods lab sections. Therefore, the findings of this study should not be generalized beyond the sample, unless data confirms the sample is representative of other populations of preservice agricultural education teachers.

Assumptions of the Study

The following assumptions were made for the purposes of this study:

1. Participants involved in the study performed to the best of their ability.
2. Participants involved in the study responded truthfully.
3. Mathematics ability, personal mathematics efficacy, mathematics teaching efficacy, and personal teaching efficacy were measured accurately.

Chapter 1 Summary

Chapter 1 provided a historical context to the continuing national quest to solve educational deficiencies among American students and focused on the educational initiatives to date designed to correct persistent student deficiency in mathematics. More purposely, Chapter 1 described the role of career and technical education in improving the mathematics content knowledge of secondary students and outlined a research response.

The reform efforts of the 1980s focused on demanding more from teachers, students, and administrators and called for a reemphasis on basic subjects and cognitive skills (National Research Council, 1988). This was a result of long standing

academic underachievement by American students (National Research Council, 1988) and a loss of educational standing in the world (National Commission of Excellence in Education, 1983).

The 1990s were a time of public concern over education, and a Gallup poll reported that education was the most important issue in the 1996 Presidential election (USA Today, 1996). Teachers were also believed to be one of the most vital aspects of improving American students' academic success (National Commission on Mathematics and Science Teaching for the 21st Century, 2000; National Commission on Teaching and America's Future, 1996; USA Today, 1996). The 1990s were also a time when the United States was still losing ground to other countries educationally (The National Commission on Teaching and America's Future, 1996). Reform in the 1990s established national goals, called attention to the need for competent teachers, and spurred the creation of content and performance standards.

Educational findings similar to the 1980s and 1990s have been reported in the 21st century. Reports from the National Center for Education Statistics (2000a, 2000b, 2004, 2009a, 2009b, 2010) still revealed that deficiencies in mathematics continue to persist among American students. In 2002, the No Child Left Behind Act was signed into law and called for highly qualified teachers and the establishment of national accountability for American schools (U. S. Department of Education, 2002). The National Governors Association (2007) called for K-12 teachers that were qualified in the STEM (science, technology, engineering, and mathematics) disciplines, and the National Commission on Mathematics and Science Teaching for the 21st Century (2000) purported the need for qualified mathematics and science teachers. The

National Commission on Mathematics and Science Teaching for the 21st Century (2000) also purported that the nation and its people have been dependent on the American education system, its effectiveness, and more specifically the mathematics and science education of American students.

Chapter 1 reported that career and technical education was found to possess great potential for improving the mathematics proficiency among American students though the use of an integrated curriculum (Bailey, 1998; Bottoms & Young, 2008; Shinn et al., 2003; Stone et al., 2006). In the 1990s, "Mathematics education researchers (Romberg & Kaput, 1999; Parnell, 1995)… [emphasized that] the current direction of math education is toward a more practical or meaningful and 'connected' form of teaching and learning" (Shinn et al., 2003, p.14). In 2003, Shinn et al. professed "contextual relationships have the potential to strengthen linkages among the learning environments of school, home, and community and add meaning to mathematics for students" (p. 5).

In 2006, Stone et al. emphasized that career and technical education provides a context for teaching mathematics, and found that teaching mathematics concepts occurring naturally within career and technical education coursework improved "students' performance on standardized measures of mathematics" (p. 69). As a result, Stone et al. also called for the Math-in-CTE model which contributed to the increase in mathematics performance on standardized measures reported above to be utilized by teacher education programs.

Shinn et al. (2003) proclaimed that "secondary agricultural education, through the use of relevant curriculum delivered from a student-centered perspective by skillful

teachers, has high potential for engaging students in active, hands-on/minds-on learning environments rich with opportunities for learning mathematics" (p. 23). Shinn et al. also called for the agricultural education profession to embrace the role of improving mathematics achievement of secondary students.

The objectives of this study were framed based on the aforementioned information. The purpose of this study was to determine the effects of MTIS on preservice agricultural teachers' mathematics ability, personal mathematics efficacy, mathematics teaching efficacy, and personal teaching efficacy in a teaching methods course.

The results of this study could provide valuable insight into improving the mathematics teaching of future secondary agricultural educators, thus improving mathematics content knowledge of secondary students (Hill, Rowan, & Ball, 2005; National Commission on Mathematics and Science Teaching for the 21st Century, 2000; National Commission on Teaching and America's Future, 1996; Sikula, Buttery & Guyton, 1996). Based on the above mentioned statement, this information would be significant to post-secondary agricultural educators, preservice teachers, secondary students, industry leaders, national economic and security leaders, and national, regional, state, university, and local educational leaders.

Chapter 1 also operationalized terms important to this study and recognized the limitations and assumptions of the study. Chapter 2 outlines and describes the study's theoretical framework and reviews literature pertinent to the study.

CHAPTER 2
REVIEW OF LITERATURE

Chapter 1 provided a historical context to the mathematics deficiency among American students that has continually persisted for over 30 years and that mathematics deficiency provided the basis for this study. The purpose of this study was outlined, which was to describe the effect of a mathematics integration treatment in a teaching methods course on preservice agricultural teachers' mathematics ability, personal mathematics efficacy, mathematics teaching efficacy, and personal teaching efficacy. Chapter 1 also provided the objectives that framed this study, along with the hypotheses. Key terms were defined and assumptions and limitations were stated.

Chapter 2 introduces constructivism and describes the theoretical framework and the conceptual model utilized to guide this study. Additionally, Chapter 2 will present prominent literature related to the various components of the conceptual model utilized in this study.

Constructivism

Constructivism is the grand theory encompassing this study. According to Doolittle and Camp (1999), constructivism is the construction of meaning from a learner's active participation in experiences. Constructivism is not seen as a single theoretical position but as a continuum that is usually divided into three categories: cognitive constructivism, social constructivism, and radical constructivism. Cognitive constructivism suggests that learning is the "process of internalization and (re)construction of external reality" (Doolittle & Camp, 1999, p. 7). Social constructivism focuses on "shared social experience and social negotiation of meaning" (Doolittle &

Camp, 1999, p. 9). Radical constructivism suggests that knowledge is subjective and is constructed internally by the learner (Doolittle & Camp, 1999).

The primary focus of constructivism is cognitive development and deep understanding that "construes learning as an interpretive, recursive, nonlinear building process by active learners interacting with their surround–physical and social world" (Fosnot, 2005, p. 34). Constructivists believe learning is development; a state of imbalance facilitates learning, reflection drives learning, and social interactions provoke further thinking (Fosnot, 2005). The following are essential factors of constructivist pedagogy:

> Learning should take place in authentic and real-world environments…. Learning should involve social negotiation and mediation…. Content and skills should be made relevant to the learner…. Content and skill should be understood within the framework of the learner's prior knowledge…. Students should be assessed formatively, serving to inform future learning experiences…. Teachers serve primarily as guides and facilitators of learning, not instructors…. Teachers should provide for and encourage multiple perspectives and representations of content. (Doolittle & Camp, 1999, pp.9-13)

Fosnot (1996) and Schunk (2004) concurred that constructivism has a theoretical foundation entrenched in Sociocultural Theory (Vygotsky, 1978) and the Theory of Cognitive Development (Piaget, 1972). According to Brooks and Brooks (1993) and Fosnot, constructivism is a theory about knowledge, thinking, and learning, not a theory about teaching. "Constructivism in the context of teaching promotes students to think, create, and be engaged in the learning process" (Thoron, 2010, p.45). More specific to mathematics,

> many contemporary theorists contend that constructivism represents a viable model for explaining how mathematics is learned (Cobb, 1994; Lampert, 1990; Resnick, 1989). Like many other forms of knowledge, mathematical knowledge is not passively absorbed from the environment

> but rather is constructed by individuals as a consequence of their interactions. (Schunk, 2000, p. 284)

Theoretical Framework

Albert Bandura's (1986) social cognitive theory served as the theoretical framework for this study. Social cognitive theory seeks to explain the cognitive developmental changes experienced by people during a lifetime and provides a foundation for social learning (Bandura, 1989). Theory asserts that cognitive development includes multifaceted sequences over time, and that most cognitive skills are socially cultivated (Bandura, 1986). The theory also asserts that cognitive change or "learning requires certain prior capabilities" (Bandura, 1986, p. 487). The symbolizing capability allows people to adapt and change their environment; the forethought capability allows people to anticipate behavioral consequences and motivate themselves based on expected results; the vicarious capability allows for observational learning; the self-regulatory capability allows people to regulate their behavior by examining internal standards and their responses to their prior actions; the self-reflective capability allows people to examine their thought processes and to analyze their personal experiences (Bandura, 1986). Thus, people have the ability to shape direct and vicarious experiences into many forms within biological limits (Bandura, 1986). "Patterns of human behavior are organized by individual experiences and retained in neural codes, rather than being provided ready-made by inborn programming" (Bandura, 1986, p. 22). Furthermore, human thought and conduct are influenced by the interaction of experiential and physiological factors (Bandura, 1986). "Social Cognitive Theory encompasses a large set of factors that operate as regulators

and motivators of established cognitive, social, and behavioral skills" (Bandura, 1997, p. 35).

Triadic Reciprocality

Bandura (1977, 1978, 1982, 1986, 1989, 1997) described behavior using the framework of triadic reciprocality or reciprocal interactions among behavior, environmental influences, and personal factors.

> In the social cognitive view people are neither driven by inner forces nor automatically shaped and controlled by external stimuli. Rather, human functioning is explained in terms of a model of triadic reciprocality [see Figure 2-1 on page 88] in which behavior, cognitive and other personal factors, and environmental events all operate as interacting determinants of each other. (Bandura, 1986, p. 18)

The interacting determinants of the triadic reciprocality model influence each other bidirectionally (Bandura, 1986). However, according to Bandura (1997), the reciprocal interactions are not of equal strength, and one determinant may demonstrate dominance over the others; although, in most situations, the determinants are vastly interdependent. Furthermore, time is needed for casual factors to exercise their influence, and that time makes it possible for one to study or understand the reciprocal causations (Bandura, 1997).

The reciprocal causation of personal factors and behavior can be characterized as the interaction between one's cognitive processes and one's actions (Bandura, 1989). Therefore, "what people think, believe, and feel affect how they behave" (Bandura, 1986, p. 25), and in return, behavior affects a person's thoughts and emotions (Bandura, 1989). Additionally, personal factors include the biological properties of a person (Bandura, 1989). For instance, the physical structure of the brain affects

behavior, and the reciprocal interaction is the effect of behavioral experiences on the structure of the brain (Bandura, 1989).

The reciprocal causation of environmental influences and personal factors can be described as the interaction between the environment and a person's thoughts, beliefs, and emotions (Bandura, 1989). A person's thoughts, beliefs, and emotions are shaped by social influences (Bandura, 1989). In addition, a person's social status and physical characteristics (e.g., age, size, race, and gender) alters their social environment (Bandura, 1989).

The reciprocal causation of behavior and environmental influences can be characterized as behavior modifying environmental conditions and those conditions affecting behavior (Bandura, 1989). The environment is not conceptualized as a fixed entity but is shaped by personal and behavioral influences (Bandura, 1989). According to Bandura (1989) most facets of the environment do not exert influence unless the environment is activated by an appropriate behavior, thus a person's actions affect environmental causation.

For this study, the behavior or teaching contextualized mathematics, the environment or the teacher education program and the teaching methods course, and personal factors or demographic variables, mathematics teaching efficacy, personal teaching efficacy, personal mathematics efficacy, and mathematics ability influence each other biodirectionally (Figure 2-2, p. 88).

Behavior: Teaching Contextualized Mathematics

The variable that will be discussed in this section is the act of teaching contextualized mathematics. In the aforementioned theoretical and conceptual frameworks, teaching contextualized mathematics is a behavior. When examined

through the theoretical lens of social cognitive theory (Bandura, 1986) teaching mathematics found naturally in agriculture or contextualized mathematics is influenced bidirectionally by environmental and personal determinants within triadic reciprocal causation (Bandura, 1977, 1978, 1982, 1986, 1997). The behavior of teaching agriculture has also been influenced by the call to integrate academic subjects within career and technical education. As stated previously, “the basis for good teaching is combining an information rich subject matter content with an experience rich context of application” (Parnell, 1996, p.1).

> Expectations and ideals endorsed by current reform efforts in mathematics education (e.g., NCTM, 2000) challenge prospective teachers in their thinking about mathematics teaching and learning. Teachers are asked to teach in ways that promote an integrated, connected view of mathematics, rather than a procedural, rule-based view. (Benken & Brown, 2008, p. 1)

As a result, emphasis has been placed on teaching academic subjects in context. Contextualized learning advocates that neither general education nor vocational education can be taught in isolation but must be integrated to maximize the benefit for the learner (Prescott, Rinard, Cockerill, & Baker, 1996). Agricultural education is a ripe academic area with numerous opportunities for contextualization (Stripling, Ricketts, Roberts, & Harlin, 2008).

The mathematics integration literature specific to agricultural education is limited. However, several studies have been conducted to test the effectiveness of the Math-in-CTE model (Stone et al., 2006), which is discussed in greater detail later in Chapter 2, on various product variables (Dunkin & Biddle, 1974). In a study of 38 secondary agricultural classes, Parr, Edwards, and Leising (2006) sought to determine if students that participated

> in a contextualized, mathematics-enhanced high school agricultural power and technology curriculum and aligned instructional approach would develop a deeper and more sustained understanding of selected mathematical concepts than students who participated in the traditional curriculum, thus resulting in less need for postsecondary mathematics remediation. (p. 84)

Results indicated that the math-enhanced agricultural power and technology curriculum significantly affected a "student's need for postsecondary mathematics remediation" (Parr et al., 2006, p. 1) as determined by the students score on the postsecondary mathematics placement test. Students who took part in the math-enhanced curriculum were less likely to need postsecondary remediation. The practical significance of the finding was reported to be a large effect – Cohen's *d* of .83. In a similar study published in 2008, Parr, Edwards, and Leising investigated if students in a math-enhanced agricultural power and technology course would differ significantly from students in a traditional agricultural power and technology course in their technical skill acquisition. The findings revealed no significant difference, thus the math-enhanced agriculture power and technology curriculum did not lessen technical skills. In a third study investigating the effects of a math-enhanced agricultural power and technology curriculum, Parr, Edwards, and Leising (2009) did not find a significant difference in the mathematics ability of the secondary students. Parr et al. (2009) hypothesized that this may have been due to the fact "of incomplete implementation of the treatment as reported by some experimental teachers coupled with an intervention time frame of only one semester" (p. 1).

The Young, Edwards, and Leising (2008, 2009) inquiries were very similar to the studies of Parr, Edwards, and Leising (2006, 2008, 2009). Young et al. (2008) sought to determine if mathematics enhanced agricultural power and technology curriculum

would significantly increase the mathematical ability of the participants compared to a traditional mathematics agricultural power and technology curriculum. The study consisted of 32 Oklahoma high school classes, but the results did not show a significant statistical difference in mathematics ability between the experimental and control groups. However, the authors reported that the results revealed practical significance and that the effect size was small (Young et al., 2008). In 2009, Young et al. published a second study that mirrored Parr et al. (2008). However, this investigation was a one year analysis verses a semester long analysis. The results also mirrored the results of Parr et al. (2008) in which technical competence was not diminished by the mathematics enhanced curriculum.

Furthermore, related to the behavior of teaching contextualized mathematics is science integration (Phipps, Osborne, Dyer, & Ball, 2008). According to Phipps, Osborne, Dyer, and Ball (2008), the call for science to be integrated into secondary agricultural education has contributed to the development of agriscience programs and coursework. Research on effective agriscience teaching includes strategies for teaching mathematical competencies (Phipps et al., 2008). Moreover, research has shown that mathematics teaching is associated with increases in science achievement (Phipps et al., 2008). However, in a synthesis of agricultural teacher education programs, Myers and Dyer (2004) discovered a gap in the literature on how agricultural teacher education programs should prepare preservice teachers to meet the academic demands of agriscience teaching.

The integration of mathematics content has also been extended to other career and technical education programs (Stone et al., 2006). To that end, Stone et al. (2006)

experimentally tested a “model for enhancing mathematics instruction in five high school career and technical education (CTE) programs (agriculture, auto technology, business/marketing, health, and information technology)” (p. ix). Each program area was considered a replication of the experimental study. The study was conducted for one academic school year, and the combined number of participants from each program area/sample consisted of 236 career and technical teachers, 104 math teachers, and 3,950 students from 12 states. The career and technical educators had a mathematics teacher partner that provided support in developing math-enhanced lessons and suggested instructional methodologies. Survey data collected from the participants of the study indicated that the “pedagogic framework to be ‘very effective’” (Stone et al., 2006, p. 40). Stone et al. found that the math-enhanced curriculum did not reduce the secondary students’ technical skill or occupational content knowledge. Three mathematics assessments (TerraNova, ACCPULACER, and WorkKeys) were given to determine if the Math-in-CTE model improved the mathematics ability of the secondary students. The TerraNova scores of the experimental group showed a positive increase in scores by slightly more than 4% and the experimental effect was reported to be a moderate or medium effect, according to Cohen. The experimental condition accounted for 13% of the variance in the classes. The ACCPULACER scores for the experimental group were also found to be higher than the control by almost 3%, and the experimental condition accounted for 10% of the variance in the classes. The effect size was determined to also be a moderate or medium effect. The third test, WorkKeys, did not reveal a significant difference in the experimental and control group scores. The researchers stated that the pretest scores were higher on the WorkKeys

test than the TerraNova and ACCPULACER. The researchers hypothesized that an effect may not have been detected because the WorkKeys test contained lower level math questions.

Qualitative data indicated that the Math-in-CTE model was a positive experience for the teachers and students. The teachers considered the model to be effective and perceived it as a true model of integration. Many teachers felt that the Math-in-CTE model improved their overall teaching competencies.

> Interestingly, many of the [CTE and math] teacher-teams reported passing through a period in which they had to overcome tensions and anxiety in working together, especially on the part of the CTE teachers who often expressed a lack of confidence in mathematics. One math teacher described his CTE partner's initial experience as one of 'absolute fear as he stepped into that realm he was not familiar with.' However, these fears dissipated and a mutual respect for each other's expertise emerged, as he further explained, 'We have three math teachers on the staff, and he (the CTE teacher) has now become a sort of de facto four. It's pretty neat!' (Stone et al., 2006, p. 56)

The math teachers expressed that the partnerships had a reciprocal effect and increased their teaching repertoire, and the CTE teachers became more confident in their ability to teach the math found within their program area. The teachers noted that developing the math-enhanced lessons and the concept maps were vital parts of the Math-in-CTE model. The teachers also noted that the students were "getting it" (Stone et al., 2006, p. 74) and were seeing the connections between their CTE class and their math class.

Table 2-1 (pp. 86-87) and Figures 2-3 and 2-4 (p. 89) illustrate and explain the seven elements of a math-enhanced lesson that were developed, utilized, and were found to be effective at increasing the mathematical ability of the secondary students in the Stone et al. (2006) study.

Personal Factors

This section will discuss demographic variables, self-efficacy/teaching efficacy and mathematics ability, which are considered personal factors. Each personal factor has a reciprocal causative relationship with the behavior of teaching contextualized mathematics and the physical and social environments of the teacher education program and the teaching methods course. According to Bandura (1997), “human adaptations and changes are rooted in social systems” (p. 6), and as a result, “personal agency operates within a broad network of sociostructural influences” (p. 6).

Demographic variables

Few studies report the effects of demographic variables such as gender and age on the behavior of teaching. Most studies only describe the sample in terms of demographic variables.

In a study by Miller and Gliem (1996), the mathematical problem solving ability of preservice agricultural teachers was found to have a negligible relationship with gender. Halat (2008) found a statistically significant difference in gender of preservice secondary mathematics teachers related to the teachers’ van Hiele level. “The van Hieles described five levels of reasoning in geometry. These levels, hierarchical and continuous, are level-I (Visualization), level-II (Analysis), level-III (Ordering), level-IV (Deduction), and level-V (Rigor)” (Halat, 2008, p. 2). Males had a mean score of 2.49, which indicated intermediate acquisition of van Hiele level III, and females had a mean score of 2.07, which indicated no acquisition of the van Hiele level III. However, Halat reported that although male preservice elementary mathematic teachers’ scored higher in thinking levels the difference was not statistically significant. Thus, significance was found related to gender in secondary preservice teachers but not elementary preservice

teachers. On the other hand, Edgar, Roberts, and Murphy (2009) determined in a study consisting of 82 preservice agricultural education teachers that gender did not have a significant effect on the teaching efficacy of preservice teachers. In addition, Edgar et al., found that age and academic standing did not have a significant effect on the teaching efficacy of preservice agricultural teachers. In a study with secondary agricultural teachers, Miller and Gliem (1994) reported that age did significantly affect mathematical problem solving ability.

Roberts, Mowen, Edgar, Harlin, and Briers (2007) collected data from 68 preservice agricultural teachers and reported that personality types of preservice agricultural teachers were negligibly related to teaching efficacy. Contradicting those results, Roberts, Harlin, and Briers (2007) found that the personality type extroversion "was substantially related to overall teaching efficacy" (p. 63) among a sample of 41 preservice agricultural teachers.

In respect to research on ethnicity, Edgar et al. (2009) found that ethnicity did not have a significant effect on the teaching efficacy of preservice agricultural teachers. Furthermore, Gordon (2002) interviewed over 200 teachers of color and stated that a surprising finding was "regardless of academic or socioeconomic standing, students of color tend not to be encouraged to enter the teaching force by their own families and community members, including classroom teachers of color" (p. 124). Gordon also suggested that teacher education programs should provide realistic experience with multicultural schools. Hodgkinson (2002) stated that if a preservice teacher's student teaching experience is in a "wealthy suburban school and their first job is in an inner-city school, success will be difficult" (p. 104).

Self-efficacy

Bandura's (1986) Social Cognitive Theory stated that a reciprocal relationship exists between personal factors, environmental factors, and behavior. According to Bandura (1997), self-efficacy is a personal factor that

> occupies a pivotal role…because it acts upon the other classes of determinants. By influencing the choice of activities and the motivational level, beliefs of personal efficacy make an important contribution to the acquisition of knowledge structures on which skills are founded. An assured sense of efficacy supports the type of efficient analytic thinking needed to ferret out predictive knowledge form causally ambiguous environments in which many factors combine to produce efforts. Beliefs of personal efficacy also regulate motivation by shaping aspirations and outcomes expected for one's efforts. A capability is only as good as its execution. The self-assurance with which people approach and manage difficult tasks determines whether they make good or poor use of their capabilities. Insidious self-doubts can easily overrule the best of skills. (p.35)

Pajares (2002) declared that many thoughts affect human behavior, and self-efficacy is a central component of social cognitive theory. Perceived self-efficacy is one's personal judgment of his/her capability to perform a task or behavior (Bandura, 1997).

> Self-efficacy is influenced by mastery experiences, vicarious experiences, social influences, and physiological or emotional states (Bandura, 1997). Thus, previous personal successes, watching others succeed, being told that he/she can succeed, and positive biological feedback can all increase a student's self-efficacy. (Roberts, 2003, p. 30)

A student's belief in their ability to manage learning and their proficiency of academic related tasks governs their ambitions, motivation for learning, and academic achievements (Bandura, 1993).

A more specific type of self-efficacy is known as teacher or teaching efficacy (Stripling et al., 2008). Teacher efficacy is the self-belief in one's capability to generate preferred outcomes in one's students (Soodak & Podell, 1996). According to

Tschannen-Moran, Woolfolk Hoy, and Hoy (1998), teacher efficacy is a teacher's self-belief in his or her ability to plan, develop, and perform learning related task in a particular context. Guskey and Passaro (1994) defined teacher efficacy as a teacher's belief in his or her ability to have an effect on student learning for all types of student. Teachers with high teaching efficacy exert more effort in planning and organization (Allinder, 1994) and persevere through challenges and undesired results (Goddard, Hoy, & Woolfolk Hoy, 2004). According to Tschannen-Moran et al. (1998), teacher efficacy is cyclical in nature with either a positive or negative effect.

> Greater efficacy leads to greater effort and persistence, which leads to better performance, which in turn leads to greater efficacy. The reverse is also true. Lower efficacy leads to less effort and giving up easily, which leads to poor teaching outcomes, which then produce decreased efficacy. Thus, a teaching performance that was accomplished with a level of effort and persistence influenced by the performer's sense of efficacy, when completed, becomes the past and a source of future efficacy beliefs. (Tschannen-Moran et al., 1998, p. 234)

Once teaching efficacy beliefs stabilize, they are difficult to change (Bandura, 1997; Tschannen-Moran et al., 1998)

Bandura (1993) stated, "teachers' beliefs in their personal efficacy to motivate and promote learning affect the types of learning environments they create and the level of academic progress their students achieve" (p. 1). Goddard, Hoy, and Woolfolk Hoy (2000) found that collective efficacy was positively related to differences between schools in student mathematics and reading achievement. Similar to teacher efficacy, collective efficacy is a social systems belief in its ability to socially execute a task or perform a behavior (Bandura, 1997). In the context of a school, collective efficacy is the summative belief of the faculty and staff to organize and implement necessary actions to positively affect students (Goddard, 2001). According to Bandura (1997), if faculty of

a school have a strong sense of collective efficacy the school will succeed academically, and when the faculty have a weak sense of collective efficacy the school will not make progress academically.

The study of teacher or teaching efficacy has also been extended to preservice teachers. Several studies have been conducted recently investigating the teaching efficacy of preservice agricultural education teachers. Knobloch (2001) investigated the personal and general teaching efficacy of prospective agricultural, extension, and agribusiness educators enrolled in an agricultural education foundations course. The spring quarter group consisted of 43 preservice teachers. Knobloch found that the personal and general teaching efficacy of the 43 preservice teachers increased but not significantly after peer-teaching. The autumn quarter group consisted of 44 preservice teachers. The personal and general teaching efficacy of the 44 participants did increase, but not significantly after an early field experience of 10 days or 80 hours. Knobloch also reported that after a peer-teaching the autumn group once again increased in personal and general teaching efficacy, and general teaching efficacy was not significantly different after the peer-teaching. However, Knobloch did report a significant increase in personal teaching efficacy after peer-teaching. Knobloch (2001) noted that “peer teaching significantly increased personal teaching efficacy after students had completed the early field experience” (p. 127). Thus, observing teaching in a natural setting may aid future educators in becoming more efficacious (Knobloch, 2001).

Knobloch (2006) compared students from two agricultural education programs: University of Illinois (UI) and The Ohio State University (OSU). “At the end of the

student teaching internship, student teachers at both universities who perceived their teacher education program positively were more efficacious at the end of their student teaching internship (r^2 = .17 & .50, large effect sizes)" (Knobloch, 2006, p. 41).

> Student teachers at the UI had five important relationships with teaching self-efficacy at the end of student teaching: trust in clients (r^2 = .26); collective efficacy (r^2 = .44); academic emphasis (r^2 = .56); cooperating teacher competence (r^2 = .19); and perception of student teaching experience (r^2 = .72). (Knobloch, 2006, p.42)

The OSU student teachers only had "one relationship with a medium effect size (r^2 = .20)" (Knobloch, 2006, p. 42), which was the perception of the student teaching experience. Knobloch also reported that students at each institution were similarly efficacious, and their teacher efficacy did not change from the beginning to the end of the student teaching experience.

Furthering the research of Knobloch (2001, 2006), Roberts, Harlin, and Ricketts (2006) examined the teaching efficacy of 33 preservice agricultural education teachers from Texas A&M University at different points during the student teaching experience. Data were collected on the first day of the four-week student teaching block, the last day of the four-week student teaching block, middle of the 11-week student teaching experience, and after the 11-week student teaching experience. The instrument utilized during the study was the *Teachers' Sense of Efficacy Scale* (Tschannen-Moran & Woolfolk Hoy, 2001). The instrument had a "9 point rating scale, framed around the question, How Much Can You Do? (1 = Nothing, 3 = Very Little, 5 = Some Influence, 7 = Quite a Bit, and 9 = A Great Deal)" (Roberts et al., 2006, p. 85).

Roberts et al. (2006) found that the teaching efficacy student engagement scores increased overall from the first day of the four-week student teaching block (M = 7.06, SD = .98) to the end of the student teaching experience (M = 7.24, SD = 1.05).

However, Roberts et al. found that teaching efficacy student engagement scores were the highest after the student teaching block (*M* = 7.31, *SD* = .96) and the lowest during the middle of the 11-week student teaching experience (*M* = 6.67, *SD* = 1.06). The "mean student engagement scores were statistically different ($F_{(3, 90)} = 9.08$, $p = .00$) [,and] the effect size for the observed difference was small ($\eta_p^2 = .23$) (Cohen, 1988)" (Roberts et al., 2006, p. 88). Similar results were reported for the teaching efficacy instructional strategies scores. Teaching efficacy in instructional strategies increased overall from the first day of the four-week student teaching block (*M* = 7.21, *SD* = .91) to the end of the student teaching experience (*M* = 7.52, *SD* = 1.06). Teaching efficacy instructional strategies scores were near their highest point after the student teaching block (*M* = 7.46, *SD* = .98) and the lowest during the middle of the 11-week student teaching experience (*M* = 7.01, *SD* = 1.12). The "instructional strategies scores also differed statistically ($F_{(3, 90)} = 4.56$, $p = .01$)" (Roberts et al., 2006, p. 88) and the observed effect size was small ($\eta_p^2 = .13$). The teaching efficacy classroom management scores were also similar to the instructional strategies and the student engagement scores. However, the overall increase was not as great compared to the two previous constructs: the first day of the four-week student teaching block (*M* = 7.37, *SD* = .88) to the end of the student teaching experience (*M* = 7.40, *SD* = 1.09). Once again however, the highest scores were reported after the four-week student teaching block (*M* = 7.46, *SD* = .96) and the lowest scores were reported during the middle of the 11-week student teaching experience (*M* = 7.05, *SD* = 1.13). In contrast to the student engagement and instructional strategies scores, "results indicated that classroom

management scores did not differ significantly ($F_{(3, 90)} = 2.53$, $p = .06$)" (Roberts, et al., 2006, p. 88).

Roberts et al. (2006) stated, "pairwise comparisons were used to confirm that the teaching efficacy scores were statistically lower during the middle of the eleven week experience for student engagement, instructional strategies, and overall teaching efficacy" (p. 89). Classroom management scores were lower during the middle of the 11-week experience, but were not statistically significant. Roberts et al. also reported the overall teaching efficacy scores: first day of the four-week block ($M = 7.21$, $SD = .85$), last day of the four week block ($M = 7.41$, $SD = .94$), middle of the 11-week student teaching experience ($M = 6.91$, $SD = 1.04$), and end of the 11-week student teaching experience ($M = 7.39$, $SD = 1.03$). The overall teaching efficacy scores increased overall from the initial data collection point to the last data collection point. The highest scores were reported after the four-week block and the lowest scores at the middle of the 11-week student teaching experience. "The overall teaching efficacy scores revealed a statistical difference ($F_{(3, 90)} = 5.78$, $p = .00$), which represented a small effect size ($\eta_p^2 = .16$)" (Roberts et al., 2006, p. 88). As described above, a general trend emerged from the data for all three constructs and overall teaching efficacy. The scores "increased during the four week block, then decreased by the mid point of the student teaching experience, and finally increase again by the conclusion of the experience" (Roberts et al., 2006, p 89).

Harlin, Roberts, Briers, Mowen, and Edgar (2007) replicated the study conducted by Roberts et al. (2006) with a sample consisting of 99 preservice agricultural education teachers from the following four institutions: Tarleton State University, Texas A&M

University, Texas Tech University, and Oklahoma State University. The following scores were reported: student engagement– first day of the four-week block (*M* = 6.91, *SD* = .80), last day of the four-week block (*M* = 7.09, *SD* = .81), middle of the 11-week student teaching experience (*M* = 6.74, *SD* = .94), and end of the 11-week student teaching experience (*M* = 7.42, *SD* = .79); instructional strategies– first day of the four-week block (*M* = 6.95, *SD* = .91), last day of the four-week block (*M* = 7.31, *SD* = .82), middle of the 11-week student teaching experience (*M* = 7.17, *SD* = .88), and end of the 11-week student teaching experience (*M* = 7.64, *SD* = .81); classroom management– first day of the four-week block (*M* = 7.23, *SD* = .98), last day of the four-week block (*M* = 7.35, *SD* = .81), middle of the 11-week student teaching experience (*M* =7.07, *SD* = 1.01), and end of the 11-week student teaching experience (*M* = 7.59, *SD* = .82); overall teaching efficacy– first day of the four-week block (*M* = 7.03, *SD* = .80), last day of the four-week block (*M* = 7.25, *SD* = .76), middle of the 11-week student teaching experience (*M* = 6.99, *SD* = .84), and end of the 11-week student teaching experience (*M* = 7.55, *SD* = .74). Results indicated statistical significance was found over time for all teaching efficacy scores, but the effect sizes were negligible. Pairwise comparison confirmed that efficacy scores were significantly lower for student engagement, instructional strategies, and overall teaching efficacy during the middle of the 11-week student teaching experience. Classroom management efficacy scores were lower but not significantly different. Consistent with Roberts et al. (2006), the data of Harlin et al. (2007) revealed the following general trend: "Scores in all three constructs and overall teaching efficacy increased during the four-week block, then decreased by the mid point

of the student teaching experience, and finally increased again at the conclusion of the student teaching experience" (p. 87).

Roberts, Mowen, Edgar, Harlin, and Briers (2007) sought to determine if a relationship existed between teaching efficacy and personality type of 68 student teachers or preservice teachers at Texas A&M University. Consistent with Roberts et al. (2006) and Harlin et al. (2007), teaching efficacy scores in student engagement and classroom management were found to be the lowest during the middle of the 11-week student teaching experience, and the scores in all three constructs and the overall teaching efficacy of the student teachers increased overall from the first data collection point at the beginning of the four week student teaching block to the final data collection point after the 11-week student teaching experience. The same theme general theme as Roberts et al. (2006) and Harlin et al. (2007) also emerged where "teaching efficacy levels increased during the four-week 'block', decreased to their lowest levels in the middle of the 11-week field experience, and then increased to their highest levels at the end of the 11-week field experience" (Roberts et al., 2007, p. 95).

On the personality type assessment (Myers-Briggs Type Indicator®), Roberts et al. (2007) reported 67.6% of the student teachers were extroversion versus 32.4% introversion, 66.2% sensing versus 33.8% intuition, 64.7% feeling versus 35.3% thinking, and 45.6% perceiving versus 54.4% judging. Only two correlations between personality type scores and teaching efficacy scores were found to be statistically significant.

> Sensing (S) had a negligible negative relationship with efficacy in instructional strategies at the end of the 11-week field experience (r = -.25)…. Judging (J) had a negligible positive relationship with efficacy in

> classroom management in the middle of the 11-week field experience (r = .26). (Roberts, 2007, p. 98)

Thus, the participants' personality type was negligibly associated to teaching efficacy (Roberts et al., 2007).

Stripling, Ricketts, Roberts, and Harlin (2008) extended the research of Roberts et al. (2006), Harlin et al. (2007) and Roberts et al. (2007) to include examining the impact of the teaching methods course on teaching efficacy. Data were collected for two years at the University of Georgia and Texas A&M University, and the sample consisted of 102 preservice agricultural education teachers. The overall teaching efficacy mean before the teaching methods course was 6.65 (*SD* = .11), after-the-methods course/before student teaching mean was 7.15 (*SD* = .11), and the after-student-teaching mean was 7.29 (*SD* = .16). Likewise, the instructional strategies, student engagement, and classroom management scores increased at each data collection point. The following scores were reported: student engagement – prior to the methods course (*M* = 6.56, *SD* = 1.03), after the methods course/before student teaching (*M* = 7.02, *SD* = .94), and after student teaching (*M* = 7.11, *SD* = 1.03); instructional strategies – prior to the methods course (*M* = 6.61, *SD* = 1.11), after the methods course/before student teaching (*M* = 7.25, *SD* = .94), and after student teaching (*M* = 7.43, *SD* = .96); after student teaching – prior to the methods course (*M* = 6.76, *SD* = 1.18), after the methods course/before student teaching (*M* = 7.17, *SD* = 1.05), and after student teaching (*M* = 7.34, *SD* = 1.04).

> Significant difference existed for mean student engagement scores over time ($F_{(2,191)} = 5.84$, $p = .00$). The effect size for the difference was a medium effect size ($\omega^2 = .09$). Significant differences were also found in the mean instructional strategies scores over time ($F_{(2,191)} = 12.16$, $p = .00$). The effect size for this difference was a large effect size ($\omega^2 = .18$). Differences were also present in the mean classroom management

> construct scores over time ($F_{(2,191)}$ = 4.86, p = .01). The effect size for the difference was a medium effect size (ω^2 = .09). (Stripling et al., 2008, p. 125)

Post hoc analysis revealed a significant difference at the .05 level for student engagement "from before the methods course (*M* = 6.65, *SD* = 1.03) to after the methods course/before student teaching (*M* = 7.02, *SD* = .94)" (Stripling et al., 2008, p. 126). Stripling et al. also reported a significant difference ($p < .05$) between the instructional strategies score from before the methods course (*M* = 6.61, *SD* = 1.11) and after the methods course/before student teaching (*M* = 7.25, *SD* = .94). The classroom management scores did not reveal a significant difference except for the aforementioned classroom management overall teaching efficacy score.

Roberts, Harlin, and Briers (2008) studied the effect that placing two student teachers at the same internship site had on teaching efficacy. The study was a quasi-experimental study, and data were collected for two years or over four semesters during the student teaching semesters at Texas A&M University. The sample consisted of 150 preservice teachers, but complete data were only collected from 138 students. Of the 150 student teachers 88 or 58.7% were placed in pairs. The data revealed that

> student teachers placed alone (*M* = 7.21, *SD* = .82) began the field experience slightly less efficacious than those placed in pairs (*M* = 7.42, *SD* = .78). By the middle of the field experience, both groups exhibited less teaching efficacy, with those placed in pairs (*M* = 6.91, *SD* = .88) slightly lower than those placed alone (*M* = 7.03, *SD* = .91). By the end of the experience, both groups rebounded; those placed alone (*M* = 7.45, *SD* = .81) were slightly higher than those placed in pairs (*M* = 7.34, *SD* = .94). Student teachers placed alone exhibited their highest levels of efficacy at the end of the experience, while those placed in pairs were most efficacious at the beginning of the field experience. (Roberts et al., 2008, p. 20)

A statistically significant difference in teaching efficacy was not found between being placed alone or in a pair ($F_{(1,130)}$ = .01, p = .93).

Edgar, Roberts, and Murphy (2009) examined the "effects implementing structured communication between cooperating teachers and student teachers would have on student teachers' self-perceived teaching efficacy during field experiences" (p. 33). The sample consisted of 82 preservice teachers that were student teaching. The overall trend in teaching efficacy scores was consistent with Roberts et al. (2006), Harlin et al. (2007), and Roberts et al. (2007), in which teaching efficacy scores decreased at the middle of the student teaching experience, but then increased above the initial measurement of efficacy. Results did not reveal a significant change in teaching efficacy because of the structured communication protocol. The researchers hypothesized that during the structured communication protocol the student teachers may have felt that their teaching was criticized, and this may have contributed to a the slight lowering of teaching efficacy as compared to the control group.

Research has also linked preservice teacher efficacy to attitudes toward children and control (Woolfolk & Hoy, 1990), and "undergraduates with a low sense of teacher efficacy tended to have an orientation toward control, taking a pessimistic view of students' motivation, relying on strict classroom regulations, extrinsic rewards, and punishments to make students study" (Tschannen-Moran et al., 1998 p. 235).

> Student teachers often underestimate the complexity of the teaching task and their ability to manage many agendas simultaneously. Interns may either interact too much as peers with their students and find their classes out of control or they may grow overly harsh and end up not liking their 'teacher self'. They become disappointed with the gap between the standards they have set for themselves and their own performance. Student teachers sometimes engage in self-protective strategies, lowering their standards in order to reduce the gap between the requirements of excellent teaching and their self-perceptions of teaching competence. (Woolfolk Hoy, 2000, p.6)

According to Tschannen-Moran et al. (1998), teacher education programs should allow preservice teachers to experience “increasing levels of complexity and challenge” (p. 236). However, teacher education programs should work on developing one skill set at a time. Student teaching allows the preservice teacher to develop personal efficacy beliefs, and a sink-or-swim approach could negatively affect teacher efficacy and the development of teaching competencies (Tschannen-Moran et al. 1998). Kagan (1992) noted,

> if a [teacher education] program is to promote growth among novices, it must require them to make their pre-existing personal beliefs explicit; it must challenge the adequacy of those beliefs; and it must give novices extended opportunities to examine, elaborate, and integrate new information into their existing belief system. In short, pre-service teachers need opportunities to make knowledge their own. (p. 77)

Mathematics ability/content knowledge

According to Putnam and Borko (2000),

> to foster students’ conceptual understanding, teachers must have rich and flexible knowledge of the subjects they teach. They must understand the central facts and concepts of the discipline, how these ideas are connected, and the processes used to establish new knowledge and determine the validity of claims. (p.6)

However, many studies have contributed to the mounting evidence that preservice teachers, in general, lack an understanding of the mathematics content that they are charged to teach (Adams, 1998; Ball & Wilson, 1990; Bryan, 1999; Frykholm, 2000; Fuller, 1996; Goulding, Rowland, & Barber, 2002; Matthews & Seaman, 2007; Miller & Gliem, 1996; Michigan State University Center for Research in Mathematics and Science Education, 2010; Stacey, Helme, Steinle, Baturo, Irwin, & Bana, 2001; Stoddart, Connell, Stofflett, & Peck, 1993; Stripling & Roberts, 2012a, 2012b, in press; Wilburne & Long, 2010).

A comprehensive literature search revealed only a few studies that investigated the mathematics ability of agricultural education teachers or preservice teachers. Stripling and Roberts (2012b) sought to determine the mathematics ability of senior preservice teachers at the University of Florida during the Fall 2010 semester. Stripling and Roberts reported that the preservice teachers averaged 35.6% on a 26 item agricultural mathematics instrument and concluded that the preservice teachers were not proficient in agricultural mathematics concepts. Additionally, Stripling and Roberts investigated the associations between the types of mathematics courses completed in high school and college and the preservice teachers' score on the mathematics ability instrument. Results revealed moderate correlations between mathematics ability and basic high school mathematics (r = -.43), advanced high school mathematics (r = .47), basic college mathematics (r = -.46), and advanced college mathematics (r = .40). In addition, Stripling and Roberts reported a low correlation between mathematics ability and intermediate college mathematics (r = .10) and a negligible correlation between mathematics ability and intermediate high school mathematics (r = .03). Therefore, Stripling and Roberts concluded that the aforesaid associations suggest that advanced mathematics coursework resulted in higher scores on the mathematics assessment.

Similarly, Stripling and Roberts (in press) investigated the mathematics ability of the nation's preservice agricultural teachers. The researchers randomly selected nine teacher education programs, which resulted in a sample of 98 preservice teachers. Based on their sampling criteria Stripling and Roberts reported that the population mean was estimated with 95% confidence to be in the range of 28.5% to 48.5%. As a result, Stripling and Roberts concluded that preservice agricultural education teachers are not

proficient in mathematics. Similar to Stripling and Roberts (2012b), Stripling and Roberts (in press) reported a substantial correlation between mathematics ability and advanced high school mathematics (r = .50), low correlations between mathematics ability and basic high school mathematics (r = -.24), advanced high school mathematics (r = .25), basic college mathematics (r = -.23), and intermediate college mathematics (r = -.14), and a negligible correlation between mathematics ability and intermediate high school mathematics (r = .06). Additionally, Stripling and Roberts (in press) observed a low correlation between mathematics ability and receiving a grade of an A (r = .22) or a grade of a B (r = -.11) in highest mathematics course completed in college and negligible correlations between mathematics ability and receiving a C (r = -.09), a D (r = -.04), or an F (r = .01) in highest mathematics course completed in college. Furthermore, Stripling and Roberts found that preservice teachers that completed an advanced mathematics course scored 19.48 percentage points higher than those that did not complete an advanced mathematics course and those that received an A in their highest college mathematics course scored 6.40 percentage points higher than those that did not receive an A. Moreover, 39% of the variance in mathematics ability was explained with the following five variables: advanced college mathematics, university 7, university 1, grade of an A in highest college mathematics, and university 8. According to Stripling and Roberts, the universities were included in the regression model because significant differences were found in the mathematics ability scores between universities.

Miller and Gliem (1994) sought to explain the variance in the mathematical ability of agricultural teachers. A mathematical problem-solving test was developed by the

researchers to test mathematical ability. Scores on the mathematical problem-solving test ranged from 26.67% to 100%. The mean score on the test was 66.47% (*SD* = 2.96). The relationships between mathematical problem-solving ability and the following variables were not significant: age and highest level of college mathematics coursework completed. However, the relationships between mathematical problem-solving ability and years of teaching experience, final college grade point average, ACT math score and attitude toward including mathematics concepts in the curriculum and instruction of secondary agriculture programs were significant. Miller and Gliem concluded that the teachers in the study were not proficient in solving agriculturally related mathematical problems. Furthermore, the researchers also stated that the highest level of mathematics need to solve the problems on the instrument was algebra.

A similar study was conducted by Miller and Gliem (1996), but the participants in the study consisted of 49 preservice agricultural education teachers from The Ohio State University. The study used the same instrument as Miller and Gliem (1994), and the range of scores was 0% to 87.8%. Miller and Gliem reported that 87.8% of the preservice teachers scored lower than 60%, and the mean score was 37.13% (*SD* = 2.92). Grade point average, level of mathematics courses taken, and gender were found to have negligible relationships with mathematical problem solving ability. A moderate relationship was found between mathematics ability and number of mathematics courses completed. A substantial positive relationship was found between mathematics ability and ACT math score. Miller and Gliem also reported that preservice teachers with higher scores had completed advanced mathematics courses, completed a fewer number of mathematics courses, and possessed higher ACT math scores. The

researchers concluded that the “preservice agriculture educators were not capable of applying basic mathematics skills to agricultural problems” (Miller & Gliem, 1996, p. 19).

Persinger and Gliem (1987) investigated the mathematical ability of secondary agricultural teachers and their students. The sample consisted of 54 teachers and 656 students. The agricultural teachers mean score on the 20 question mathematics ability test was 12.35 (*SD* = 4.36) problems solved correctly, or 61.75%. The researchers reported that 28% of the teachers solved 50% or less of the problems correctly. Students of the mathematics deficient teachers were also shown to not be competent in mathematics. The average score for the secondary students was 5.6 (*SD* = 4.54) out of 20 or 28%. Persinger and Gliem also reported that 82% of the students scored lower than 50%, and that the teacher’s test score was significantly correlated with the scores of their students.

A plethora of research has been conducted on the mathematics ability/content knowledge of preservice elementary teachers. Hill, Rowan, and Ball (2005) reported that “teachers’ mathematical knowledge was significantly related to student achievement gains” (p. 371). Matthews and Seaman (2007), in a study involving 48 preservice elementary teachers, found the participants “struggled with problems that deal with averages….[and] with conceptual understanding of algorithms used to solve whole number computation problems” (p. 8). In a study of 366 preservice teachers, Pomerantsev and Korosteleva (2003) reported that preservice teachers lack a conceptual understanding of mathematical symbols, have “poor knowledge of the structure of an algebraic expression” (p. 6), and possess a poor grasp of algebraic rules. A study that consisted of 93 preservice elementary teachers reported the

participants possessed deficiencies in understanding the real number system (Adams, 1990). Simon (1993) found that 41 preservice elementary teachers were deficient in their conceptual understanding and procedural understanding of division. Fuller's (1996) data suggested that preservice elementary teachers have mainly a procedural knowledge of mathematics, and preservice teachers believe good teachers show and tell students how to do work. The Fuller findings are supported by Ball and Willson (1990), Borko et al. (1992), and Onslow, Beynon, & Geddis (1992).

Putt (1995) reported that 52% of the 704 elementary and middle school preservice teachers in the researcher's sample were unable to order numbers containing decimals from smallest to largest. In a similar study, Stacey et al. (2001) investigated the knowledge of 553 preservice elementary school teachers and determined that 20% of the preservice teachers did not possess an expert knowledge of decimal numeration. Stacey et al. (2001) also reported that 13% of the preservice teachers "made errors when comparing a number with zero" (p. 222).

Stoddart, Connell, Stofflett, and Peck (1993) stated that an entry-level assessment showed that the sample of teacher candidates or elementary preservice teachers (n = 83) are deficient in the mathematics content they are required to teach (54% were mathematically inadequate). Stoddard et al. (1993) also reported that a majority of the participants could solve simple computation problems, but only 50% of the participants "could correctly solve items involving multiplication, division, and equivalency of fractions" (p. 234). Furthermore, only 10% were able to provide accurate conceptual information related to their problem solving, and only 4% "demonstrated both procedural and conceptual control" (Stoddart et al., 1993, p. 235).

Similarly, Bryan (1999) reported a lack of mathematics conceptual depth among secondary preservice mathematics teachers. The study conducted by Bryan utilized interviews to explore the conceptual understandings of mathematical ideas. The researcher reported that 37% of the time, participants could not offer an explanation for a mathematical idea. If an explanation was given, the explanation was flawed 37% of the time, and the participants were only able to offer a conceptual sound explanation 22% of time. Consequently, many of the participants indicated that mathematics content to be learned had only been presented as something to be memorized.

Results from Even (1990, 1993) suggested that secondary preservice teachers' knowledge of functions was not sufficient. Wilburne and Long (2010) investigated the mathematics ability of 70 secondary preservice teachers as measured by items developed from the 11th grade Pennsylvania mathematics assessment. "The mean proportion of correct responses for number and operations, geometry and measurement, algebra, and data analysis and probability strands were .86, .84, .79, and .78 respectively" (Wilburne & Long, 2010, p. 5). The preservice teachers scored considerably lower on the pre-calculus items with a mean proportion of correct responses of .37, thus indicating a need for increased competency in pre-calculus concepts before student teaching.

Ball and Wilson (1990) compared the mathematics ability and pedagogical content knowledge gained from alternative-routes versus traditional teacher education programs. Results of the study suggested that "neither group could explain the underlying mathematical meanings of the procedures and ideas" (Ball & Wilson, 1990, p. 5) of mathematics problems. The researchers stated that it was "distressing how little

either group knows about the mathematics of these common school problems" (Ball & Wilson, 1990, p. 5). Ball and Wilson also reported that less than 50% of either group could develop representations of division of fractions, and both groups lacked an understanding of mathematical proofs. No significant differences were found in the mathematic ability of alternatively prepared or traditionally prepared preservice teachers entering or exiting their programs.

Latterell (2008) described the mathematics knowledge of 10 secondary mathematics preservice teachers using both qualitative and quantitative data and conceptualized the study as a snapshot of a typical preservice secondary mathematics teacher. From the data the following four themes emerged:

> The pre-service secondary mathematics teacher enjoys and has knowledge of secondary mathematics; does not enjoy nor have a deep understanding of undergraduate mathematics; is drawn to teaching and not overly drawn to mathematics; and has a medium-level of commitment to the National Council of Teachers of Mathematics [standards]. (Latterell, 2008, p. 1)

Results from Latterell indicating that preservice teacher are competent in secondary mathematics (all participants scored 90% or above on an instrument based on secondary mathematics) are contradictory to the findings of many of the studies mentioned above.

Environment

In this section, two variables will be discussed the teacher education program and the teaching methods course. Both variables have reciprocal causative relationships with the behavior of teaching contextualized mathematics and the various personal factors under investigation in this study.

Teacher education program

In the context of social cognitive theory and triadic reciprocality, the teacher education program is the underlying environment for preservice teachers to develop into effective educators. "The goal of preservice teacher education is to make the most effective use of the time available to prepare future educators for the task awaiting them" (Myers & Dyer, 2004, p. 47). More specifically, teacher education programs should "create opportunities for prospective teachers to develop productive beliefs and attitudes toward teaching and learning mathematics" (Charalambous, Panaoura, & Philippou, 2009, p. 161). Ensor (2001) found that beginning teachers drew upon their experiences in a teacher education program to develop "a professional argot–a way of talking about teaching and learning mathematics" (p. 296).

Berry (2005) stated that research-proven instructional strategies in mathematics and literacy make a difference in student achievement as teacher educators incorporate the strategies into the teacher education program. However, Wilson, Floden, and Ferrini-Munday (2001) purported that the research base in teacher education is thin. As a result, Berry (2005) called for teacher education programs to collect data on the effectiveness of the teachers their programs produce. According to Berry (2005), approximately 50% of students in a teacher education program will graduate as teacher candidates, and only 70% of the graduates will enter the teaching profession. Furthermore, preservice teachers sometimes finish their academic program with trivial changes in their content knowledge, teaching, and learning beliefs (Kagan, 1992; Seaman, Szydlik, Szydlik, & Beam, 2006). One cause is that teacher education programs do not connect pedagogy and academic content throughout the teacher education program (Ishler, Edens, & Berry, 1996).

Swortzel (1999) professed that there is also a lack of empirical research on teacher education in agriculture. Swortzel's study described the landscape of agricultural teacher education programs in the United States. According to Swortzel (1999), "the average preservice agricultural education program has 41 teaching majors educated by 1.7 full-time equivalent faculty members" (p. 37). Swortzel also reported that 59% of the agricultural teacher education programs were located in colleges of agriculture, 23% were in colleges of education, and 18% were in colleges of business or technology. According to Swortzel, most teacher education programs (86%) are on the semester system, offer a four year degree program (81%), and are accredited by a regional or national association (96%). Swortzel also discovered that the median minimum grade point average for admissions to an agricultural teacher education program was 2.50, and the mean number of semester credit hours for four year degree certification programs was 130.5 with a range of 120-148. In addition, Swortzel reported agricultural teacher education programs require a median of 12 weeks of student teaching, and 93% also required early field based experiences before student teaching (average of 60.2 clock hours). Swortzel also reported that 71% of agricultural teacher education programs require multicultural education coursework, 75% require exceptional children coursework, and 88% require coursework in computers/instructional technologies.

McLean and Camp (2000) qualitatively investigated 10 teacher education programs that were nominated as quality programs by peers in the profession. McLean and Camp (2000) found considerable variations in course offerings with 18 total courses being identified and "no two programs offering the same combination of courses" (p.

30). Methods of teaching agriculture was the most common, followed closely by program planning in agricultural education, and student teaching. The least offered courses were agricultural youth organizations, curriculum assessment and development, ethics in agricultural education and extension, and FFA advisement. McLean and Camp also identified 118 topics taught in the courses and suggested that these topics could be divided into five curricular areas or courses: experiential components, foundations, program and curriculum planning, teaching methods, and teaching technology.

Myers and Dyer (2004) emphasized the importance of field experience in agricultural education programs and stated that early field experience "aides students in their decision to pursue a career in agricultural education" (p. 48). Harlin, Edwards, and Briers (2002) investigated preservice teachers' perceived elements of importance before and after a student teaching experience. According to Harlin et al., student teachers perceived a cooperating teacher who is willing to be a mentor, a cooperating teacher who communicates clear expectations to the student teacher, and discipline policies that are in place and enforced as the most important elements before a student teaching experience. Harlin et al. reported after the student teaching experience the perceived elements of importance were a well-rounded program emphasizing instruction, SAEs, and youth leadership activities and a cooperating teacher who is willing to be a mentor. As a result, the cooperating teacher and the student teaching site affect preservice teachers' perceptions of the agricultural teaching profession (Harlin et al., 2002), and what is more, the teaching methods utilized by the cooperating teacher influence the teaching practices of the preservice teacher (Garton & Cano,

1994; McKee, 1991). Additionally, Myers and Dyer (2004) purported that the "relationship between the cooperating teacher and the student teacher, the relationship between the cooperating teacher and the university supervisor also appears to be very important" (p. 49).

Myers and Dyer (2004) also reported that the "best predictor of teaching performance was found to be agricultural education coursework grade point average" (p. 46) from a teacher preparation program. Shinn (1997) reported that the number of classes taken in teaching and learning was the most influential factor in selecting effective teaching strategies, and this supported Myers and Dyer's statement that teaching and learning should be the primary focus of agricultural teacher education programs. Barrick (1993) also supported the claim above by professing that teaching and learning are the central mission of the profession. According to Myers and Dyer the literature on preservice agricultural teacher education revealed the following nine deficiencies:

1. Evaluation of coursework and experiences needed throughout the teacher preparation program to best prepare future teachers of agriculture.
2. An investigation of why more female and ethnic minorities are not entering the agricultural education professorate. In addition to identifying obstacles, solutions to these problems also need to be investigated.
3. A trend analysis of teacher education faculty numbers and identification of duties beyond traditional teacher education.
4. The importance of agricultural education student organizations in the preparation of future teachers of agriculture and in the recruitment and retention of students into teacher preparation programs.
5. An analysis of alternative certification practices for secondary teachers of agriculture.
6. Characteristics of successful cooperating teachers.

7. Characteristics of successful preservice teachers.

8. Identification of predictors of success for student teachers.

9. Evaluation of the teacher education program model to determine if the current model is still the best fit for teacher education programs to fulfill growing and diverse roles and responsibilities. (p. 49)

Myers and Dyer (2004) also stated that "a number of institutions with agricultural education programs are not actively producing certified agricultural education instructors" (p. 45). In 1995, only 79 of 93 agricultural education programs produced a qualified agricultural teacher graduate (Camp, 1998). This may be attributed to the teacher educator's changing role. According to Hillison (1998), the teacher educator's role has evolved from preparing preservice teachers and providing professional development for secondary teachers to other duties, such as developing and delivering postsecondary faculty development, student recruitment, and teaching college-wide coursework.

In regard to teacher education coursework requirements, the American Association for Agricultural Education (2001) called for general education requirements that develop theoretical and practical understanding and suggested that general education comprise one-third of the agricultural education program hours. In addition, the standards stated that mathematics coursework is an expectation within general education, but no specific recommendations for coursework were given. However, according to Conant (as cited in Swortzel, 1995), "only through pursing a subject past an introductory level can prospective teachers gain a coherent picture of the subject so it can be communicated and taught to others" (p. 36). With this in mind and based on the National Council for Accreditation of Teacher Education (1994) standards, Swortzel (1995) recommended that the agricultural preservice teacher curriculum require two

mathematics courses: calculus and statistics/data analysis. Swortzel's study was the only literature found that specifically identified or suggested mathematics requirements for agricultural teacher education programs.

Teaching methods course

The teaching methods course is theoretically expressed as part of the physical and social environment from a social cognitive prospective, which as stated earlier, is bidirectionally affected by the determinants of the triadic recepricality model (Bandura, 1986, 1997). The teaching methods course is an instructional methodology course that focuses on the selection and use of appropriate teaching strategies and techniques in formal educational settings (Roberts, 2009). Furthermore, in the context of this study, the preservice teachers will teach contextualized mathematics lessons to each other during the teaching methods course. The behavior of micro-teaching is theoretically a component of the social environment. As stated previously, in social cognitive theory, the environment is not conceptualized as a fixed entity but is shaped by personal and behavioral influences (Bandura, 1989). Thus, micro-teaching influences the environment of the teaching methods course. To that end, Bandura (1986) stated that not only do people learn from their actions, they can also learn by vicarious experiences or by observational learning. Observational learning allows a person to develop generalizations that can be used to influence future behavior without having to learn by experimentation or trial and error (Bandura, 1986). According to Bandura, most human behaviors are learned by observing others. Moreover, observational learning increases one's knowledge and cognitive skills (Bandura, 1986).

The literature specific to an agricultural education teaching methods course is limited. However, as described in the self-efficacy section, several studies have been

conducted to determine the effects of a methods course on teaching efficacy in agricultural education.

McClean and Camp (2000) recommended that preservice agricultural teacher education programs include lessons and experiences related to teaching methods for agricultural education. To that end, Ball and Knobloch (2005) examined the pedagogical knowledge acquired in agricultural education teaching methods courses. A census study was conducted to identify the following: "(a) required reading resources, (b) nature and type of assignments, and (c) teaching methods" (Ball & Knobloch, 2005, p. 49). A survey was administered to collect the data, and 47 of 64 teacher educators responded for a 73% response rate. However, only 43 responses were usable based on the *a priori* criteria of the course being exclusive to agricultural education. As a result, 43 teaching methods course syllabi were obtained for analysis. The researchers found that a total of 72 readings were required by 42 teachers.

> Four teacher educators (9.30%) required four reading resources. Three teacher educators (7.0%) required three reading resources. Fourteen teacher educators (32.6%) required two reading resources. Twenty-one educators (48.8%) required one reading resource. One teacher educator (2.3%) did not require a reading resource. (Ball & Knobloch, 2005, p. 51)

Newcomb, McCracken, and Warmbrod's (1986, 1993), *Methods of Teaching Agriculture* was required by 25.7% of teacher educators. Ball and Knobloch (2005) reported that this made the Newcomb et al. book the most frequently required text. As a result, Ball and Knobloch recommended that teacher educators consider texts outside of the profession, since one resource that was originally published in 1986 is widely used. Furthermore, one teacher educator's syllabus noted, "a good, comprehensive, up-to-date textbook is not currently available for this course" (Ball & Knobloch, 2005, p. 53).

The most frequent assignments found within the teaching methods course syllabi were lesson plans and micro-teaching, which were required by 90% of teacher educators. The mean number of required lesson plans was 4.19 ($\sigma = 2.42$), and the mean number of micro-teachings was 3.89 ($\sigma = 2.27$) per course. Exams and participation/attendance were the second-most frequent assignments, required by 67.5% of the teacher educators. Quizzes were required by 47.5% of teacher educators, and unit plans, papers, essays, philosophy statements, and critiques were required by 40%. The following is a list of other assignments that were reported in the teaching methods syllabi of the teacher educators: homework (35%), field experiences (17.5%), portfolio (17.5%), technology (12.5%), bulletin boards (12.5%), course notebooks/internship handbooks (10%), management plans (10%), objectives, questions/cognitive levels (7.5%), modules (7.5%), interest approaches (7.5%), FFA activities/guidebook (5%), and games (2.5%).

Ball and Knobloch (2005) also found that 22 different teaching methods were taught among the teaching methods courses.

> Teacher educators spent 20.8% (Range: 2.2 to 55.7%) of their course time on teaching methods. More than one-third (*N* = 15) of the courses spent less than 15% on teaching methods. The problem solving approach to teaching was taught by 23 teacher educators, and 11.6% of course time was spent teaching this method. One-third (*N* = 13) of the teacher educators listed teaching methods, in general, as a topic in their syllabi. Nine of the top ten most commonly espoused methods were identical to methods cited in Newcomb et al.'s (1986, 1993) book. (Ball & Knobloch, 2005, p. 52)

The researchers concluded that little time is actually spent on teaching methods, and "perhaps one teaching methods course simply does not permit enough time to absorb, practice, and reflect upon the vast amount of pedagogical knowledge that an agriculture teacher must obtain" (Ball & Knobloch, 2005, p. 55).

A study by Cano and Garton (1994a) sought to determine the personality type of preservice agricultural education teachers enrolled in an agricultural teaching methods course and determined that all personality types were represented as measured by the *Myers Briggs Type Indicator*. As a result, Cano and Garton (1994a) suggested that teacher educators use "teaching approaches effective with all of the learning preferences" (p. 11). In a related study, Cano and Garton (1994b) investigated the relationships between preservice agricultural teachers (n = 82) learning styles as determined by the *Group Embedded Figures Test*, performance during a micro-teaching of a teaching methods course, and the final course grade of the teaching methods course. Results indicated that 41% of the participants were field-dependent and 59% were field-independent learners. "A low positive relationship (r = .20) was found between learning style and microteaching laboratory score" (Cano & Garton, 1994b, p. 8), and the results suggested that the more field-independent a preservice teacher is the higher their score might be in a micro-teaching that uses the problem-solving approach. "The relationship between preservice teachers' preferred learning style and final course score was low and positive (r = .21)" (Cano & Garton, 1994b, p. 8), indicating that field-independent preservice teachers are more likely to have a higher final course average. As a result, Cano and Garton (1994b) purported that preservice teachers of agriculture need to have an understanding of how learning styles affect teaching and learning and be "taught how to adapt their teaching style to be inclusive of the various learning styles of students" (p. 9).

Several studies have been conducted investigating various aspects of a mathematics methods course. Burton, Daane, and Gieson (2008) "compared the

content knowledge for teaching mathematics differences between elementary pre-service teachers in a traditional versus an experimental mathematics methods course" (p. 1). The experimental methods course incorporated 20 minutes of mathematics content into each class session. The difference in scores was found to be significant in favor of the experimental group, as measured by the *Content Knowledge for Teaching Mathematics Measure* (Hill, Schilling, & Ball, 2004). The addition of 20 minutes of mathematics content instruction accounted for 18% of the variance in content knowledge for teaching mathematics scores.

Dogan-Dunlap, Dunlap, Izquierdo, and Kosheleva (2007) tested *An Integrated Collaborative, Field-Based Approach to Teaching and Learning Mathematics* (ICFB). ICFB is a pedagogical approach in which learners enrolled in a teacher education program simultaneously take mathematics teaching methods and mathematics content courses. The instructors of the courses collaborate and share common assignments and requirements. A one-group pretest-posttest design was utilized for the survey research. A majority of the participants were of Hispanic ethnicity and were preservice elementary teachers. Typical responses in the pre-survey by the participants "reveal strong emotional, low confidence and negative attitudes toward mathematics" (Dogan-Dunlap et al., 2007, p. 8). The pre-survey also indicated that 26% believed an understanding of mathematical concepts would help in solving real life problems, and another 15% indicated that "mathematics involves logical (or critical) thinking and reasoning" (Dogan-Dunlap et al., 2007, pp. 8-9). The post-survey found that fewer students indicated that mathematics was difficult, and 58% believed mathematics was helpful in solving real life problems, compared to 26% on the pre-survey. The

researchers concluded that the ICFB approach was effective in changing “attitudes, perceptions and performance in mathematics” (Dogan-Dunlap et al., 2007, p. 12).

Rule and Harrell (2006) analyzed mathematical attitudes through the use of symbolic drawings before and after a mathematics teaching methods course with 52 preservice elementary teachers. The pretest images were “63.2% negative in tone and the associated emotions were 60.4% negative” (Rule & Harrell, 2006, p. 241). The posttest images were 72.1% positive and with 70.5% positive associated images. Qualitative data suggested that “mathematics anxiety decreased and motivation changed from extrinsic to intrinsic” (Rule & Harrell, 2006, p. 241) as a result of the teaching methods course.

> Pretest images and interpretations focused on grades, time and peer/teacher pressure, struggle, and lack of success in mathematics. In contrast, posttest images and interpretations revealed (a) greater understanding of mathematical concepts through use of concrete materials; (b) greater engagement in mathematics through interesting activities and discourse with peers; (c) a sense of accomplishment from teaching practicum lessons taught to elementary students. (Rule & Harrell, 2006, p. 255)

The researchers recommended that the symbolic drawings be utilized in a teaching methods course because the drawings help to shift mathematics anxiety to a more positive state.

Kinach (2002) sought to develop the mathematics pedagogical content knowledge of secondary preservice teachers through a series of three tasks during a teaching methods course. Kinach (2002) developed the teaching experiment “to make prospective teachers’ views about instructional explanations explicit for specific school mathematics topics” (p. 56). Kinach collected data qualitatively. In Task 1 participants of the study were asked to explain integer addition and subtraction, but only 1 of 21

participants gave an accurate explanation. The preservice teachers possessed procedural knowledge of integer addition and subtraction at this stage of the experiment. Task 2 was designed to challenge and develop the preservice teachers' beliefs by asking them to explain integer subtraction on the number line. During Task 2 participants discovered they lacked the conceptual knowledge to explain integer subtraction on the number line and started to sense a need to develop knowledge about why rules work to complement their procedural understanding to effectively teach mathematics. Task 3 was designed to test the progression of the preservice teachers' integer understandings with the use of algebra tiles. Algebra tiles "provide a discrete environment for explaining integer computation (Kinach, 2002, p. 63). Qualitative data suggested that by the end of the teaching experiment the preservice teachers advocated "understanding over memorization as a desired learning goal" (Kinach, 2002, p. 63). The data also revealed that "when pressed to teach for understanding, and not just information or skills, teacher candidates began to see the conceptual intricacies of so-called simple topics like adding and subtracting integers" (Kinach, 2002, p. 63). As a result of the favorable findings, the researcher proposed a general cognitive strategy to be used in a mathematics methods course for the development of pedagogical content knowledge. The cognitive strategy utilizes the following five elements to guide cognitive development for pedagogical content knowledge: identify, assess, challenge, transform, and sustain.

In a study involving one preservice mathematics teacher, Wilson (1994) examined "the evolving knowledge and beliefs of a preservice secondary mathematics teacher as she participated in a mathematics education course [teaching methods] that

emphasized mathematical and pedagogical connections and applications of the function concept" (p. 346). Data were collected by interviews, observations, collecting assignments and test, and a written instrument. Wilson found that the participant did not like theoretical mathematics that did not result in procedural or concrete answers. The preservice teacher believed teachers are responsible for teaching "correct rules and procedures in an organized fashion, explaining exactly which procedures students are expected to use, so there is no confusion" (Wilson, 1994, p. 354). Before the methods course the preservice teacher believed functions to be a collection of concrete procedures. By the end of the course, Wilson reported that the preservice teacher's understanding of functions were at acceptable levels. Wilson also recommended that

> models for mathematics teacher education should seriously consider the idea of integrating mathematics content and pedagogy, with a significant component of that integration consisting of activities that encourage teachers to reflect on their own views of mathematics and mathematics teaching while actively exploring important mathematical concepts and processes that they will be required to teach. Such an approach will allow teachers to make important connections in their own mathematical understanding and improve the chances that such an integrated approach will be reflected in their future teaching. (Wilson, 1994, p. 369)

Chapter 2 Summary

Chapter 2 provided a review of the literature related to the problem of this study. Constructivism was framed as the overarching grand theory for this study. Bandura's (1986) social cognitive theory and the model of triadic reciprocality provided the theoretical and conceptual frameworks. Relevant research related to the three classes of determinants of the triadic reciprocality model were summarized, and teaching contextualized mathematics was conceptualized as a behavioral determinant.

The behavior of teaching contextualized mathematics by preservice teachers is influenced by academic integration, demographic variables, self-efficacy, mathematics

ability, and teacher education program variables. Stone et al. (2006) has provided a research proven method for teaching mathematics in career and technical education classrooms. Several studies in agricultural education have also shown the Stone et al. model to be effective at teaching mathematical concepts in secondary classrooms. Research on demographic variables revealed a negligible effect on the behavior of teaching. Self-efficacy and more specifically teacher efficacy research revealed that teaching efficacy is affected by various components of the triadic reciprocality model, and research related to the mathematical ability of preservice agricultural education teachers showed mounting evidence of mathematical deficiencies. Finally, the teacher education program was conceptualized as the physical and social environment for developing teaching competencies, and teaching methods courses that incorporated academic content were shown to be effective at increasing mathematical ability.

Chapter 3 will provide the methodology that outlined this study.

Table 2-1. The Seven Elements: Components of a Math-Enhanced Lesson.

Elements/Steps	Teacher Directions
1. Introduce the CTE lesson.	Explain the CTE lesson. Identify, discuss, point out, or pull out the math embedded in the CTE lesson.
2. Assess students' math awareness as it relates to the CTE lesson.	As you assess, introduce math vocabulary through the math example embedded in the CTE. Employ a variety of methods and techniques for assessing awareness of all students, e.g., questioning, worksheets, group learning activities, etc.
3. Work through the math example embedded in the CTE lesson.	Work through the steps/processes of the embedded math example. Bridge the CTE and math language. The transition from CTE to math vocabulary should be gradual throughout the lesson, being sure never to abandon completely either set of vocabulary once it is introduced.
4. Work through *related, contextual* math-in-CTE examples.	Using the same math concept *embedded* in the CTE lesson: Work through similar problems/examples in the same occupational context. Use examples with varying levels of difficulty; order examples from basic to advanced. Continue to bridge CTE and math vocabulary. Check for understanding.

Table 2-1. Continued

Elements/Steps	Teacher Directions
5. Work through *traditional math* examples.	Using the same math concept as in the *embedded and related, contextual examples*: Work through traditional math examples as they may appear on tests. Move from basic to advanced examples. Continue to bridge CTE and math vocabulary. Check for understanding.
6. Students demonstrate their understanding.	Provide students opportunities for demonstrating their understanding of the math concepts embedded in the CTE lesson. Conclude the math examples back to the CTE content; conclude the lesson on the topic of CTE.
7. Formal assessment.	Incorporate math questions into formal assessments at the end of the CTE unit/course.

Note. *Building Academic Skills in Context: Testing the Value of Enhanced Math Learning in CTE* (Stone et al., 2006, 12).

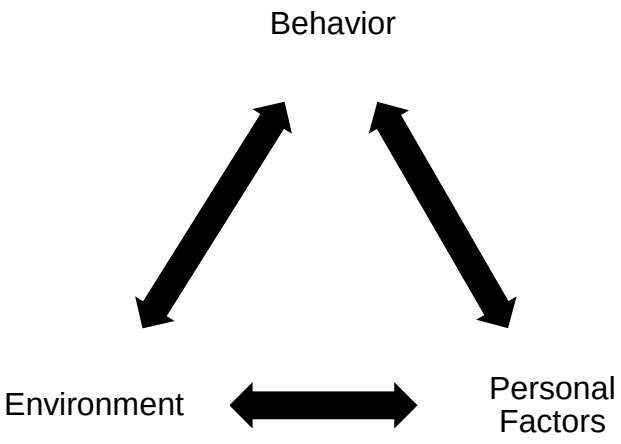

Figure 2-1. Triadic reciprocality model (Bandura, 1986, p. 24).

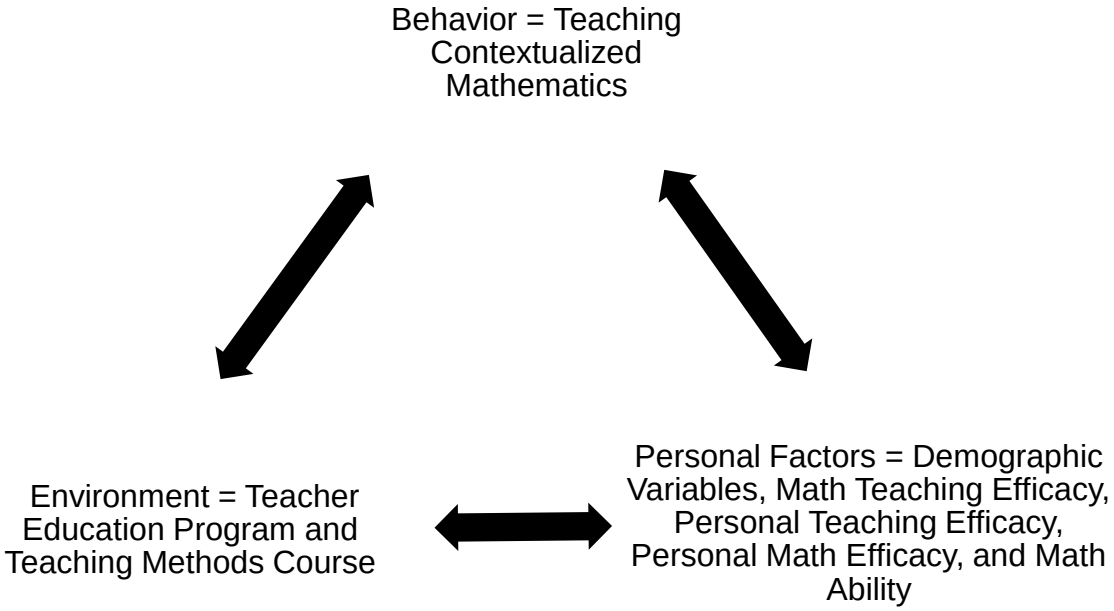

Figure 2-2. Triadic reciprocality model of variables under investigation. Adapted from Social Foundation of Thought and Action (Bandura, 1986).

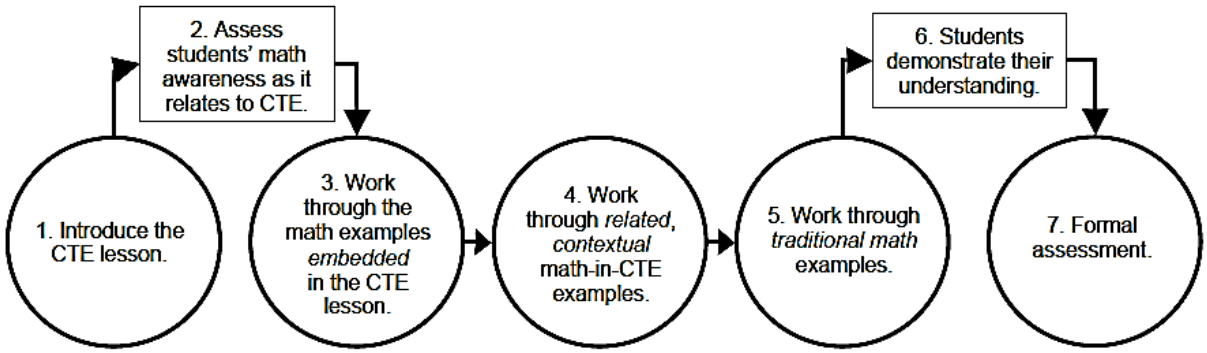

Figure 2-3. The National Research Center for Career and Technical Education: Seven Elements of a Math-Enhanced Lesson model (Stone et al., 2006, p. 13).

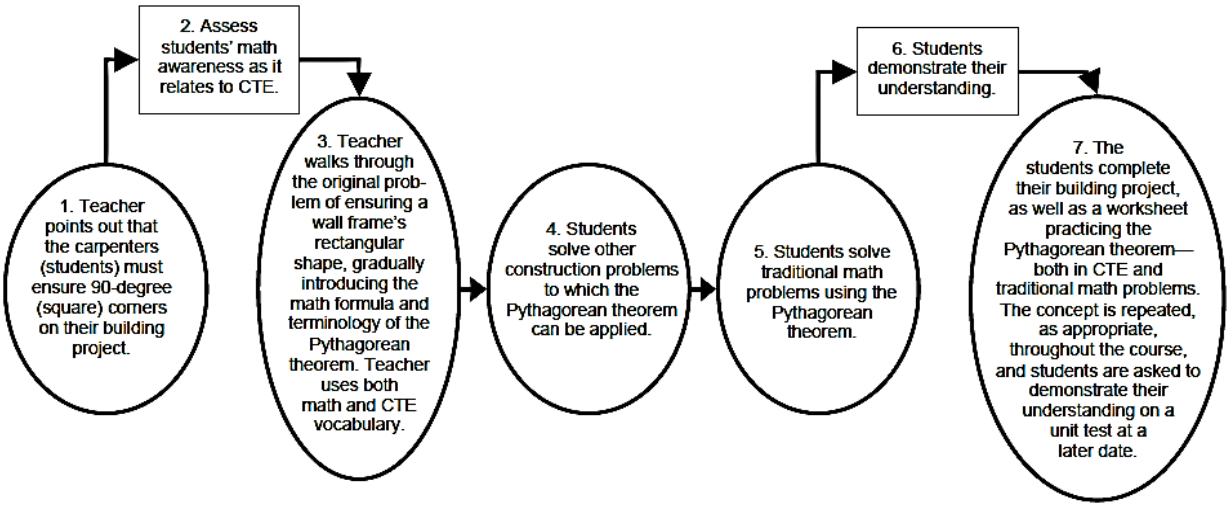

Figure 2-4. Sample building trades math-enhanced lesson: Using the Pythagorean theorem (Stone et al., 2006, p. 13).

CHAPTER 3
METHODOLOGY

Chapter 1 provided a historical context to the mathematics deficiency among American students that has continually persisted for over 30 years and that mathematics deficiency provided the basis for this study. The purpose of this study was outlined, along with specific objectives and hypotheses. Key terms were defined and assumptions and limitations were stated.

Chapter 2 described the theoretical framework and the conceptual model utilized to guide this study. Additionally, Chapter 2 presented prominent literature related to the various components of the conceptual model utilized in this study.

In Chapter 3, the methods used to address the research objectives are discussed. Specifically, Chapter 3 reports the research design, procedures, population and sample, instrumentation, data collection, and data analysis.

For this study, the independent variable of interest was the mathematics teaching and integration strategies (MTIS) treatment. Dependent variables included mathematics teaching efficacy, personal mathematics efficacy, personal teaching efficacy, and mathematics ability of the preservice agricultural education teachers. The following student characteristics were included as antecedent variables: gender, grade point average, number and type of mathematics courses completed in high school and college, grade received in last mathematics course completed, and age of the preservice agricultural teachers. Finally, to account for differences in prior knowledge, pretest mathematics ability scores were considered as a covariate.

Research Design

This research was quasi-experimental and utilized a nonequivalent control group design (Campbell & Stanley, 1963). This design was utilized because random assignment of subjects was not possible due to the fact that the subjects under investigation self-registered for a section of a teaching methods course (AEC 4200 *Teaching Methods in Agricultural Education*) that best fit their schedule of classes. To that end, the agricultural education teaching methods course is organized into lectures and labs. The lectures are utilized to deliver content information related to teaching methods, strategies, and approaches. The labs are utilized to allow the preservice teachers to deliver micro-teachings to their peers, and the micro-teachings are based on the content discussed in the lectures. The MTIS treatment utilized in this study was assigned to the teaching methods lab sections randomly. The treatment group was administered the MTIS, and the control group received the same instruction except for the MTIS. The composition of the teaching methods course and the treatment are discussed further in the procedures section.

The *Mathematics Ability Test* (Stripling & Roberts, 2012b) was used to compare mathematics knowledge before and after the MTIS treatment. The research design was illustrated by Campbell and Stanley (1963) and is shown in Figure 3-1 on page 102.

The *Mathematics Enhancement Teaching Efficacy Instrument* (Jansen, 2007) was used to compare efficacy measures before, during, and after the MTIS treatment. As a result, a variation of Campbell and Stanley's (1963) nonequivalent control group design was implemented for this study and is shown in Figure 3-2 on page 102.

According to Campbell and Stanley (1963), selection interaction effects and possibly regression are threats to the internal validity of the nonequivalent control group

design. Selection interaction effects are when other threats to interval validity interact with the selection of groups in multiple-group, quasi-experimental designs and are mistaken for the effect of the treatment (Campbell & Stanley, 1963). In this study, selection interaction effects were partially controlled by using the pretest mathematics ability scores as a covariate; however, this does not completely eliminate the risk of possible selection interaction effects. Thus, selection interaction effects are a limitation of this study. Statistical regression is the selection of participants based upon extreme scores (Campbell & Stanley, 1963). This was not an issue in this study. Participants were not selected based on extreme scores. Furthermore, the following possible threats to internal validity are controlled by the nonequivalent control group design: history, maturation, testing, instrumentation, selection, and mortality (Campbell & Stanley, 1963).

Procedures

The treatment of this study was devised by the researcher and was incorporated into the teaching methods course during the final year of a teacher education program at the University of Florida. The MTIS treatment consisted of three parts. First, the researcher prepared and delivered a lecture (Appendix A) to the treatment group of preservice teachers, which explained and demonstrated how to use the National Research Center for Career and Technical Education's seven components of a math-enhanced lesson model (Stone, Alfeld, Pearson, Lewis, & Jensen, 2006) to teach contextualized mathematics concepts. The lecture was reviewed by an expert on the seven components of a math-enhanced lesson to ensure validity. Second, each preservice agricultural education teacher in the treatment group was randomly assigned two of the 13 National Council of Teachers of Mathematics (NCTM) sub-standards

(Carpenter & Gorg, 2000) that have been cross-referenced to the National Agriculture, Food and Natural Resources Career Cluster Content Standards. Third, the preservice teachers in the treatment group were required to teach the two NCTM sub-standards to their peers in the treatment group using the seven components of a math-enhanced lesson (Stone et al., 2006). Therefore, each preservice teacher in the treatment group participated in the math-enhanced lesson lecture, integrated mathematics into two of the eight normally required micro-teachings of the teaching methods course, and observed their peers teaching up to 12 math-enhanced lessons, while roleplaying as a secondary student. In summary, beyond what was previously required in the teaching methods course the treatment added the following three elements: (a) a lecture on the seven components of a math-enhanced lesson, (b) random assignment of the NCTM sub-standards among the preservice teachers, and (c) requiring two of the micro-teaching lessons to be math-enhanced.

Population and Sample

The target population for this study was Florida preservice agricultural education teachers. The accessible population for this study was present undergraduate and graduate students in their final year of the agricultural teacher education program at the University of Florida. For this study, the accessible population was a convenience sample, which was conceptualized as a slice in time (Oliver & Hinkle, 1981). Gall, Borg, and Gall (1996) stated that convenience sampling is appropriate as long as the researcher provides a detailed description of the sample used and the reasons for selection. To that end, the sample was selected based on Stripling and Roberts' (2012b) study that discovered that Florida preservice teachers were not proficient in the cross-referenced NCTM sub-standards.

The sample consisted of 19 preservice agricultural education teachers, 16 females and 3 males. The average age of the sample was 21.5 years old (*SD* = 1.12) with a range of 20 to 25. All of the participants described their ethnicity as white and were seniors in an undergraduate agricultural education program. Their self-reported mean college grade point average was 3.44 (*SD* = 0.28) on a 4-point scale. The number of college level mathematics courses completed by the participants ranged from 1 to 5 with a mean of 3.02 (*SD* = 1.09), and two of the participants reported that they had not completed a mathematics course since high school. To that end, the time since the participants' last math course ranged from the previous semester in college to their senior year in high school or about four years prior. Lastly, 31.6% received an A, 21.1% a B+, 26.3% a B, and 21.4% a C in their highest level of mathematics successfully completed in college, and the highest most commonly completed course in college was introductory statistics.

Instrumentation

Two instruments were used during this study for data collection, the *Mathematics Ability Test* (Stripling & Roberts, 2012b) and the *Mathematics Enhancement Teaching Efficacy Instrument* (Jansen, 2007). The *Mathematics Ability Test* is a researcher-developed instrument that was developed based on the 13 NCTM sub-standards (Carpenter & Gorg, 2000) that are cross-referenced with the National Agriculture, Food and Natural Resources Career Cluster Content Standards (National Council for Agricultural Education, 2009). The *Mathematics Ability Test* consists of 26 open-ended mathematical word problems or two items for each cross-referenced NCTM sub-standard, and the sum of the 26 items measures one construct – mathematics ability. During item development, the researcher met with a secondary mathematics expert to

determine which items from Miller and Gliem's (1996) agricultural problem solving test would meet the requirements of the 13 NCTM sub-standards. The secondary mathematics expert determined that seven of Miller and Gliem's 15 items aligned with the 13 NCTM sub-standards, and therefore, all seven items were included on the *Mathematics Ability Test*. The remaining 19 items were developed based on NCTM examples problems (Carpenter & Gorg, 2000). The 13 cross-referenced NCTM sub-standards and the corresponding content or process area are provided in Table 3-1 on page 101.

The instrument was pilot tested during the Fall 2010 semester at the University of Florida. The pilot test consisted of 25 preservice agricultural education teachers and yielded a Cronbach's alpha coefficient of .80 for the mathematics ability construct. Face and content validity of the instrument was established by a panel of experts consisting of agricultural education and mathematics faculty from three universities and two secondary mathematics experts.

A demographic section was added to the *Mathematics Ability Test* and the participants self-reported gender, age, ethnicity, grade point average, number of math courses taken, highest level of mathematics taken, and grade received in last mathematics course completed. Additionally, the researcher and a mathematics expert individually scored the *Mathematics Ability Test*, and items were scored incorrect, partially correct (students set the problem up correctly but made a calculation error), or correct. The scorers used a rubric that was developed by two secondary mathematics experts to score each item. Inter-rater reliability was assessed using Cohen's Kappa,

and the analysis yielded a Cohen's Kappa of .95. Furthermore, a copy of the instrument is provided in Appendix B.

The *Mathematics Enhancement Teaching Efficacy Instrument* (Jansen, 2007) was developed and validated during a doctoral dissertation at Oregon State University and is divided into the following three constructs: mathematics teaching efficacy, personal mathematics efficacy, and personal teaching efficacy (see Appendix C). The instrument utilizes a different rating scale for each construct – personal mathematics efficacy (1 = *not at all confident* to 4 = *very confident*), mathematics teaching efficacy (1 = *strongly disagree* to 5 = *strongly agree*), and personal teaching efficacy (1 = *nothing* to 9 = *a great deal of influence*) (Jansen, 2007). Jansen reported that face and content validity was established by a panel of experts that included representatives from Oregon, Utah, and Washington. Exploratory and confirmatory factor analyses were used to verify the construct and discriminate validity of the instrument. Jansen pilot tested the instrument with Utah secondary agricultural teachers and reported that the Cronbach's alpha coefficients for the mathematics teaching efficacy, personal mathematics efficacy, and personal teaching efficacy constructs to be .92, .89, and .91, respectively. Jansen also conducted a larger study with a target population of all Oregon and Washington secondary agricultural teachers. The larger study consisted of 230 participants, and Jansen reported the Cronbach's alpha coefficients for the mathematics teaching efficacy, personal mathematics efficacy, and personal teaching efficacy constructs to be .88, .84, and .91, respectively. Scores for each construct were calculated by averaging the corresponding items after reverse coding items 2, 4, 5, 7, 9, 10, 11, and 13. Lastly, for this study, the post-hoc reliabilities for the mathematics

teaching efficacy, personal mathematics efficacy, and personal teaching efficacy constructs were .93, .80, and .89, respectively.

Data Collection

The data collection period of this study was during the Fall 2011 academic semester. Data were collected from preservice agricultural teachers during their final year of an agricultural teacher education program at the University of Florida. The agricultural education preservice teachers volunteered to participate and take the *Mathematics Ability Test* and the *Mathematics Enhancement Teaching Efficacy Instrument* (Jansen, 2007) by signing an informed consent, which was approved by the Institutional Review Board at the University of Florida (Appendix D). Participants were informed that the researcher would protect their privacy rights by ensuring anonymity and appropriate storage of data. In addition, since students received and completed the instruments during their agricultural education courses, they were informed that participation in the study would not have an impact on their course grades. A script (Appendix E) was also developed and read to standardize administration, minimize error variance, and experimenter effects.

The *Mathematics Ability Test* took the participants approximately 60 minutes to complete and was administered twice: (a) week two of the Fall 2011 semester; and (b) week 16 or the last week of the Fall 2011 semester. The *Mathematics Enhancement Teaching Efficacy Instrument* (Jansen, 2007) took the participants approximately 8 minutes to complete and was administered three times: (a) week two of the Fall 2011 semester; (b) week 12 of the Fall 2011 semester/after the preservice teachers in the treatment group delivered their first mathematics enhanced lesson; and (c) week 15 of the Fall 2011 semester.

Analysis of Data

Data were analyzed using SPSS® version 17 for Windows™. Frequencies, means, and standard deviations were calculated to summarize demographics, mathematics teaching efficacy, personal mathematics efficacy, personal teaching efficacy, and mathematics ability of the preservice agricultural education teachers. MANOVAs were used to determine if significant differences existed in mathematics teaching efficacy, personal mathematics efficacy, and personal teaching efficacy based upon the MTIS treatment. ANCOVA was also used to determine if a significant difference existed in mathematics ability based upon the MTIS treatment. Partial eta squared was used to calculate effect size, and Huck's (2008) descriptors were utilized to describe the effect (.01 is a small effect size, .06 is a medium effect size, and .14 is a large effect size).

According to Huck (2008) the use of inferential statistics is appropriate for this type of research. Huck stated that inferential statistics can be used with a current sample to make inferences to an abstract population – population that is comprised of present and future members. Huck (2008) also purported that abstract populations exists "hypothetically as a larger 'mirror image' of the sample" (p.102) or current accessible populations. Furthermore, Huck stated that abstract populations can be conceptualized from convenience samples that are described in detail. Consistent with Huck, Gall, Gall, and Borg (2003) justified the use of inferential statistics with a convenience sample. Gall et al. (2003) stated that "inferential statistics can be used with data collected from a convenience sample if the sample is carefully conceptualized to represent a particular population" (p.176). Demographic data from the previous year of graduating preservice agricultural education teachers at the University of Florida

supported that the convenience sample was representative of the target population. In addition, qualitative data from the teacher educators at the University of Florida confirmed that the convenience sample was representative of the target population.

Despite the researcher's efforts to reduce deviations from the aforementioned methodology, a few differences should be noted in the actual implementation. First, 2 of the 13 preservice teachers in the experimental group only developed and taught one math-enhanced lesson. Secondly, 2 of the 13 preservice teachers in the experimental group misplaced their second assigned National Council of Teachers of Mathematics sub-standard, and as a result, were randomly assigned another sub-standard to replace the standard that was lost by the preservice teachers. Thirdly, a few preservice teachers were absent on the scheduled data collection days. Two preservice teachers were absent on the initial administration of the *Mathematics Enhancement Teaching Efficacy Instrument* (Jansen, 2007). Therefore, they completed the instrument two days after the other participants. For the third administration of the *Mathematics Enhancement Teaching Efficacy Instrument*, one preservice teacher was absent and completed the efficacy measure one day after the other participants. One preservice teacher was also absent on the second administration of the *Mathematics Ability Test*. This preservice teacher completed the mathematics ability instrument one day after the other participants. The researcher was unable to compare the data collected during and after the scheduled data collections, because the data was collected anonymously. However, after visually inspecting scatterplots of the data, the research determined that there were no outliers present, and therefore, the deviations in data collection did not affect the results of the study.

Also, the second administration of the *Mathematics Ability Test* was inadvertently given on the same day as a final for a number of the participants. This may explain why some of the preservice teachers anecdotally put forth less effort and showed less work on the open-ended mathematical word problems on the second administration. Lastly, one preservice teacher was absent for one of the math-enhanced micro-teaching labs.

Chapter 3 Summary

In Chapter 3, the methods used to address the research objectives were discussed. Specifically, Chapter 3 reported the research design, procedures, population and sample, instrumentation, data collection, and data analysis.

The independent variable in this study was the MTIS treatment. Dependent variables were mathematics teaching efficacy, personal mathematics efficacy, personal teaching efficacy, and mathematics ability of the preservice teachers. Student characteristics were included as antecedent variables. The research design of this study was identified as a nonequivalent control group design (Campbell & Stanley, 1963) and threats to validity were discussed.

The target population of this study was Florida preservice agricultural education teachers, and the accessible population was acknowledged. The accessible population was also categorized as a convenience sample and justification for the method was given. The instruments used in the study were identified and the validity and reliability for each instrument was discussed. The data collection methods were outlined, and the methods used to analyze the data were reported.

Chapter 4 will present the findings of this study based on the research objectives.

Table 3-1. Cross-referenced NCTM Sub-standards for Grades 9-12

Content/Process Area	NCTM Sub-standards
Number & Operations	1A. Understand numbers, ways of representing numbers, relationships among numbers, and number systems.
	1B. Understand meanings of operations and how they relate to one another.
	1C. Compute fluently and make reasonable estimates.
Algebra	2C. Use mathematical models to represent and understand quantitative relationships.
	2D. Analyze change in various contexts.
Geometry	3A. Analyze characteristics and properties of two- and three dimensional geometric shapes and develop mathematical arguments about geometric relationships.
Measurement	4A. Understand measurable attributes of objects and the units, systems, and processes of measurement.
	4B. Apply appropriate techniques, tools, and formulas to determine measurements.
Data Analysis & Probability	5A. Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.
	5B. Select and use appropriate statistical methods to analyze data.
	5C. Develop and evaluate inferences and predictions that are based on data.
Problem Solving	6B. Solve problems that arise in mathematics in other contexts.
	6C. Apply and adapt a variety of appropriate strategies to solve problems.

Note. *Principle and Standards for School Mathematics* (Carpenter & Gorg, 2000).

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Figure 3-1. Research design mathematics ability.

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Figure 3-2. Research design efficacy measures.

CHAPTER 4
RESULTS

Chapter 1 provided a historical context to the mathematics deficiency among American students that has continually persisted for over 30 years and that mathematics deficiency provided the basis for this study. The purpose of this study was outlined, along with specific objectives and hypotheses. Key terms were defined and assumptions and limitations were stated.

Chapter 2 described the theoretical framework and the conceptual model utilized to guide this study. Additionally, Chapter 2 presented prominent literature related to the various components of the conceptual model utilized in this study.

Chapter 3 discussed the methods used to address the research objectives and reported the research design, procedures, population and sample, instrumentation, data collection, and data analysis.

The independent variable in this study was the mathematics teaching and integration strategies (MTIS) treatment. Dependent variables included mathematics teaching efficacy, personal mathematics efficacy, personal teaching efficacy, and mathematics ability of the preservice agricultural education teachers. The following student characteristics were treated as antecedent variables: gender, grade point average, number and type of mathematics courses completed in high school and college, grade received in last mathematics course completed, and age of the preservice agricultural teachers. Also, to account for differences in prior mathematics knowledge, pretest mathematics ability scores were used as a covariate. The research design was quasi-experimental and utilized a nonequivalent control group design (Campbell & Stanley, 1963). Data collected were mathematics ability (as measured by

the *Mathematics Ability Test),* mathematics teaching efficacy, personal mathematics efficacy, and personal teaching efficacy (as measured by the *Mathematics Enhancement Teaching Efficacy Instrument*). Data were analyzed using frequencies, means, standard deviations, an ANCOVA, and MANOVAs.

Chapter 4 presents the findings obtained by this study. The results address the objectives and hypotheses in determining the influence of the MTIS treatment on the preservice teachers' mathematics ability, mathematics teaching efficacy, personal mathematics efficacy, and personal teaching efficacy.

The sample consisted of preservice teachers enrolled in AEC 4200 *Teaching Methods in Agricultural Education* during the Fall 2011 semester (n = 19). As outlined in Chapter 3, mathematics ability data were collected (a) week two of the Fall 2011 semester; and (b) week 16/the last week of the Fall 2011 semester. Mathematics teaching efficacy, personal mathematics efficacy, and personal teaching efficacy data were collected (a) week two of the Fall 2011 semester; (b) week 12 of the Fall 2011 semester/after the preservice teachers in the treatment group delivered their first mathematics enhanced lesson; and (c) week 15 of the Fall 2011 semester. The response rate for each collection was 100%.

Prior to the study, the researcher-developed *Mathematics Ability Test* was pilot tested during the Fall 2010 semester at the University of Florida to assess reliability. The pilot test consisted of 25 preservice agricultural education teachers and yielded a Cronbach's alpha coefficient of .80 for the mathematics ability construct. The *Mathematics Enhancement Teaching Efficacy Instrument* was developed and validated during a doctoral dissertation at Oregon State University and is divided into the following

three constructs: mathematics teaching efficacy, personal mathematics efficacy, and personal teaching efficacy. Jansen (2007) pilot tested the instrument and reported that the Cronbach's alpha coefficients for the mathematics teaching efficacy, personal mathematics efficacy, and personal teaching efficacy constructs to be .92, .89, and .91, respectively. For this study, the post-hoc reliabilities for the mathematics teaching efficacy, personal mathematics efficacy, and personal teaching efficacy constructs were .93, .80, and .89, respectively.

Descriptive Statistics of Variables in this Study

Mathematics Ability

As depicted in Table 4-1 on page 116, the control group's pretest mathematics ability scores week two of the teaching methods course averaged 45.51% (*SD* = 9.32), and the pretest scores ranged from 30.77% to 57.69%. At the end of the teaching methods course or week 16, the control group's posttest mathematics ability scores averaged 45.19% (*SD* = 11.26), and the posttest scores ranged from 30.77% to 59.62%. The control group's mathematics ability mean decreased 0.32% from week two to week 16 of the teaching methods course. A distribution of the control group's pretest mathematics ability scores may be found in Figure 4-1 on page 122, and their posttest scores in Figure 4-2 on page 122.

The experimental group's pretest mathematics ability scores increased from week two to week 16 of the teaching methods course (Table 4-1, p. 116). The pretest scores averaged 38.31% (*SD* = 11.03), and the pretest scores ranged from 23.08% to 59.62%. At the end of the teaching methods course or week 16, the control group's posttest mathematics ability scores averaged 45.71% (*SD* = 11.69), and the posttest scores ranged from 36.54% to 69.23%. The experimental group's mathematics ability mean

increased 7.40% from week two to week 16 of the teaching methods course. A distribution of the experimental group's pretest mathematics ability scores may be found in Figure 4-3 on page 123, and their posttest scores in Figure 4-4 on page 123.

Personal Mathematics Efficacy

The control group's personal mathematics efficacy scores increased from week two to week 15 of the teaching methods course (Table 4-2, p. 116; Figure 4-11, p. 129). The control group's personal mathematics efficacy scores week two of the teaching methods course averaged 3.52 (*SD* = 0.43). After the preservice teachers in the treatment group delivered their first mathematics enhanced lesson (week 12 of the teaching methods course), the control group's personal mathematics efficacy scores averaged 3.67 (*SD* = 0.49). Week 15 of the teaching methods course, the control group's personal mathematics efficacy scores averaged 3.67 (*SD* = 0.67). A distribution of the control group's personal mathematics efficacy scores may be found in Figures 4-5, 4-6, and 4-7 on pages 124, 125, and 126, respectively.

The experimental group's personal mathematics efficacy scores increased at each data collection point (Table 4-2, p. 116; Figure 4-11, p. 129). The week two teaching methods course average was 3.39 (*SD* = 0.49). After delivering their first mathematics enhanced lesson or week 15, the experimental group's personal mathematics efficacy scores averaged 3.46 (*SD* = 0.37). Week 15 of the teaching methods course, the experimental group's personal mathematics efficacy scores averaged 3.50 (*SD* = 0.44). A distribution of the experimental group's personal mathematics efficacy scores may be found in Figures 4-8, 4-9, and 4-10 on pages 127, 128, and 129 respectively.

In addition, the mean differences in personal mathematics efficacy scores from week two to week 15 of the teaching methods course (data collection points 1 and 3),

from week two to week 12 of the teaching methods course/after the preservice teachers in the treatment group delivered their first mathematics enhanced lesson (data collection points 1 and 2), and from week 12 to week 15 of the teaching methods course (data collection points 2 and 3) are presented in Table 4-3 on page 116.

Mean differences in the control group's personal mathematics efficacy scores were as follows: (a) data collection points three minus one was 0.15 (*SD* = 0.09); (b) data collection points two minus one was 0.15 (*SD* = 0.20); and (c) data collection points three minus two was 0.00 (*SD* = 0.21). Mean differences in the experimental group's personal mathematics efficacy scores were as follows: (a) data collection points three minus one was 0.11 (*SD* = 0.28); (b) data collection points two minus one was 0.07 (*SD* = .31); and (c) data collection points three minus two was 0.04 (*SD* = 0.25).

Mathematics Teaching Efficacy

As depicted in Table 4-4 (p. 116) and Figure 4-18 (p. 134), the control group's mathematics teaching efficacy scores increased from week two to week 15 of the teaching methods course. The week two teaching methods course average was 3.40 (*SD* = 0.47). After the preservice teachers in the treatment group delivered their first mathematics enhanced lesson (week 12 of the teaching methods course), the control group's mathematics teaching efficacy scores averaged 3.37 (*SD* = 0.67). Week 15 of the teaching methods course, the control group's mathematics teaching efficacy scores averaged 3.50 (*SD* = 0.56). A distribution of the control group's mathematics teaching efficacy scores may be found in Figures 4-12, 4-13, and 4-14 on pages 130, 131, and 132, respectively.

The experimental group's mathematics teaching efficacy scores decreased from week two to week 15 of the teaching methods course (Table 4-4, p. 116; Figure 4-18, p.

134). The experimental group's mathematics teaching efficacy scores week two of the teaching methods course averaged 3.69 (*SD* = 0.61). After delivering their first mathematics enhanced lesson (week 12 of the teaching methods course) the experimental group's mathematics teaching efficacy scores averaged 3.41 (*SD* = 0.97). Week 15 of the teaching methods course, the experimental group's mathematics teaching efficacy scores averaged 3.50 (*SD* = 0.98). A distribution of the experimental group's personal mathematics efficacy scores may be found in Figures 4-15, 4-16, and 4-17 on pages 132, 133, and 134, respectively.

The mean differences in mathematics teaching efficacy scores from week two to week 15 of the teaching methods course (data collection points 1 and 3), from week two of the teaching methods course to week 12 of the teaching methods course/after the preservice teachers in the treatment group delivered their first mathematics enhanced lesson (data collection points 1 and 2), and from week 12 to week 15 of the teaching methods course (data collection points 2 and 3) are presented in Table 4-5 on page 116.

Mean differences in the control group's mathematics teaching efficacy scores were as follows: (a) data collection points three minus one was 0.10 (*SD* = 0.50); (b) data collection points two minus one was -0.03 (*SD* = 0.63); and (c) data collection points three minus two was 0.13 (*SD* = 0.14). Mean differences in the experimental group's mathematics teaching efficacy scores were as follows: (a) data collection points three minus one was -0.19 (*SD* = 0.60); (b) data collection points two minus one was -0.28 (*SD* = 0.49); and (c) data collection points three minus two was 0.09 (*SD* = 0.41).

Personal Teaching Efficacy

As depicted in Table 4-6 (p. 117) and Figure 4-25 (p. 139), the control group's personal teaching efficacy scores week two of the teaching methods course averaged 7.32 (*SD* = 0.62). After the preservice teachers in the treatment group delivered their first mathematics enhanced lesson (week 12), the control group's personal teaching efficacy scores averaged 7.00 (*SD* = 0.73). Week 15 of the teaching methods course, the control group's personal teaching efficacy scores averaged 7.03 (*SD* = 0.42). A distribution of the control group's personal teaching efficacy scores may be found in Figures 4-19, 4-20, and 4-21 on pages 135, 136, and 137, respectively.

The experimental group's personal teaching efficacy scores decreased at each data collection point (Table 4-6, p. 117; Figure 4-25, p. 139). The experimental group's personal teaching efficacy scores week two of the teaching methods course averaged 7.67 (*SD* = 0.61). After delivering their first mathematics enhanced lesson (week 12), the experimental group's personal teaching efficacy scores averaged 7.57 (*SD* = 0.72). Week 15 of the teaching methods course, the experimental group's personal teaching efficacy scores averaged 7.46 (*SD* = 1.04). A distribution of the experimental group's personal teaching efficacy scores may be found in Figures 4-22, 4-23, and 4-24 on pages 137, 138, and 139, respectively.

The mean differences in personal teaching efficacy scores from week two to week 15 of the teaching methods course (data collection points 1 and 3), from week two to week 12 of the teaching methods course/after the preservice teachers in the treatment group delivered their first mathematics enhanced lesson (data collection points 1 and 2), and from week 12 to week 15 of the teaching methods course (data collection points 2 and 3) are presented in Table 4-7 on page 117.

Mean differences in the control group's personal teaching efficacy scores were as follows: (a) data collection points three minus one was -0.29 (*SD* = 0.38); (b) data collection points two minus one was -0.32 (*SD* = 0.48); and (c) data collection points three minus two was 0.03 (*SD* = 0.55). Mean differences in the experimental group's personal teaching efficacy scores were as follows: (a) data collection points three minus one was -0.21 (*SD* = 0.82); (b) data collection points two minus one was -0.10 (*SD* = .52); and (c) data collection points three minus two was -0.11 (*SD* = 0.52).

Relationships Between Variables

As part of the description of the variables in this study, all variables were examined for correlations. For the purpose of discussion, the terminology proposed by Davis (1971) was used to indicate the magnitude of the correlations. Correlations from .01 to .09 are negligible, .10 to .29 are low, .30 to .49 are moderate, .50 to .69 are substantial, .70 to .99 are very strong, and a correlation of 1.00 is perfect. Pearson correlations were used for continuous data (Table 4-8, p. 118), and point biserial correlations were used for dichotomous data (Table 4-9, p. 119).

With that in mind, group was coded as control (0) or experimental (1), gender was coded as male (0) or female (1), grade received in most recent college mathematics course was coded as not the grade received (0) or grade received (1), completing a mathematics courses in high school for college credit was coded as not completed (0) or completed (1), and the types of mathematics courses were coded as not completed (0) or completed (1). The types of mathematics courses completed in high school and college by the preservice agricultural teachers were categorized into basic, intermediate, and advanced mathematics by a mathematics expert. The mathematics expert categorized algebra, algebra II, and college algebra as basic mathematics,

trigonometry, pre-calculus, and statistics as intermediate mathematics, and calculus as advanced mathematics. Furthermore, for readability abbreviations for mathematics teaching efficacy (MTE), personal mathematics efficacy (PME), and personal teaching efficacy (PTE) were used when reporting the results of the correlations.

As would be expected, very strong or substantial correlations were discovered within the MTE, PME, PTE, and mathematics ability measures. Moderate and substantial associations were found between all the MTE and PME measures but not between PTE and the other efficacy measures.

MTE 3 was substantially associated with the number of mathematics courses completed in college (r = .52) and a grade of a C in most recent college mathematics course (r = – .69). MTE 3 was moderately associated with completing an advanced mathematics course in high school (r = .38) and a grade of a B in most recent college mathematics course (r = .48).

PME 3 was substantially associated with completing a basic mathematics course in high school (r = – .52) and completing an advanced mathematics course in high school (r = .57). PME 3 was moderately associated with PTE 1(r = .34), PTE 3 (r = .30), pretest math ability (r = .47), posttest math ability (r = .40), the number of mathematics courses completed in college (r = .33), completing a basic mathematics course in college (r = – .32), completing an advanced mathematics course in college (r = .39), and a grade of a C in most recent college mathematics course (r = – .35).

PTE 3 was moderately associated with age (r = .38), GPA (r = – .36), and completing an advanced mathematics course in high school (r = .37). Lastly, posttest mathematics ability was moderately associated with completing an advanced

mathematics course in high school (r = .33), completing a basic mathematics course in college (r = – .30), and with completing a mathematics courses in high school for college credit (r = .45).

Antecedent Variables

The following student characteristics were included in this study as antecedent variables: gender, grade point average, number and type of mathematics courses completed in high school and college, grade received in last mathematics course completed, and age of the preservice agricultural teachers. Each of the aforementioned variables was examined to determine if differences were present between the control and experimental groups. Chi-squares were used to determine if significant differences existed between the groups for categorical data, and independent samples t-test were used to determine if significant differences existed between the groups for continuous data. No statistically significant differences were found between the control and experimental groups in regard to the antecedent variables (Tables 4-10 and 4-11, p. 120).

Hypothesis Tests

Dependent variables in this study included mathematics teaching efficacy, personal mathematics efficacy, personal teaching efficacy, and mathematics ability of the preservice agricultural education teachers. All of the aforementioned variables were interval data. The independent variable in this study was the MTIS treatment, and it is categorical in nature. In addition, the covariate used in the analysis of hypothesis one was the mathematics ability pretest scores, and this data was interval.

To determine if significant differences existed in the mathematics teaching efficacy, personal mathematics efficacy, personal teaching efficacy, and mathematics

ability scores of preservice teacher based upon the MTIS treatment, hypotheses were formulated to frame this study. The decisions to reject or fail-to-reject the null hypotheses were based upon the ANCOVA and MANOVA procedures used in this study and *a priori* significance level of .05.

Hypothesis Related to Mathematics Ability

H_{01} – There is no significant difference in the mathematics ability of preservice agricultural education teachers based upon the mathematics teaching and integration strategies treatment.

This hypothesis was tested using an ANCOVA, and the analysis revealed a significant difference in the mathematics ability of preservice agricultural education teachers based upon the MTIS treatment, while controlling pretest mathematics ability scores, $F(1, 16) = 5.36$, $p < .05$ (Table 4-12, p. 120). Thus, the control group's adjusted posttest mean score ($M = 40.25$, $SE = 2.72$) was significantly lower than the experimental group's adjusted posttest mean ($M = 47.99$, $SE = 1.81$; Table 4-13, p. 120). The practical significance of the difference was assessed using a partial eta squared, and the effect size was .25, which is a large effect according to Huck (2008). Based on the statistically significant difference in adjusted posttest mean and the large effect size, the null hypothesis was rejected.

Hypothesis Related to Personal Mathematics Efficacy

H_{02} – There is no significant difference in the personal mathematics efficacy of preservice agricultural education teachers based upon the mathematics teaching and integration strategies treatment.

This hypothesis was tested using a MANOVA. The mean differences between the personal mathematics efficacy data collection points were the dependent variables.

With that in mind, the analysis did not reveal a significant difference in the personal mathematics efficacy of preservice agricultural education teachers based upon the MTIS treatment, $T = .02$, $F(2, 16) = 0.15$, $p > .05$ (Table 4-14, p. 120). Therefore, the researcher failed-to-reject the null hypothesis.

Hypothesis Related to Mathematics Teaching Efficacy

H_{03} – There is no significant difference in the mathematics teaching efficacy of preservice agricultural education teachers before and after mathematics teaching and integration strategies.

This hypothesis was tested using a MANOVA. The mean differences between the mathematics teaching efficacy data collection points were the dependent variables, and the analysis did not reveal a significant difference in the mathematics teaching efficacy of preservice agricultural education teachers based upon the MTIS treatment, $T = .06$, $F(2, 16) = 0.50$, $p > .05$ (Table 4-15, p. 121). Therefore, the researcher failed-to-reject the null hypothesis.

Hypothesis Related to Personal Teaching Efficacy

H_{04} – There is no significant difference in the personal teaching efficacy of preservice agricultural education teachers before and after mathematics teaching and integration strategies.

This hypothesis was tested using a MANOVA. The mean differences between the personal mathematics efficacy data collection points were the dependent variables, and the analysis did not reveal a significant difference in the personal teaching efficacy of preservice agricultural education teachers based upon the MTIS treatment, $T = .06$, $F(2, 16) = 0.49$, $p > .05$ (Table 4-16, p. 121). Therefore, the researcher failed-to-reject the null hypothesis.

Chapter 4 Summary

Chapter 4 presented the findings of this study. The findings were structured based on the objectives and hypothesis that guided this research. The descriptive statistics that were presented were based on the following objectives: (a) determine the effects of MTIS in the teaching methods course on mathematics ability; (b) determine the effects of MTIS in the teaching methods course on personal mathematics efficacy; (c) determine the effects of MTIS in the teaching methods course on mathematics teaching efficacy; and (d) determine the effects of MTIS in the teaching methods course on personal teaching efficacy. The null hypothesis tested in this study were: (a) there is no significant difference in the mathematics ability of preservice agricultural education teachers based upon the MTIS treatment; (b) there is no significant difference in the personal mathematics efficacy of preservice agricultural education teachers based upon the MTIS treatment; (c) there is no significant difference in the mathematics teaching efficacy of preservice agricultural education teachers based upon the MTIS treatment; and (d) there is no significant difference in the personal teaching efficacy of preservice agricultural education teachers based the MTIS treatment.

The findings presented in Chapter 4 will be discussed in greater detail in Chapter 5. To that end, Chapter 5 will provide conclusions, recommendations, and implications regarding the findings of this study.

Table 4-1. Mathematics Ability means

	Pretest		Posttest		Difference posttest – pretest	
	M	*SD*	*M*	*SD*	*M*	*SD*
Control group	45.51	9.32	45.19	11.26	– 0.32	5.36
Experimental group	38.31	11.03	45.71	12.69	7.40	6.56

Table 4-2. Personal Mathematics Efficacy

	Control group		Experimental group	
Time	*M*	*SD*	*M*	*SD*
Week two of the teaching methods course	3.52	0.43	3.39	0.49
Week 12 of the teaching methods course/after the preservice teachers in the treatment group delivered their first mathematics enhanced lesson	3.67	0.49	3.46	0.37
Week 15 of the teaching methods course	3.67	0.38	3.50	0.44

Note. 1 = not at all confident to 4 = very confident (Jansen, 2007).

Table 4-3. Mean differences in data collection points for Personal Mathematics Efficacy

	M difference 3 – 1	*SD*	*M* difference 2 – 1	*SD*	*M* difference 3 – 2	*SD*
Control group	0.15	0.09	0.15	0.20	0.00	0.21
Experimental group	0.11	0.28	0.07	0.31	0.04	0.25

Table 4-4. Mathematics Teaching Efficacy

	Control group		Experimental group	
Time	*M*	*SD*	*M*	*SD*
Week two of the teaching methods course	3.40	0.47	3.69	0.61
Week 12 of the teaching methods course/after the preservice teachers in the treatment group delivered their first mathematics enhanced lesson	3.37	0.67	3.41	0.97
Week 15 of the teaching methods course	3.50	0.56	3.50	0.98

Note. 1 = strongly disagree to 5 = strongly agree (Jansen, 2007).

Table 4-5. Mean differences in data collection points for Mathematics Teaching Efficacy

	M difference 3 – 1	*SD*	*M* difference 2 – 1	*SD*	*M* difference 3 – 2	*SD*
Control group	0.10	0.50	– 0.03	0.63	0.13	0.14
Experimental group	– 0.19	0.60	– 0.28	0.49	0.09	0.41

Table 4-6. Personal Teaching Efficacy

Time	Control group *M*	Control group *SD*	Experimental group *M*	Experimental group *SD*
Week two of the teaching methods course	7.32	0.62	7.67	0.61
Week 12 of the teaching methods course/after the preservice teachers in the treatment group delivered their first mathematics enhanced lesson	7.00	0.73	7.57	0.72
Week 15 of the teaching methods course	7.03	0.42	7.46	1.04

Note. 1 = nothing to 9 = a great deal of influence (Jansen, 2007).

Table 4-7. Mean differences in data collection points for Personal Teaching Efficacy

	M difference 3 – 1	*SD*	*M* difference 2 – 1	*SD*	*M* difference 3 – 2	*SD*
Control group	– 0.29	0.38	– 0.32	0.48	0.03	0.55
Experimental group	– 0.21	0.82	– 0.10	0.52	– 0.11	0.52

Table 4-8. Correlations between continuous variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. MTE 1	—	.80	.74	.43	.48	.59	.33	.20	.16	.36	.39	– .11	.39	– .11	.44
2. MTE 2		—	.92	.47	.65	.67	.34	.12	.11	.10	.35	– .12	.15	.00	.42
3. MTE 3			—	.50	.65	.66	.26	.13	.11	.25	.19	– .12	.16	– .15	.52
4. PME 1				—	.81	.86	.39	.42	.35	.51	.60	– .14	.11	– .11	.19
5. PME 2					—	.84	.27	.20	.22	.68	.60	– .26	.09	– .07	.03
6. PME 3						—	.34	.29	.30	.47	.40	– .18	.10	– .25	.33
7. PTE 1							—	.74	.63	.01	.24	.44	– .26	.13	.33
8. PTE 2								—	.82	.02	.36	.30	– .29	– .14	.22
9. PTE 3									—	.04	.24	.38	– .36	– .18	.12
10. Pretest math ability										—	.81	– .48	.36	.16	– .38
11. Posttest math ability											—	– .26	.17	.22	– .25
12. Age												—	– .21	.06	.36
13. GPA													—	– .28	.19
14. Time of last math course														—	– .31
15. Number of college math courses															—

Note. MTE = Mathematics Teaching Efficacy, PME = Personal Mathematics Efficacy, and PTE = Personal Teaching Efficacy.

Table 4-9. Correlations between continuous and dichotomous variables

	Group	Gender	Basic HS math course	Intermediate HS math course	Advanced HS math course	Basic College math course	Intermediate College math course	Advanced College math course	Grade of an A	Grade of an B	Grade of an C	College math credit in HS
1. MTE 1	.24	.08	– .19	– .05	.27	– .16	– .13	.24	.15	.15	– .36	.15
2. MTE 2	.02	– .02	– .23	– .06	.32	– .24	– .15	.31	.09	.38	– .57	.43
3. MTE 3	.00	.02	– .16	– .17	.38	– .21	.01	.11	.09	.48	– .69	.24
4. PME 1	– .13	– .06	– .48	– .08	.62	– .36	.07	.14	.07	.23	– .36	.19
5. PME 2	– .24	– .11	– .57	.06	.54	– .46	– .01	.29	.03	.40	– .52	.42
6. PME 3	– .19	– .08	– .52	– .01	.57	– .32	– .17	.39	.09	.20	– .35	.19
7. PTE 1	.27	– .44	– .52	.18	.35	– .12	.05	.02	– .32	.26	.04	.19
8. PTE 2	.36	– .23	– .26	– .18	.50	– .02	.03	– .02	– .29	.14	.15	– .01
9. PTE 3	.23	– .27	– .26	– .07	.37	– .02	.13	– .13	– .22	.13	.09	– .16
10. Pretest math ability	– .32	– .12	– .19	.02	.18	– .22	– .06	.20	.09	.21	– .36	.53
11. Posttest math ability	.02	– .02	– .23	– .07	.33	– .30	– .01	.19	– .06	.17	– .14	.45
12. Age	.43	– .32	.04	– .03	– .01	– .11	.13	– .08	– .02	– .26	.34	– .43
13. GPA	– .32	– .10	.14	– .06	– .08	.26	– .17	.04	.57	– .28	– .31	– .02
14. Time of last math course	.33	.29	.00	.12	– .15	– .16	.06	.03	– .07	– .00	.09	.31
15. Number of college math courses	.07	– .13	– .08	– .14	.24	.11	– .18	.13	.16	– .13	– .01	– .24

Note. Group was coded as control (0) or experimental (1), gender was coded as male (0) or female (1), grade received in most recent college mathematics course was coded as not the grade received (0) or grade received (1), completing a mathematics courses in high school for college credit was coded as not completed (0) or completed (1), and the types of mathematics courses were coded as not completed (0) or completed (1).

Table 4-10. Independent samples t-test for continuous antecedent variables

	M difference	*SE* difference	*t*	*p*
Age	– 1.01	0.52	– 1.97	.66
GPA	0.18	0.13	1.39	.18
Time of last math course	– 0.63	0.44	– 1.43	.17
Number of college math courses	– 0.17	0.56	– 0.30	.77

Table 4-11. Chi-square for categorical antecedent variables

	X^2	*p*
Gender	2.03	.15
Basic HS math course	0.42	.52
Intermediate HS math course	0.69	.41
Advanced HS math course	0.10	.75
Basic College math course	2.29	.13
Intermediate College math course	0.80	.37
Advanced College math course	0.01	.94
Grade of an A	1.38	.24
Grade of an B	0.02	.88
Grade of an C	2.34	.13
College math credit in HS	1.38	.24

Note. Gender was coded as male (0) or female (1), types of mathematics courses were coded as not completed (0) or completed (1), grade received in most recent college mathematics course was coded as not the grade received (0) or grade received (1), and completing a mathematics courses in high school for college credit was coded as not completed (0) or completed (1).

Table 4-12. ANCOVA summary

	SS	*df*	*MS*	*F*	*p*	η_p^2
Group	221.00	1	221.00	5.36	.03	.25
Error	660.21	16	41.26			

Table 4-13. Adjusted posttest Mathematics Ability means

	M	*SE*
Control group	40.25	2.72
Experimental group	47.99	1.81

Table 4-14. MANOVA Personal Mathematics Efficacy

	Hotelling's Trace	*df*	*F*	*p*
Personal Mathematics Efficacy	.02	2	0.15	.86

Table 4-15. MANOVA Mathematics Teaching Efficacy

	Hotelling's Trace	*df*	*F*	*p*
Mathematics Teaching Efficacy	.06	2	0.50	.61

Table 4-16. MANOVA Personal Teaching Efficacy

	Hotelling's Trace	*df*	*F*	*p*
Personal Teaching Efficacy	.06	2	0.49	.62

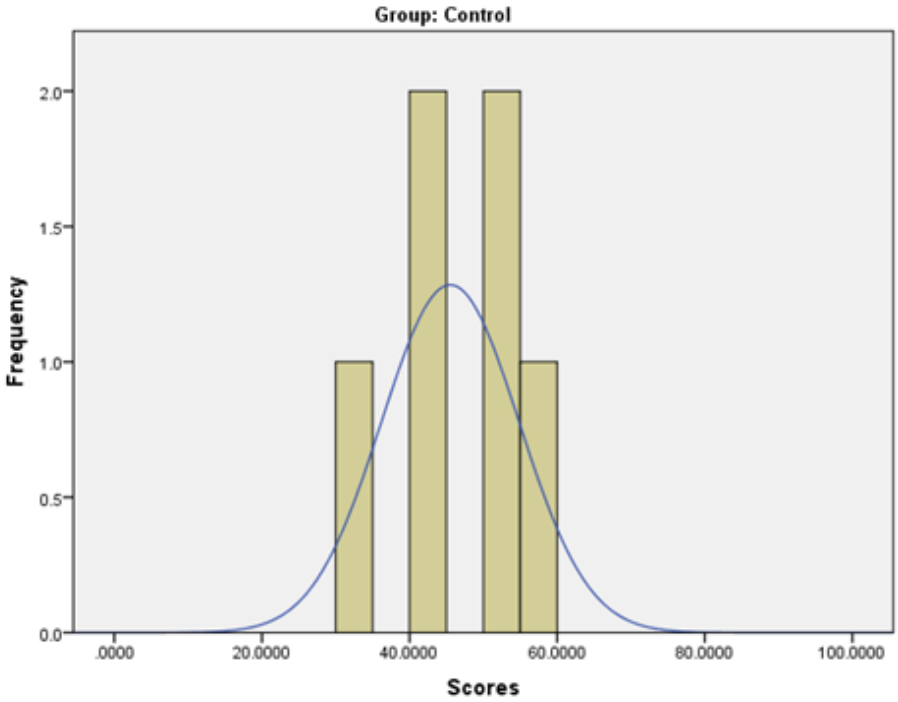


Figure 4-1. Distribution of the control group's pretest Mathematics Ability scores

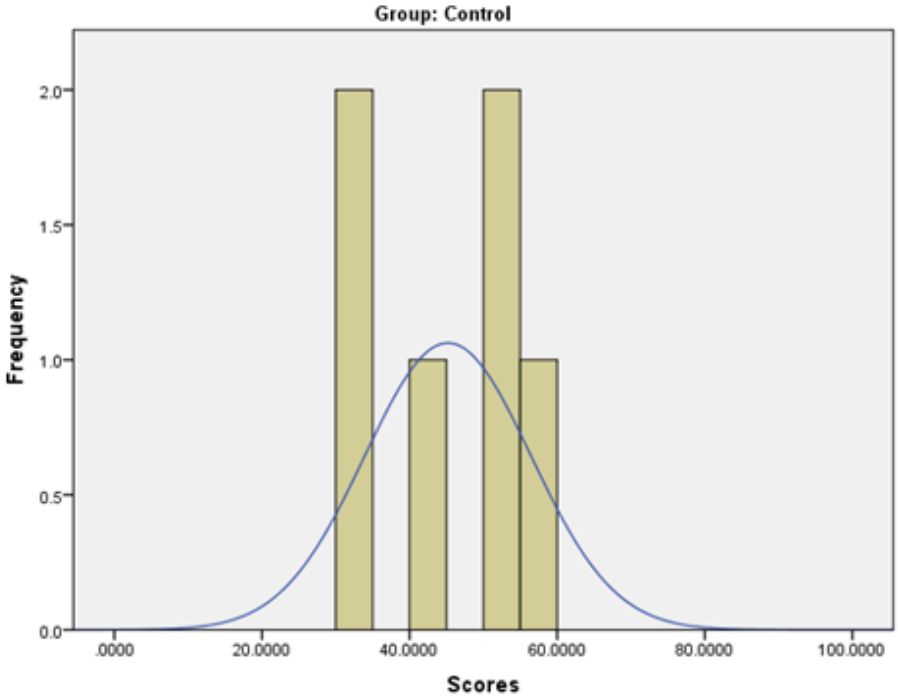


Figure 4-2. Distribution of the control group's posttest Mathematics Ability scores

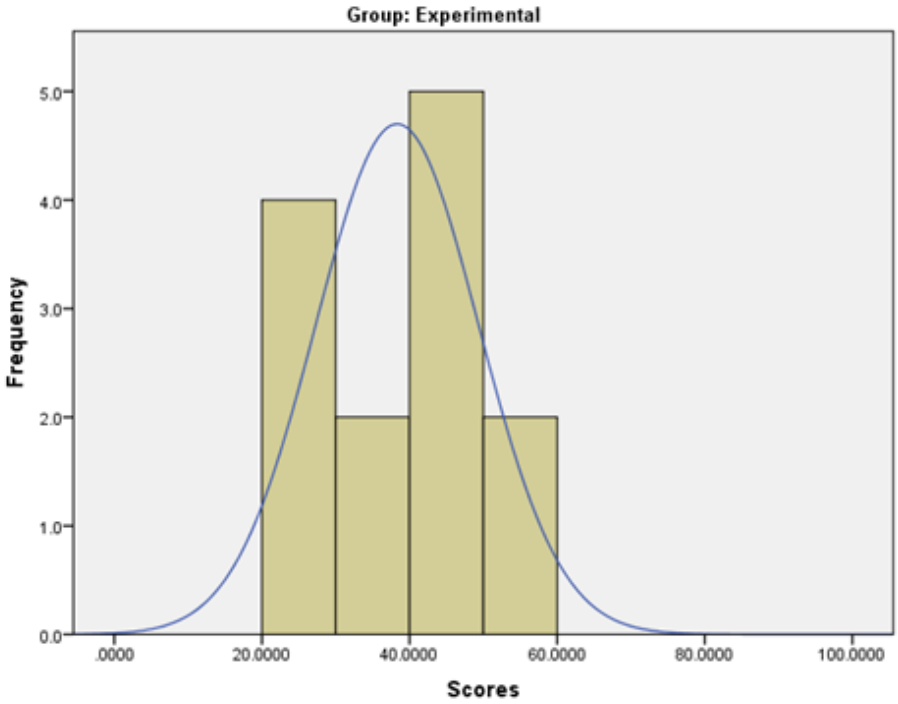


Figure 4-3. Distribution of the experimental group's pretest Mathematics Ability scores

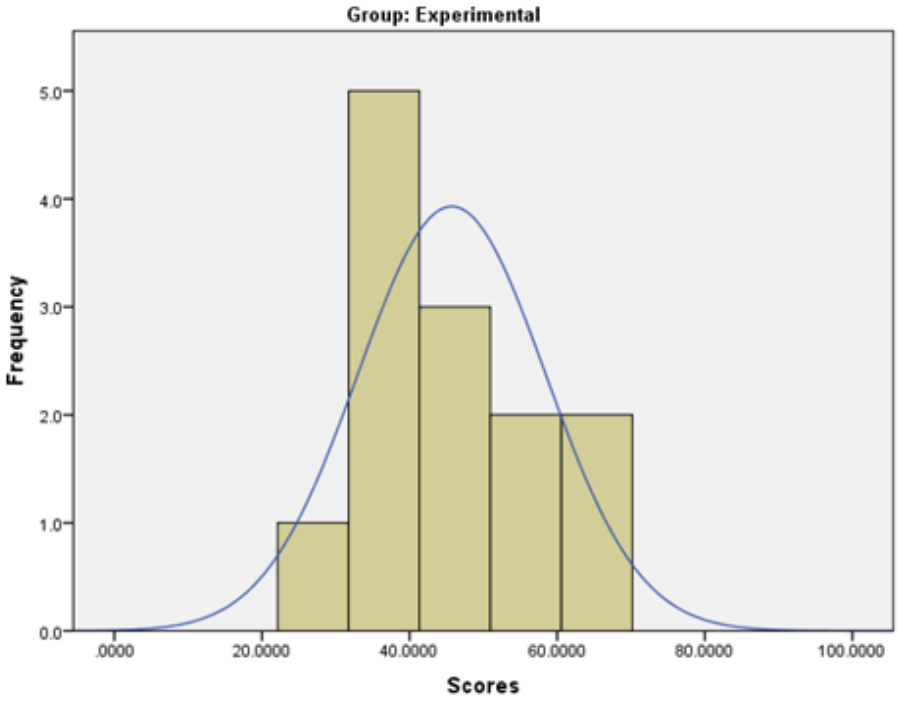


Figure 4-4. Distribution of the experimental group's posttest Mathematics Ability scores

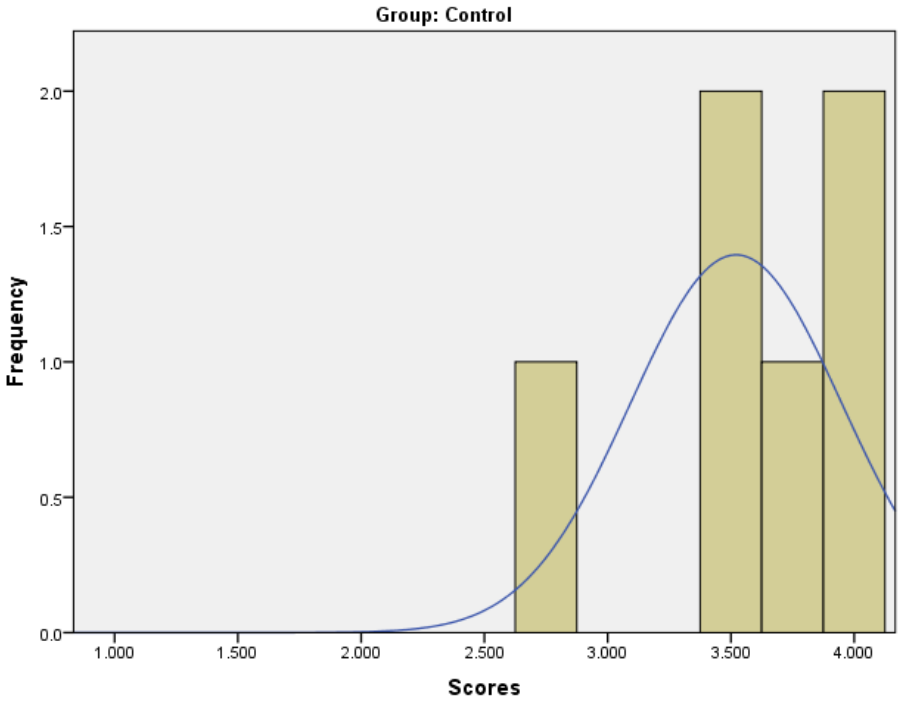


Figure 4-5. Distribution of the control group's Personal Mathematics Efficacy scores week two of the teaching methods course

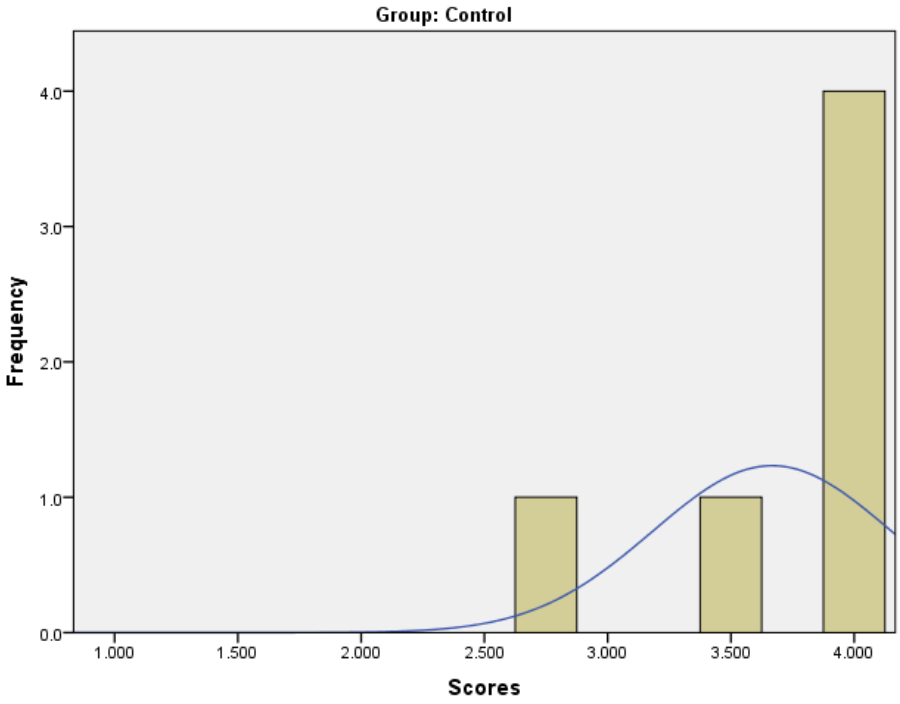


Figure 4-6. Distribution of the control group's Personal Mathematics Efficacy scores week 12 of the teaching methods course/after the preservice teachers in the treatment group delivered their first mathematics enhanced lesson

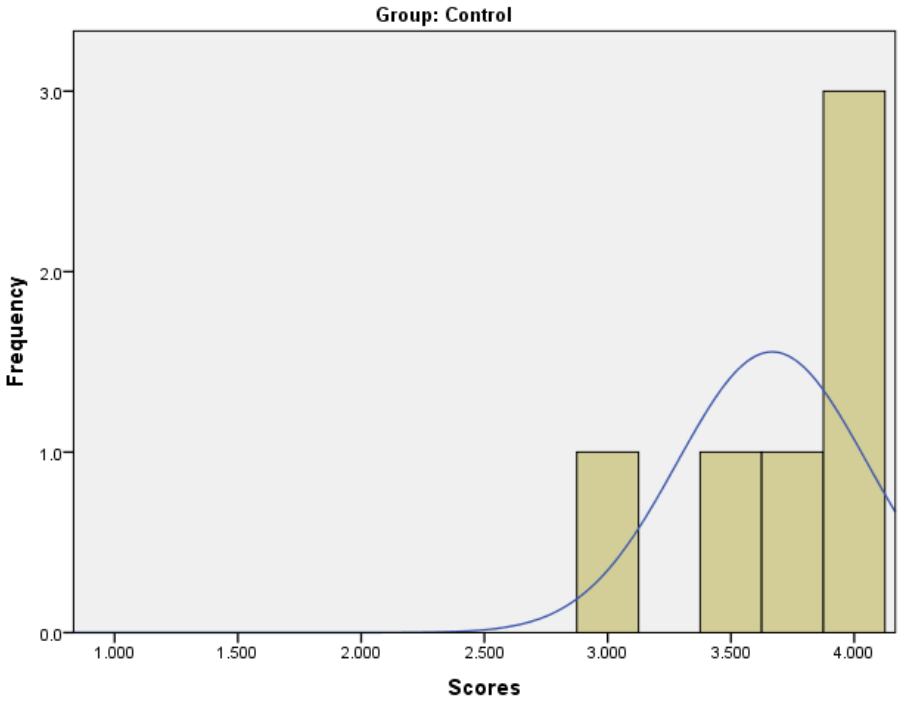


Figure 4-7. Distribution of the control group's Personal Mathematics Efficacy scores week 15 of the teaching methods course

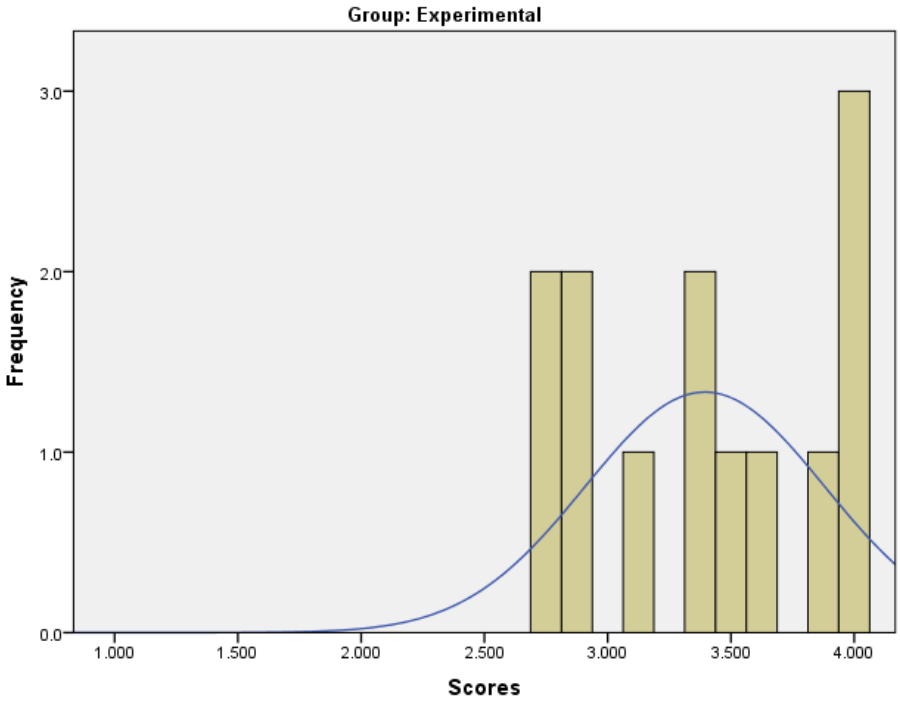


Figure 4-8. Distribution of the experimental group's Personal Mathematics Efficacy scores week two of the teaching methods course

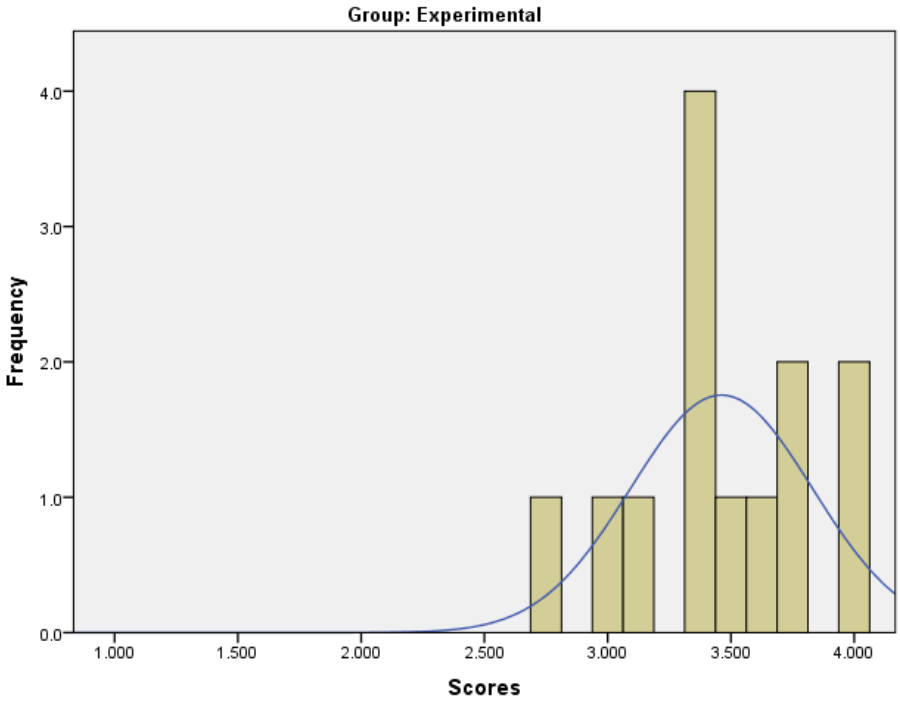


Figure 4-9. Distribution of the experimental group's Personal Mathematics Efficacy scores week 12 of the teaching methods course/after the preservice teachers in the treatment group delivered their first mathematics enhanced lesson

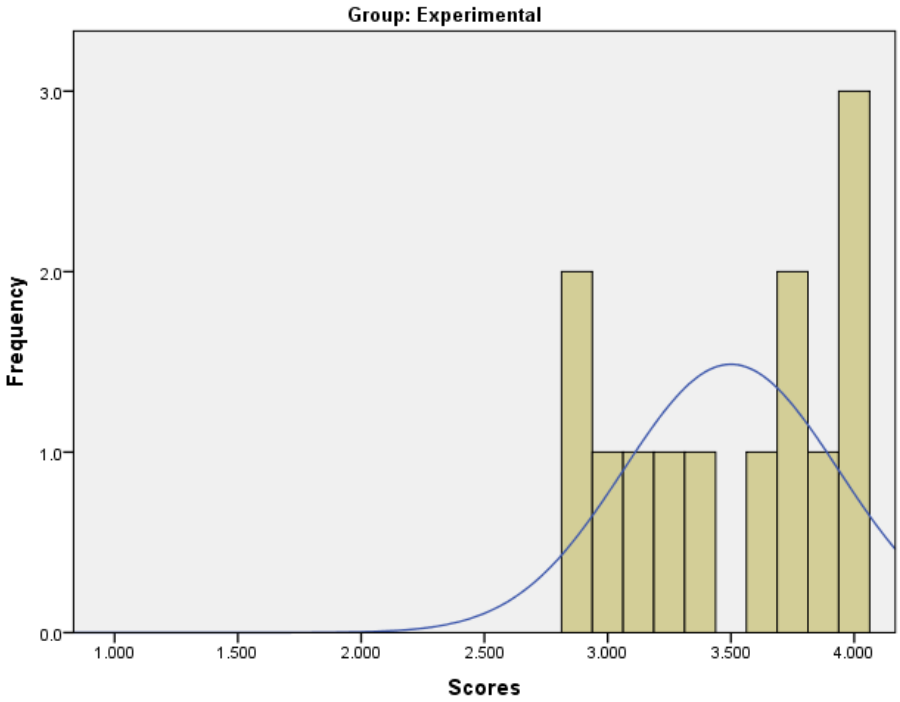


Figure 4-10. Distribution of the experimental group's Personal Mathematics Efficacy scores week 15 of the teaching methods course

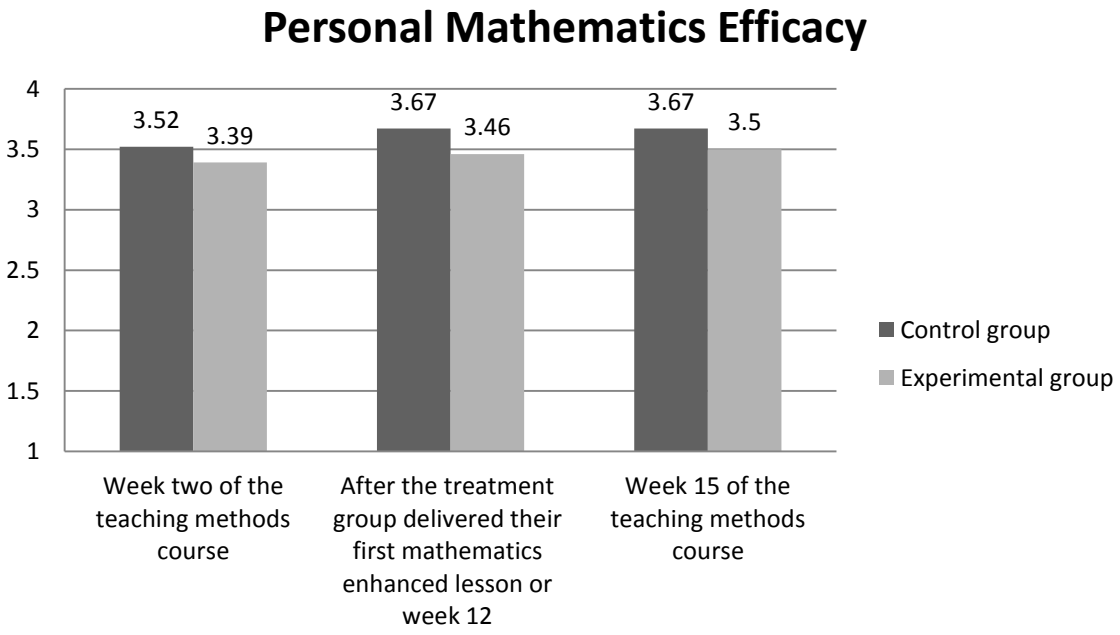


Figure 4-11. Personal Mathematics Efficacy

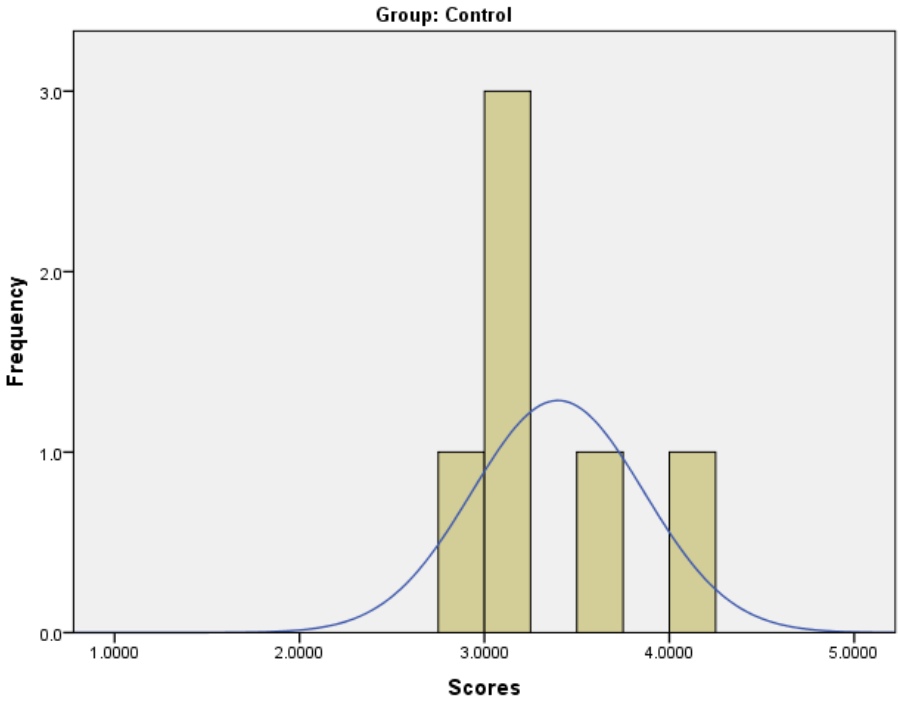


Figure 4-12. Distribution of the control group's Mathematics Teaching Efficacy scores week two of the teaching methods course

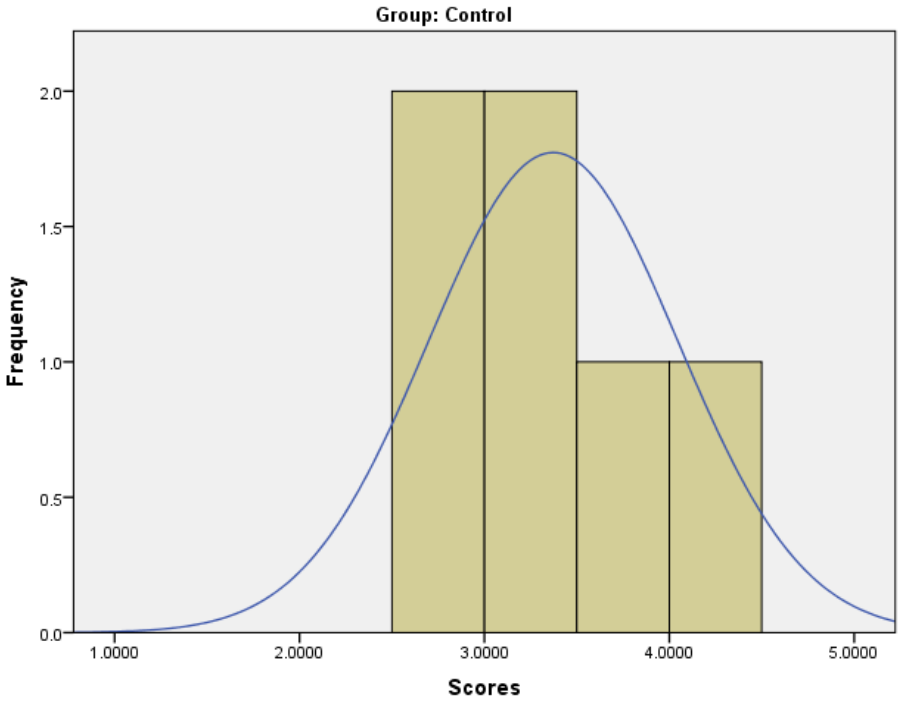


Figure 4-13. Distribution of the control group's Mathematics Teaching Efficacy scores week 12 of the teaching methods course/after the preservice teachers in the treatment group delivered their first mathematics enhanced lesson

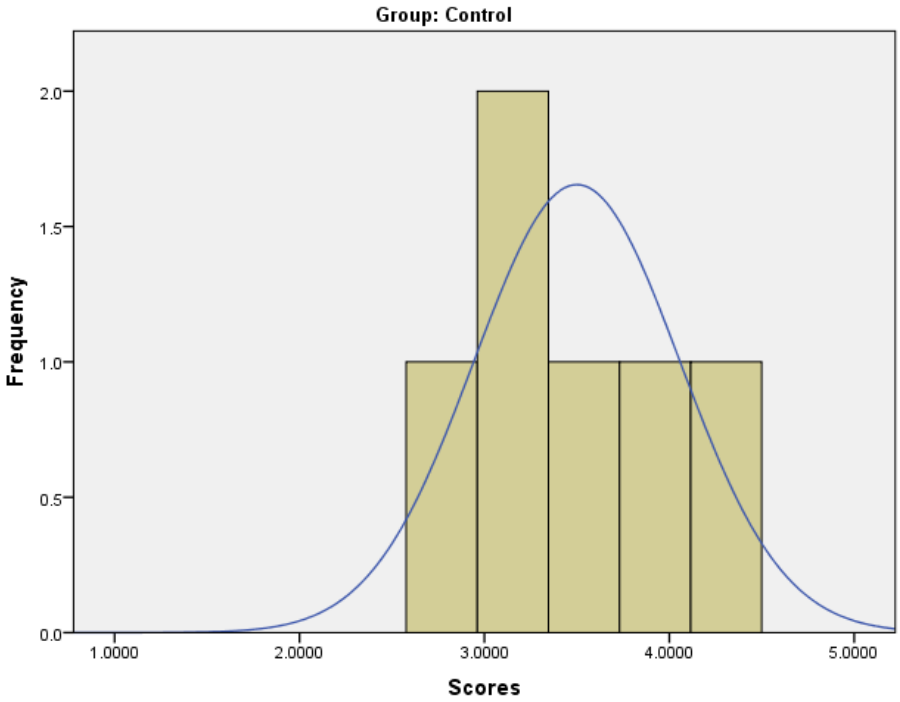


Figure 4-14. Distribution of the control group's Mathematics Teaching Efficacy scores week 15 of the teaching methods course

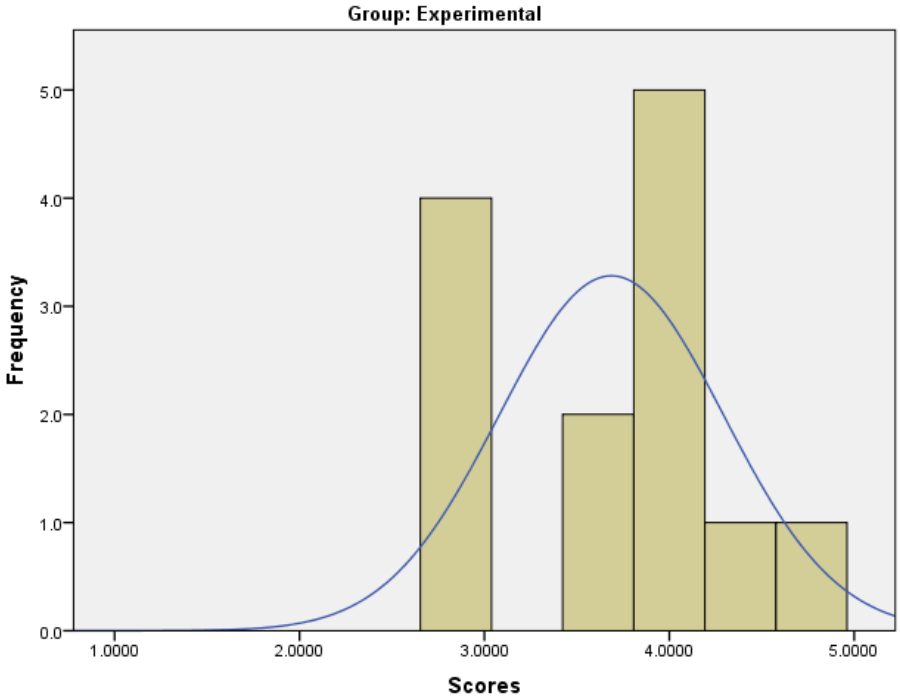


Figure 4-15. Distribution of the experimental group's Mathematics Teaching Efficacy scores week two of the teaching methods course

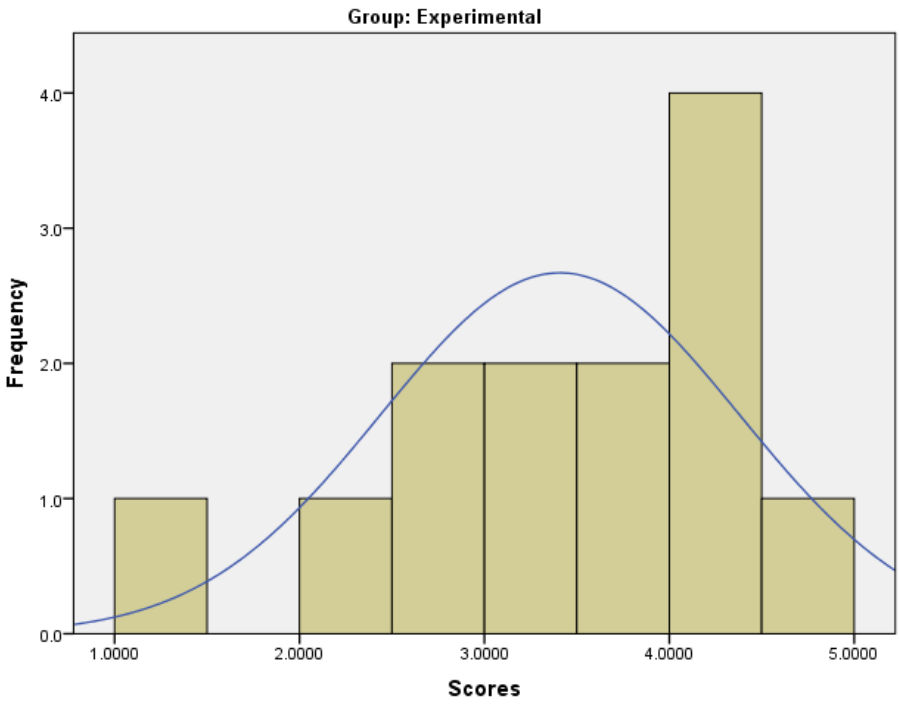


Figure 4-16. Distribution of the experimental group's Mathematics Teaching Efficacy scores week 12 of the teaching methods course/after the preservice teachers in the treatment group delivered their first mathematics enhanced lesson

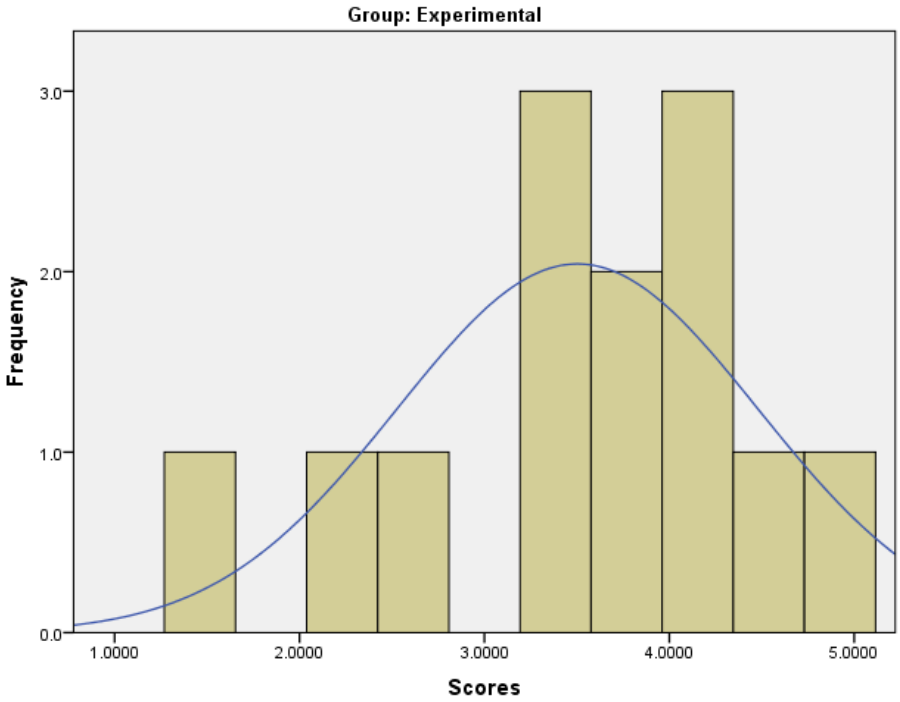


Figure 4-17. Distribution of the experimental group's Mathematics Teaching Efficacy scores week 15 of the teaching methods course

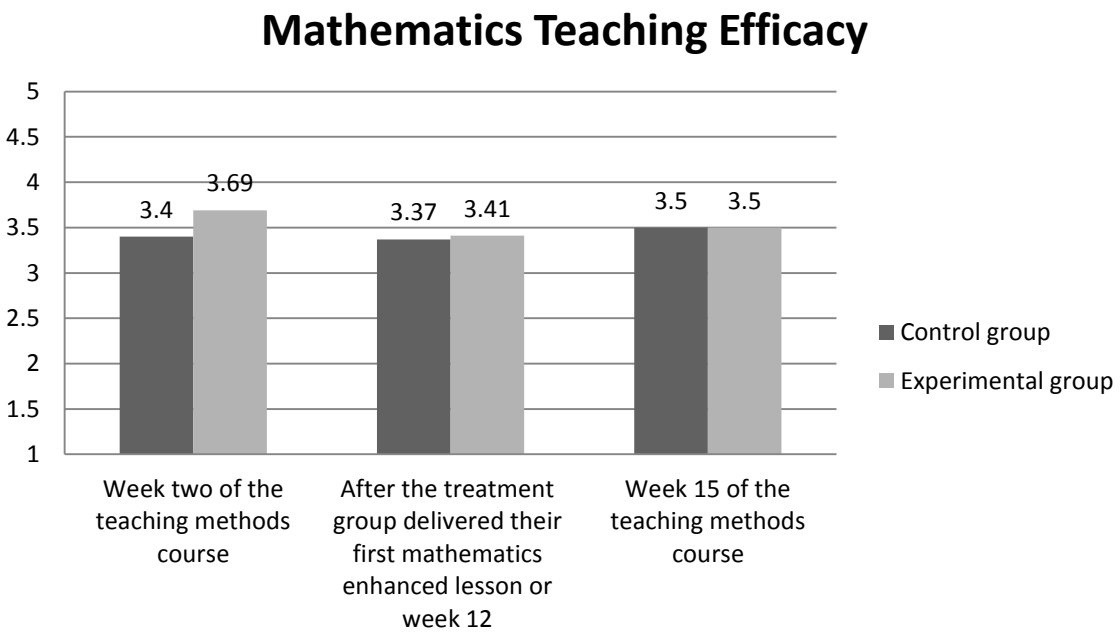


Figure 4-18. Mathematics Teaching Efficacy

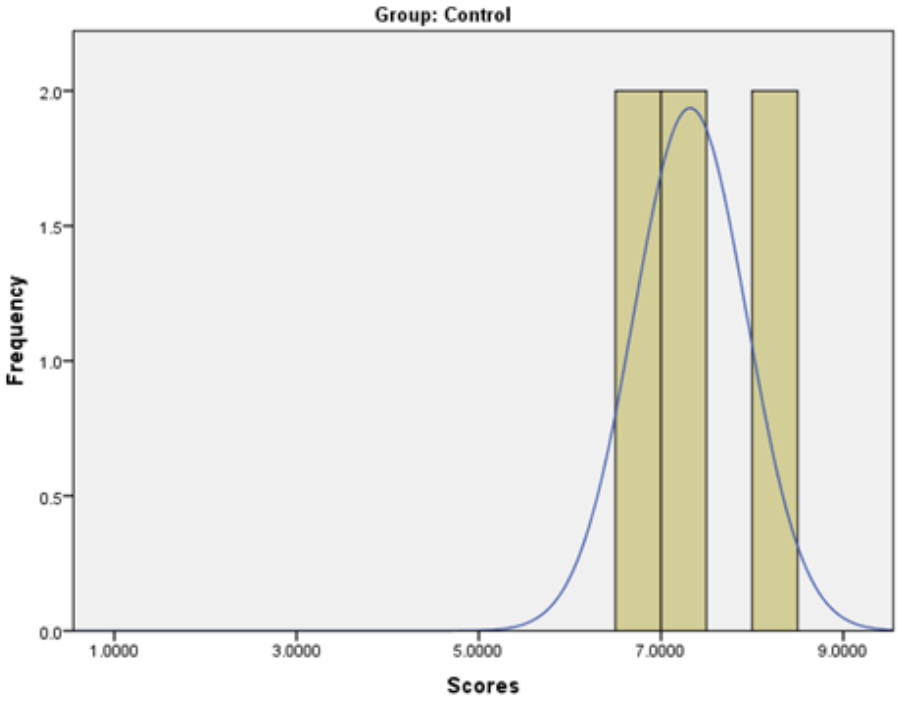


Figure 4-19. Distribution of the control group's Personal Teaching Efficacy scores week two of the teaching methods course

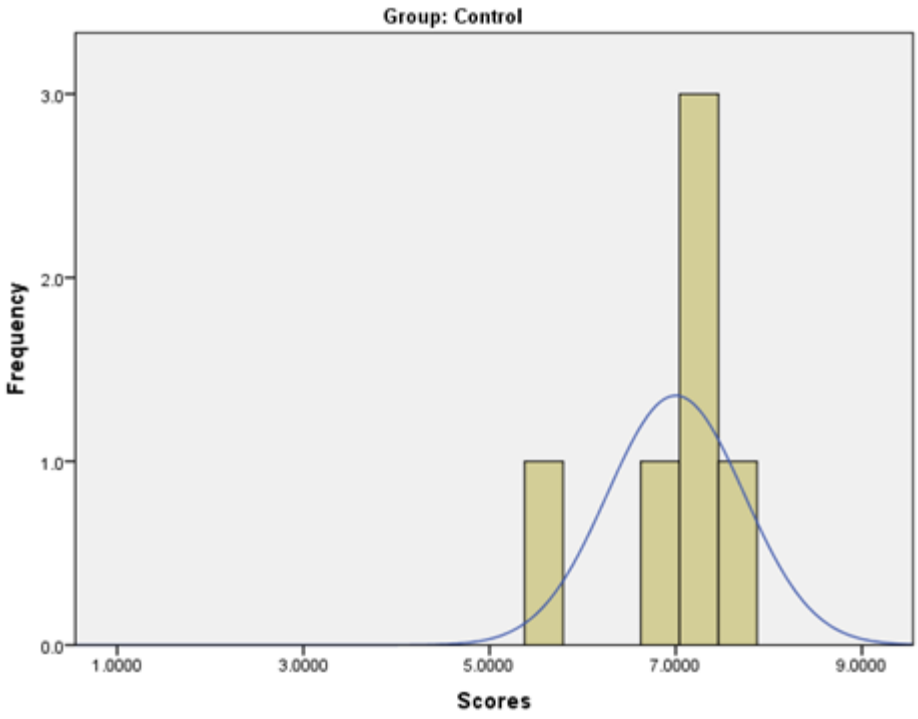


Figure 4-20. Distribution of the control group's Personal Teaching Efficacy scores week 12 of the teaching methods course/after the preservice teachers in the treatment group delivered their first mathematics enhanced lesson

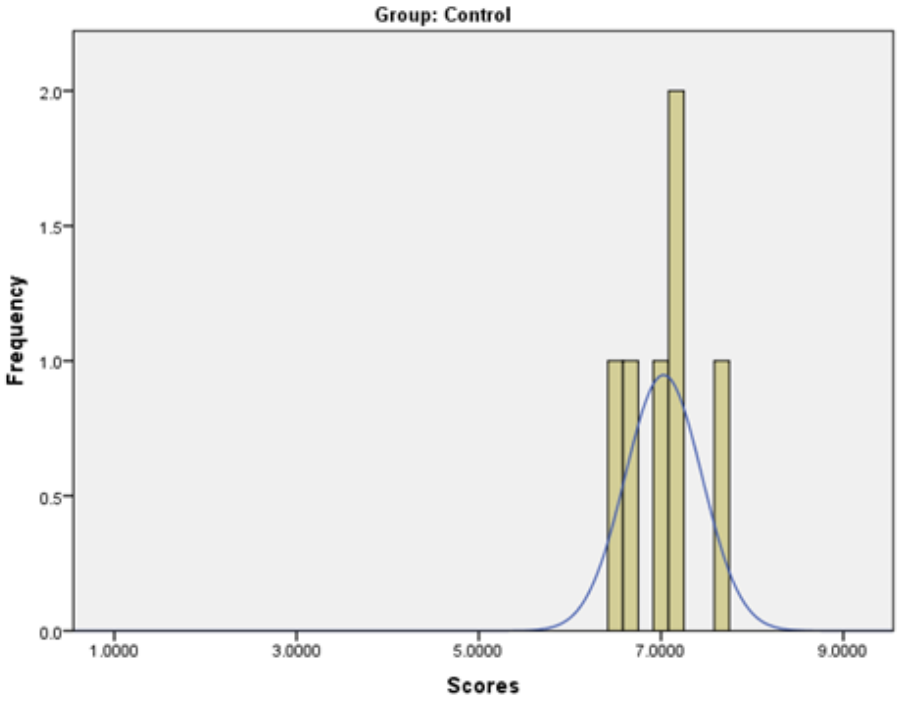


Figure 4-21. Distribution of the control group's Personal Teaching Efficacy scores week 15 of the teaching methods course

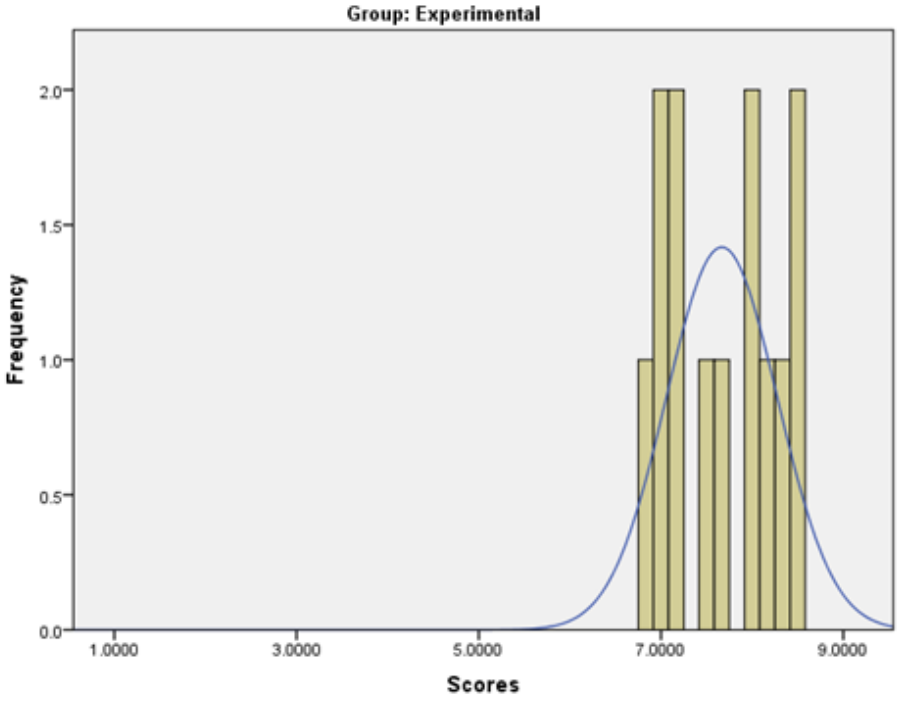


Figure 4-22. Distribution of the experimental group's Personal Teaching Efficacy scores week two of the teaching methods course

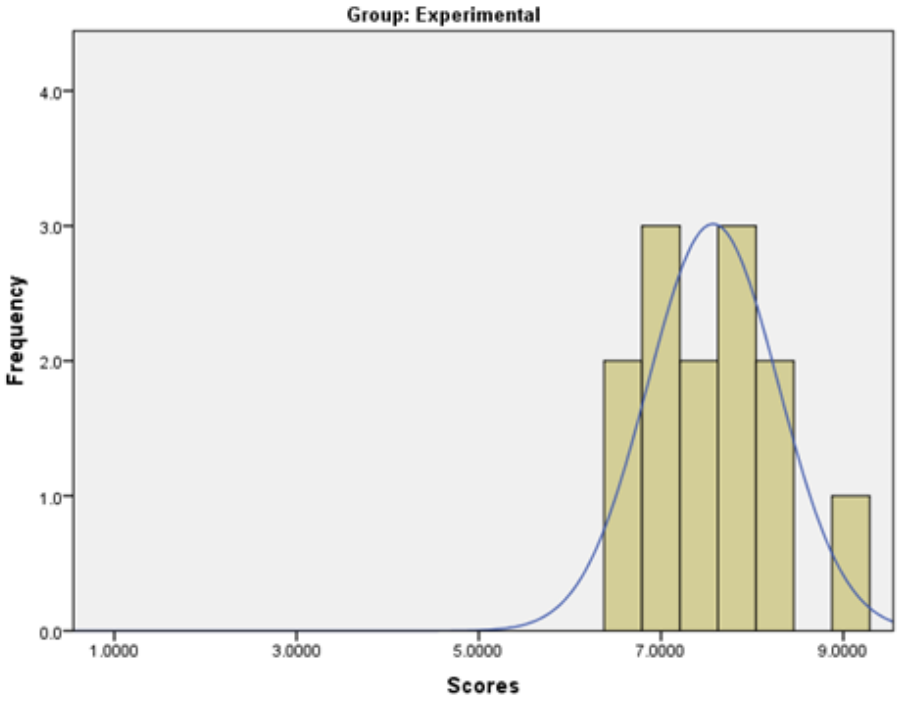


Figure 4-23. Distribution of the experimental group's Personal Teaching Efficacy scores week 12 of the teaching methods course/after the preservice teachers in the treatment group delivered their first mathematics enhanced lesson

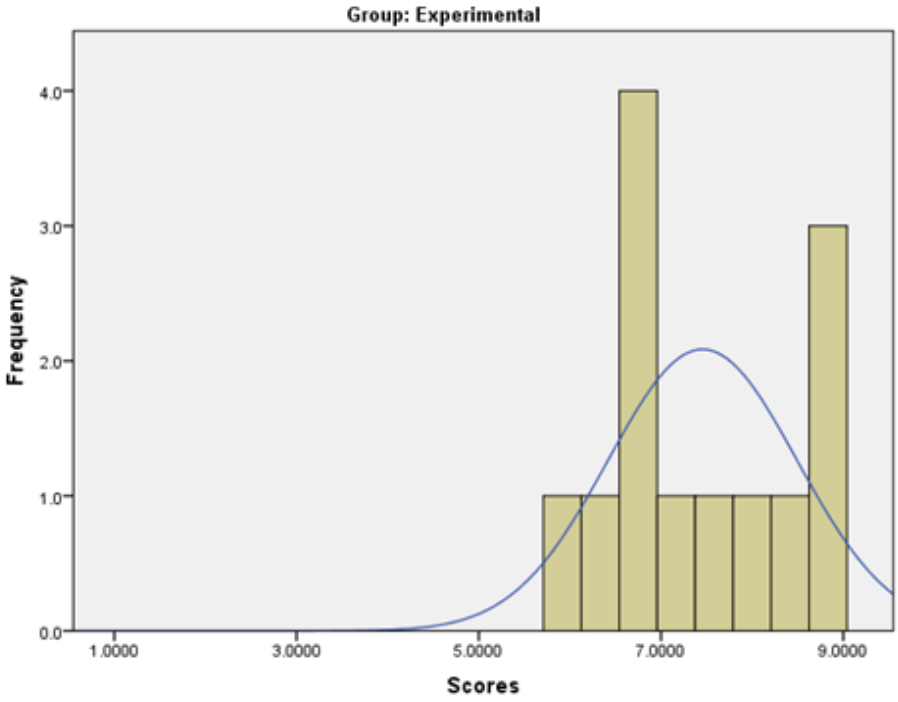


Figure 4-24. Distribution of the experimental group's Personal Teaching Efficacy scores week 15 of the teaching methods course

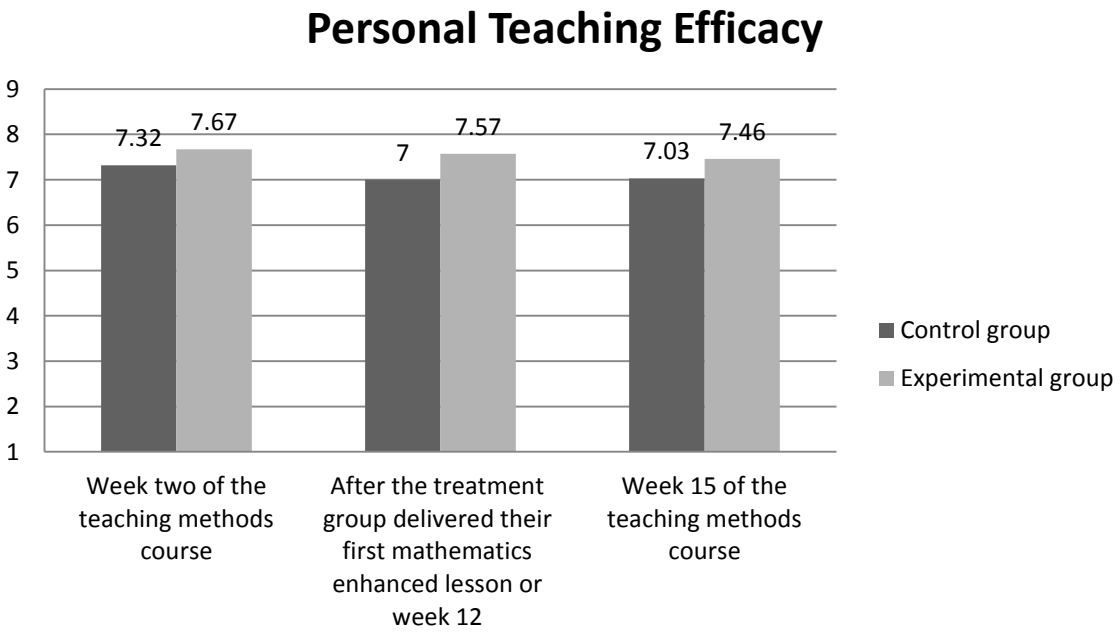


Figure 4-25. Personal Teaching Efficacy

CHAPTER 5
SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this study was to determine the effects of mathematics teaching and integration strategies (MTIS) on preservice agricultural teachers' mathematics ability, personal mathematics efficacy, mathematics teaching efficacy, and personal teaching efficacy in a teaching methods course. The independent variable in this study was the MTIS treatment. Dependent variables included mathematics ability, personal mathematics efficacy, mathematics teaching efficacy, and personal teaching efficacy of the preservice agricultural education teachers. To account for differences in prior mathematics knowledge, pretest mathematics ability scores were used as a covariate. The following research objectives and hypotheses guided this study.

Objectives

This study was framed by four objectives.

1. Determine the effects of mathematics teaching and integration strategies in the teaching methods course on mathematics ability.
2. Determine the effects of mathematics teaching and integration strategies in the teaching methods course on personal mathematics efficacy.
3. Determine the effects of mathematics teaching and integration strategies in the teaching methods course on mathematics teaching efficacy.
4. Determine the effects of mathematics teaching and integration strategies in the teaching methods course on personal teaching efficacy.

Hypotheses

The research questions were framed as null hypotheses for statistical analysis, and the significance level of .05 was determined *a priori*.

H_{01} – There is no significant difference in the mathematics ability of preservice agricultural education teachers based upon the mathematics teaching and integration strategies treatment.

H_{02} – There is no significant difference in the personal mathematics efficacy of preservice agricultural education teachers based upon the mathematics teaching and integration strategies treatment.

H_{03} – There is no significant difference in the mathematics teaching efficacy of preservice agricultural education teachers based upon the mathematics teaching and integration strategies treatment.

H_{04} – There is no significant difference in the personal teaching efficacy of preservice agricultural education teachers based upon the mathematics teaching and integration strategies treatment.

Methodology

This research was quasi-experimental and utilized a nonequivalent control group design (Campbell & Stanley, 1963). This design was utilized because random assignment of subjects was not possible due to the fact that the subjects under investigation self-registered for a teaching methods lab section that best fit their schedule of classes. The treatment utilized in this study was assigned to the teaching methods lab sections randomly. The treatment group was administered the MTIS treatment, which added the following three elements to the teaching methods lab: (a) a lecture on the seven components of a math-enhanced lesson, (b) random assignment of the NCTM sub-standards among the preservice teachers, and (c) requiring two of the micro-teaching lessons to be math-enhanced. The control group received the same instruction in their teaching methods lab except for the aforementioned elements that constituted the MTIS treatment.

The target population for this study was Florida preservice agricultural education teachers. The accessible population for this study was present undergraduate and graduate students in their final year of the agricultural teacher education program at the University of Florida. For this study, the accessible population was a convenience sample, which was conceptualized as a slice in time (Oliver & Hinkle, 1981). The

sample consisted of preservice teachers enrolled in AEC 4200 *Teaching Methods in Agricultural Education* during the Fall 2011 semester (*n* = 19).

The data collection period of this study was during the Fall 2011 academic semester. Data were collected from preservice agricultural teachers during their final year of an agricultural teacher education program at the University of Florida. Two instruments, the *Mathematics Ability Test* and Jansen's (2007) *Mathematics Enhancement Teaching Efficacy Instrument* were utilized. The *Mathematics Ability Test* took the participants approximately 60 minutes to complete and was administered twice: (a) week two of the Fall 2011 semester; and (b) week 16 or the last week of the Fall 2011 semester. The *Mathematics Enhancement Teaching Efficacy Instrument* took the participants approximately 8 minutes to complete and was administered three times: (a) week two of the Fall 2011 semester; (b) week 12 of the Fall 2011 semester/after the preservice teachers in the treatment group delivered their first mathematics enhanced lesson; and (c) week 15 of the Fall 2011 semester. Additionally, the researcher and a mathematics expert individually scored the *Mathematics Ability Test*, and items were scored incorrect, partially correct (students set the problem up correctly but made a calculation error), or correct. The scorers used a rubric that was developed by two secondary mathematics experts to score each item. Inter-rater reliability was assessed using Cohen's Kappa, and the analysis yielded a Cohen's Kappa of .95.

Data were analyzed using SPSS® version 17 for Windows™. Frequencies, means, and standard deviations were calculated to summarize demographics, mathematics teaching efficacy, personal mathematics efficacy, personal teaching efficacy, and mathematics ability of the preservice agricultural education teachers.

MANOVAs were used to determine if significant differences existed in mathematics teaching efficacy, personal mathematics efficacy, and personal teaching efficacy based upon the MTIS treatment. ANCOVA was also used to determine if significant differences existed in mathematics ability based upon the MTIS treatment.

Summary of Findings

The findings of this study were structured based on the objectives and hypothesis that guided this research.

Descriptive Statistics of Variables in this Study

Mathematics ability

The control groups' pretest mathematics ability scores changed slightly from week two to week 16 of the teaching methods course. Their average week two of the teaching methods course was 45.51% (*SD* = 9.32), and their average week 16 of the teaching methods course was 45.19% (*SD* = 11.26). Thus, the control group's mathematics ability mean decreased 0.32% from week two of the teaching methods course to week 16 of the teaching methods course. In addition, the ranges of scores were very similar. The pretest scores ranged from 30.77% to 57.69%, and the posttest scores ranged from 30.77% to 59.62%.

The experimental group's mathematics ability mean increased 7.40% from week two of the teaching methods course to week 16 of the teaching methods course. Their pretest average was 38.31% (*SD* = 11.03), and their posttest average was 45.71% (*SD* = 11.69). This increase in scores can also be seen in the range of scores week two and week 16 of the teaching methods course. The pretest scores ranged from 23.08% to 59.62%, and the posttest scores ranged from 36.54% to 69.23%.

Personal mathematics efficacy

Personal mathematics efficacy was measured on a four-point scale: 1 = not at all confident to 4 = very confident (Jansen, 2007). The control group's personal mathematics efficacy scores increased from week two to week 15 of the teaching methods course. The week two teaching methods course average was 3.52 (*SD* = 0.43). After the preservice teachers in the treatment group delivered their first mathematics enhanced lesson (week 12 of the teaching methods course), the control group's personal mathematics efficacy mean increased to 3.67 (*SD* = 0.49). Week 15 of the teaching methods course, the control group's personal mathematics efficacy mean (3.67, *SD* = 0.67) was identical to the previous data collection point, but was higher than the initial personal mathematics efficacy mean.

The experimental group's personal mathematics efficacy scores increased at each data collection point. The week two teaching methods course average was 3.39 (*SD* = 0.49). After delivering their first mathematics enhanced lesson (week 12 of the teaching methods course), the experimental group's personal mathematics efficacy mean increased to 3.46 (*SD* = 0.37). Week 15 of the teaching methods course, the experimental group's personal mathematics efficacy mean increased to 3.50 (*SD* = 0.44).

Mean differences in the control group's personal mathematics efficacy scores were as follows: (a) data collection points three minus one was 0.15 (*SD* = 0.09); (b) data collection points two minus one was 0.15 (*SD* = 0.20); and (c) data collection points three minus two was 0.00 (*SD* = 0.21). Mean differences in the experimental group's personal mathematics efficacy scores were as follows: (a) data collection points

three minus one was 0.11 (*SD* = 0.28); (b) data collection points two minus one was 0.07 (*SD* = .31); and (c) data collection points three minus two was 0.04 (*SD* = 0.25).

Mathematics teaching efficacy

Mathematics teaching efficacy was measured on a five-point scale: 1 = strongly disagree to 5 = strongly agree (Jansen, 2007). The control group's mathematics teaching efficacy scores week two of the teaching methods course averaged 3.40 (*SD* = 0.47). After the preservice teachers in the treatment group delivered their first mathematics enhanced lesson (week 12 of the teaching methods course), the control group's mathematics teaching efficacy mean decreased to 3.37 (*SD* = 0.67). From the previous data collection point to week 15 of the teaching methods course, the control group's mathematics teaching efficacy mean increased to 3.50 (*SD* = 0.56), which is also higher than the initial mathematics teaching efficacy mean.

The experimental group's mathematics teaching efficacy scores week two of the teaching methods course averaged 3.69 (*SD* = 0.61). After delivering their first mathematics enhanced lesson (week 12 of the teaching methods course), the experimental group's mathematics teaching efficacy mean decreased to 3.41 (*SD* = 0.97). Then, week 15 of the teaching methods course, the experimental group's mathematics teaching efficacy mean was 3.50 (*SD* = 0.98). Therefore, the week 15 teaching methods course mean was lower than the initial mathematics teaching efficacy mean.

Mean differences in the control group's mathematics teaching efficacy scores were as follows: (a) data collection points three minus one was 0.10 (*SD* = 0.50); (b) data collection points two minus one was -0.03 (*SD* = 0.63); and (c) data collection points three minus two was 0.13 (*SD* = 0.14). Mean differences in the experimental group's

mathematics teaching efficacy scores were as follows: (a) data collection points three minus one was -0.19 (*SD* = 0.60); (b) data collection points two minus one was -0.28 (*SD* = 0.49); and (c) data collection points three minus two was 0.09 (*SD* = 0.41).

Personal teaching efficacy

Personal teaching efficacy was measured on a nine-point scale: 1 = nothing to 9 = a great deal of influence (Jansen, 2007). The control group's personal teaching efficacy scores week two of the teaching methods course averaged 7.32 (*SD* = 0.62). After the preservice teachers in the treatment group delivered their first mathematics enhanced lesson (week 12 of the teaching methods course), the control group's personal teaching efficacy scores averaged 7.00 (*SD* = 0.73). Week 15 of the teaching methods course, the control group's personal teaching efficacy scores averaged 7.03 (*SD* = 0.42). Thus, personal mathematics efficacy decreased from week two to week 15 of the teaching methods course.

The experimental group's personal teaching efficacy scores decreased at each data collection point. The week two teaching methods course average was 7.67 (*SD* = 0.61). After delivering their first mathematics enhanced lesson (week 12 of the teaching methods course), the experimental group's personal teaching efficacy scores averaged 7.57 (*SD* = 0.72). Week 15 of the teaching methods course, the experimental group's personal teaching efficacy scores averaged 7.46 (*SD* = 1.04).

Mean differences in the control group's personal teaching efficacy scores were as follows: (a) data collection points three minus one was -0.29 (*SD* = 0.38); (b) data collection points two minus one was -0.32 (*SD* = 0.48); and (c) data collection points three minus two was 0.03 (*SD* = 0.55). Mean differences in the experimental group's personal teaching efficacy scores were as follows: (a) data collection points three minus

one was -0.21 (*SD* = 0.82); (b) data collection points two minus one was -0.10 (*SD* = .52); and (c) data collection points three minus two was -0.11 (*SD* = 0.52).

Hypothesis One

This hypothesis was that there is no significant difference in the mathematics ability of preservice agricultural education teachers based upon the MTIS treatment. The ANCOVA procedure revealed a significant difference in mathematics ability scores, $F(1, 16) = 5.36$, $p < .05$ (Table 4-5, p. 116). Thus, the control group's adjusted posttest mean score ($M = 40.25$, $SE = 2.72$) was significantly lower than the experimental group's adjusted posttest mean ($M = 47.99$, $SE = 1.81$). The practical significance of the difference was assessed using a partial eta squared, and the effect size was .25, which is a large effect. Based on the statistically significant difference in adjusted posttest mean and the large effect size, the null hypothesis was rejected.

Hypothesis Two

This hypothesis was that there is no significant difference in the personal mathematics efficacy of preservice agricultural education teachers based upon the MTIS treatment. This hypothesis was tested using a MANOVA, and the analysis did not reveal a significant difference in personal mathematics efficacy, $T = .02$, $F(2, 16) = 0.15$, $p > .05$. Therefore, the researcher failed-to-reject the null hypothesis.

Hypothesis Three

This hypothesis was that there is no significant difference in the mathematics teaching efficacy of preservice agricultural education teachers before and after MTIS. This hypothesis was tested using a MANOVA, and the analysis did not reveal a significant difference in mathematics teaching efficacy, $T = .06$, $F(2, 16) = 0.50$, $p > .05$. Therefore, the researcher failed-to-reject the null hypothesis.

Hypothesis Four

This hypothesis was that there is no significant difference in the personal teaching efficacy of preservice agricultural education teachers before and after MTIS. This hypothesis was tested using a MANOVA, and the analysis did not reveal a significant difference in personal teaching efficacy, $T = .06$, $F(2, 16) = 0.49$, $p > .05$. Therefore, the researcher failed-to-reject the null hypothesis.

Conclusions

The sample used in this study was not randomly drawn from the population. With this limitation in mind and based on the findings of this study, the following conclusions were drawn:

1. The MTIS treatment had a positive effect on the mathematics ability scores of the participants.
2. The MTIS treatment did not have an effect on the personal mathematics efficacy scores of the participants.
3. The MTIS treatment did not have an effect on the mathematics teaching efficacy scores of the participants.
4. The MTIS treatment did not have an effect on the personal teaching efficacy scores of the participants.

Discussion and Implications

Hypothesis Related to Mathematics Ability

H_{01} – There is no significant difference in the mathematics ability of preservice agricultural education teachers based upon the mathematics teaching and integration strategies treatment. The null hypothesis was rejected.

Conclusion: The MTIS treatment had a positive effect on the mathematics ability scores of the participants. To that end, the MTIS treatment had a large effect ($\eta_p^2 = .25$) on the preservice teachers' mathematics ability scores. This finding is

consistent with Stripling and Roberts (2012a) who reported that a math-enhanced agricultural teaching methods course significantly increased the mathematics ability scores of preservice agricultural education teachers at the University of Florida. Further, this finding is consistent with Burton, Daane, and Gieson (2008) who also found that the incorporation of mathematics into a teaching methods course positively affected mathematics content knowledge of preservice teachers, and Berry (2005) who stated that research-proven instructional strategies in mathematics and literacy make a difference in student achievement as teacher educators incorporate the strategies into the teacher education program. In addition, the results and micro-teaching utilized in this study support Pascarella and Terenzini (2005), which stated that peer-interaction that reinforce academics "appear to influence positively knowledge acquisition and academic skill development during college" (p. 121). Thus, the findings of this study suggests that micro-teaching that utilizes the seven components of a math-enhanced lesson (Stone et al., 2006) can be an appropriate means to improve the mathematics ability of preservice agricultural education teachers.

The results of this study also support Bandura's (1986) social cognitive theory, which purports that cognitive skills can be socially cultivated, and that environment and behavior influences personal factors. In this study, the results suggests that the environment or the math-enhanced teaching methods course and the behaviors of developing math-enhanced lessons, teaching those lessons to peers, and roleplaying as secondary students within the teaching methods course positively influences the personal factor of mathematics ability. This may also support Bandura's assertion that observational learning increases one's knowledge and cognitive skills.

The descriptive statistics indicated that the treatment had a leveling effect on the mathematics ability of the preservice teachers enrolled in the teaching methods course. Week two of the teaching methods course, the experimental group's pretest mathematics ability scores were lower than the control group's pretest mathematics ability scores. By week 16 of the teaching methods course, the experimental and the control groups' posttest mathematics ability scores were within a few tenths of a percentage point. This may suggest that the MTIS treatment is effective at providing some remediation to preservice teachers with lower mathematics ability scores.

Hypothesis Related to Personal Mathematics Efficacy

H_{02} – There is no significant difference in the personal mathematics efficacy of preservice agricultural education teachers based upon the mathematics teaching and integration strategies treatment. The null hypothesis was retained.

Conclusion: The MTIS treatment did not have an effect on the personal mathematics efficacy scores of the participants. This finding is consistent with Stripling and Roberts (2012a). Stripling and Roberts reported that preservice teachers enrolled in the fall 2010 agricultural teaching methods course at the University of Florida were confident in their mathematics ability before and after a math-enhanced agricultural teaching methods course. Bandura's (1986) social cognitive theory would suggest that confidence in personal mathematics efficacy should positively influence the behavior of teaching contextualized mathematics. Then again, Bandura's social cognitive theory would also suggest that low mathematics ability should negatively influence one's belief in their mathematics ability. Thus, there is a disconnect between personal mathematics efficacy and mathematics ability among the preservice teachers. One explanation may be that even after the MTIS treatment the preservice teachers are

ill-informed of the level of mathematics present in the secondary agricultural education standards. Understanding this disconnect is important because personal mathematics efficacy is a preservice teacher's perception of their mathematics content knowledge, which Darling-Hammond and Bransford (2005) would call subject matter knowledge. According to Darling-Hammond and Bransford, subject matter knowledge is an essential type of knowledge for effective teaching.

Even though there is a disconnect between personal mathematics efficacy and the preservice teachers' mathematics ability scores, the researcher finds the mathematical confidence encouraging, because the MTIS did not negatively affect the personal mathematics efficacy of the preservice teachers. Theoretically and based on previous research, the fact that the preservice teachers were confident in their personal mathematics efficacy before and after the MTIS treatment should positively impact (a) their motivation (Bandura, 1997), which in the context of this study is motivation for teaching contextualized mathematics; (b) the effort put forth in designing learning activities (Allinder, 1994) or math-enhanced lessons, (c) the challenges encountered in the learning environment (Goddard, Hoy, & Woolfolk Hoy, 2004),which in this study would be related to teaching contextualized mathematics, (d) and the acquisition of knowledge (Bandura, 1997) related to mathematics.

The MTIS treatment did not improve the personal mathematics efficacy scores of the preservice teachers; however, the treatment did not negatively affect personal mathematics efficacy. This is encouraging given the fact that the treatment had a positive effect on the mathematics ability scores of the preservice teachers.

Hypothesis Related to Mathematics Teaching Efficacy

H_{03} – There is no significant difference in the mathematics teaching efficacy of preservice agricultural education teachers before and after mathematics teaching and integration strategies. The null hypothesis was retained.

Conclusion: The MTIS treatment did not have an effect on the mathematics teaching efficacy scores of the participants. The aforementioned conclusion related to mathematics teaching efficacy is consistent with Stripling and Roberts (2012a). Stripling and Roberts reported that preservice teachers enrolled in the fall 2010 agricultural teaching methods course at the University of Florida were moderately efficacious in mathematics teaching efficacy before and after a math-enhanced agricultural teaching methods course. The MTIS treatment did not improve the mathematics teaching efficacy scores of the preservice teachers, but then again the treatment did not negatively affect mathematics teaching efficacy.

The fact that the preservice teachers were moderately efficacious is encouraging because mathematics teaching efficacy is a measure of the preservice teachers' perceptions of their ability to teach mathematics or pedagogical content knowledge, which according to Darling-Hammond and Bransford (2005) is an essential type of knowledge for teaching. This fact is also encouraging because according to Bandura's (1986) social cognitive theory, personal factors influence behavior and the environment. Therefore, in the context of this study, mathematics teaching efficacy should positively impact the teacher education program, the agricultural teaching methods course, and the teaching of contextualized mathematics. On the other hand, the preservice teachers were only moderately efficacious and were not fully confident in the ability to teach contextualized mathematics.

Hypothesis Related to Personal Teaching Efficacy

H_{04} – There is no significant difference in the personal teaching efficacy of preservice agricultural education teachers before and after mathematics teaching and integration strategies. The null hypothesis was retained.

Conclusion: The MTIS treatment did not have an effect on the personal teaching efficacy scores of the participants. The MTIS treatment did not improve the personal teaching efficacy of the preservice teachers, but conversely the treatment did not negatively affect personal teaching efficacy. This finding is consistent with Stripling and Roberts (2012a). Stripling and Roberts reported that preservice teachers enrolled in the fall 2010 agricultural teaching methods course at the University of Florida perceived themselves has having *Quite a Bit of influence* in affecting student learning before and after a math-enhanced agricultural teaching methods course.

Bandura's (1986) social cognitive theory states that personal factors influence behavior and the environment. In the context of this study, personal teaching efficacy should positively impact the teacher education program, the agricultural teaching methods course, and the preservice teachers' teaching. To that end, the researcher is encouraged because the preservice teachers were efficacious and the treatment did not negatively impact personal teaching efficacy, which is a measure of the preservice teachers' perceptions of their ability to teach or pedagogical knowledge. According to Darling-Hammond and Bransford (2005), pedagogical knowledge is essential for teaching. However, the preservice teachers were not fully confident in the ability to teach and guide student learning.

Recommendations for Teacher Education

Based on the findings of this study, the following recommendations were made for agricultural teacher education:

1. The MTIS treatment should be considered for use in an agricultural teaching methods course to increase the mathematics ability of preservice agricultural teachers.

2. Agricultural educators should consider integrating content related to mathematics and mathematics instruction into teacher education courses.

Recommendations for Future Research

Based upon the findings of this study, the following recommendations for further research were made:

1. Due to the limited scope of this study, replication that utilizes preservice teachers from other teacher education programs should be conducted to further validate the effectiveness of the MTIS treatment in increasing the mathematics ability of preservice teachers.

2. A major component of the treatment of this study was the preparation of math-enhanced lessons by the preservice teachers, micro-teachings of math-enhanced lessons delivered by the preservice teachers, and the preservice teachers role-playing as secondary students during the micro-teachings. To that end, is the value of this component of the treatment in the preservice teachers preparing the lessons, teaching the lessons, participating as students in the lessons, or a combination of these activities? Future research should further investigate the effects of preparing math-enhanced lessons, teaching math-enhanced lessons, and participating in micro-teachings of math-enhanced lessons on preservice teachers' mathematics ability, personal mathematics efficacy, mathematics teaching efficacy, and personal teaching efficacy.

3. Consistent with prior research, the preservice teachers in this study were not proficient in mathematics but were confident in their mathematics ability. Therefore, there is a disconnect between the preservice teachers' personal mathematics efficacy and mathematics ability. Future research should inquire into this disconnect.

4. Consistent with prior research, the preservice teachers in this study were moderately efficacious in mathematics teaching efficacy. Future research should seek to improve mathematics teaching efficacy.

5. Future research should seek to determine if the use of the MTIS treatment in an agricultural teaching methods course impacts the teaching of mathematics in the secondary agricultural classes of the preservice teachers after graduation.

6. Future research should seek to determine if mathematics can be effectively and efficiently integrated into other agricultural teacher education courses.

7. Future research is warranted to investigate why preservice teachers have such low mathematics ability.

8. Future research should seek to determine the effects of having an expert in contextualized mathematics deliver instruction to preservice teachers on the teaching of contextualized mathematics.

Reflections

Upon completion of this study, the researcher reflected on the process and the application of this work. The following paragraphs are the researcher's reflections.

Self-efficacy is a social construct by nature (Bandura, 1997). In this study, self-efficacy of the preservice teachers may have been influenced by the other preservice teachers in the agricultural teaching methods course. This may explain why the preservice teachers were efficacious in personal mathematics efficacy and moderately efficacious in mathematics teaching efficacy when their mathematics ability scores suggested otherwise. The social nature of self-efficacy may have led the preservice teachers to believe that they were as competent in mathematics and the teaching of contextualized mathematics as their peers, resulting in the disconnect between efficacy scores and mathematics ability scores. Potential implications of a false sense of self-efficacy are (a) the preservice teachers may not feel a need to improve their mathematics ability and their teaching of contextualized mathematics, (b) the disconnect between ability and efficacy may negatively impact the mathematics achievement of the preservice teachers' future secondary students as a result of being ill-prepared in mathematics and for the teaching of contextualized mathematics within the agricultural

education curricula, and (c) a false sense of self-efficacy may negatively influence the social learning environment of the agricultural teaching methods course and the teacher education program.

Furthermore, a philosophical discussion that should take place within agricultural teacher education is how to best prepare preservice teachers for meeting the demands of teaching a subject that contributes to the STEM disciplines. How should the profession ensure that beginning agricultural education teachers are prepared to make a meaningful contribution? With the aforementioned question in mind, Myers and Dyer (2004) discovered a gap in the literature on how agricultural teacher education programs should prepare preservice teachers to meet the academic demands of agriscience teaching. Agricultural teacher education programs are limited in the number of credit hours available in a program of study for agricultural teacher preparation. So, is the incorporation of STEM content such as the teaching of contextualized mathematics and science into agricultural teacher education coursework appropriate or the best way to prepare preservice teachers for teaching STEM related subject matter? If so, what information or content will be removed from current teacher education courses to allow for the incorporation of STEM content? Regardless of the answer to the aforementioned question, the author believes the incorporation of STEM content is appropriate because of the nature of agriculture. Agriculture is an applied science. For that reason, the author believes that the incorporation of STEM content is essential for developing the pedagogical content knowledge of preservice teachers. Research in teacher education has shown that the *subject matters*, and that “subject-specific pedagogical knowledge…enables teachers to represent the subject matter so that it will

be accessible to learners" (Darling-Hammond, 2006, p. 82). Thus, generic pedagogy alone does not fully prepare preservice agricultural education teachers for teaching the science of agriculture; therefore, there is a need for teaching methods to be taught within the context of the subject (Darling-Hammond, 2006). As the role of the secondary agricultural teacher has changed from vocational education to career and technical education that emphasize core academics and seeks to create informed citizens (Phipps, Osborne, Dyer, and Ball, 2008), agricultural teacher education programs must also change to meet the demands of the changing role of the secondary agricultural education teacher.

However, are the current cross-referenced National Council of Teachers of Mathematics (NCTM) sub-standards appropriate for secondary agricultural education? The author believes the NCTM sub-standards are appropriate for secondary agricultural education. The NCTM sub-standards require the teaching of basic and intermediate mathematics such as algebra, geometry, and basic statistics, which are embedded within essential agricultural skills needed for agricultural careers and college preparation. The author believes that lowering the mathematics standards for secondary agricultural education would prevent the profession from answering the numerous calls for agricultural education to support core academics and the STEM disciplines. Additionally, the author holds the view that mathematics is fundamental to science, and research has shown that mathematics teaching is associated with increases in science achievement (Phipps et al., 2008). Thus, lowering the secondary mathematics standards may have a negative effect on science achievement of secondary students.

As a result of this study, the author plans to continue a similar line of inquiry for at least the next five years. This line of inquiry will have an overarching goal of preparing preservice agricultural teachers to teach mathematics found naturally within the agricultural education curricula. This research will focus on four primary teacher education variables: (a) preservice teachers, (b) teacher educators, (c) cooperating teachers, and (d) curriculum/instruction. The anticipated outcomes/impacts are (a) improved mathematics content knowledge of preservice agricultural education teachers, (b) improved mathematics pedagogical content knowledge of preservice agricultural education teachers, (c) preservice agricultural education teachers that are proficient in teaching contextualized mathematics, (d) efficient and effective math-enhanced teacher education courses, (e) effective secondary agricultural education mathematics instruction, and (f) secondary agricultural education students that are better prepared for agriculture, food, and natural resources careers.

In addition, the author hopes this study will shed light on the issue of preparing preservice agricultural teachers for their evolving role within the larger context of American education. Moreover, the author hopes the results of this study will spur the philosophical discussion described above and the products of the discussion will be (a) improved agricultural teacher education programs, (b) secondary agricultural education students prepared for scientific careers, (c) an agricultural workforce prepared for the challenges of the 21st century, and (d) an agricultural education profession that contributes to a growing and vibrant democracy.

APPENDIX A
TREATMENT MATERIALS

Lecture Outline

Title: Teaching Mathematics Found Naturally in Agriculture

Course: AEC 4200 –*Teaching Methods in Agricultural Education*

Essential Questions:

1. How do we teach contextualized mathematics?
2. What are the 7 elements of a math-enhanced lesson?
3. What are the cross-referenced NCTM standards?

Discuss the 7 Elements of a Math-Enhanced Lesson

Discuss the example math-enhanced lesson plan

Ask for questions related to the seven elements and the example lesson plan

Discuss micro-teachings:

Lab 6: Video and Cooperative Learning – Math-Enhanced Lesson

Lab 8: Demonstration and Individualized Instruction – Math-Enhanced Lesson

Discuss cross-referenced NCTM Standards

Ask for questions related to the cross-referenced NCTM standards

Essential Questions/Review:

1. How do we teach contextualized mathematics?
2. What are the 7 elements of a math-enhanced lesson?
3. What are the cross-referenced NCTM standards?

Table A-1. Example Seven Elements of a Math-enhanced Lesson

Daily Plan		**Instructor:**	Mr. Stripling
Lesson Title:	Got Feed?		
Unit Title:	Animal Nutrition		
Course:	Animal Science		
Estimated Time:	50 minutes		
Materials, Supplies, Equipment, References, and Other Resources:			
Cattle feed Calculators Optional: Oats Corn Cottonseed Hull Whole Cottonseed Soybean Wheat			
Student Performance Standards (SPSs):		**Sunshine State Standards:**	
02.02		SC.912.P.8.7	
02.03		SC.912.P.8.8	
02.04		SC.912.P.8.9	
Daily Objectives			
1. SWBAT identify feedstuff commonly found in feed rations using no references with 100% accuracy. 2. SWBAT determine the percentages of each ingredient in a feed ration using no references with 100% accuracy.			

Table A-1. Continued

Preflection/Introduction (Interest Approach)	**Estimated Time:**
1. Introduce the CTE Lesson. Lead the student through the following adventure: Close your eyes and imagine you are in a feed store...you are riding a forklift...oh no...you just poked a hole in a bag of cow feed. You notice that the feed has corn in it...okay look harder...what else do you see...maybe oats, rye,...Now you are thinking that you could make cow feed, but first you realize you need to calculate the percentages of each ingredient. How are you going to do this? Okay open your eyes. **2. Assess students' math awareness as it relates to the CTE lesson.** **Show me what you know E-moment** If 50 pounds of feed contains 30 pounds of corn, 10 pounds of oats, and 10 pounds of other ingredients. What percentage of corn is in the feed ration? • Take up show me what you know activity • Briefly glance at them while students are working on learning activity one to gain an understanding of the students' prior mathematics knowledge.	

Learning Activity 1	**Estimated Time:**
Instructor Directions / Materials	**Brief Content Outline**
Show students examples of different feedstuff found within a feed mix. Then allow the students to find as many feed ingredients as possible in a small feed sample. Next have the students tape and label the feed ingredients on a sheet of paper in their agriscience notebooks.	List of commonly found ingredients: Oats Corn Cottonseed Hull Whole Cottonseed Soybean Wheat

Table A-1. Continued

Learning Activity 2	**Estimated Time:**
Instructor Directions / Materials	**Brief Content Outline**
3. Work through the math example embedded in the CTE lesson. Demonstrate how to solve feed example from preflection.	(30 pounds of corn/50 pounds of feed)*100 = 60%
4. Work through related, contextual math-in-CTE examples.	If a farmer plants 25 acres of a 30 acre field, what percentage of the field did he plant? • (25 acres/30 acres)*100 = 83.34%
5. Work through traditional math examples.	Write each ratio as a percent. 1. 4/6 2. 2/7 3. 31/100 4. 3/10 5. 1/25

Table A-1. Continued

Learning Activity 3	**Estimated Time:**
Instructor Directions / Materials	**Brief Content Outline**
6. Students demonstrate their understanding. Students will calculate and mix one pound of feed	See lab worksheet - Mixing Cattle Feed.

Summary (Reflection)	**Estimated Time:**
Ticket out the door: Were you able to successfully calculate and mix one pound of feed today? If you were successful, describe the process/step you took to accomplish the task. If you were not successful, what prevented you from being successful (i.e. calculating percentages, identifying feedstuff)? What must you do to overcome these barriers to success?	

Evaluation
7. Formal assessment. Today's objectives will be assessed on a quiz and a unit test. On these assessments, students will identify feedstuff and work related math examples in an agricultural and traditional context.

Table A-2. Cross-referenced NCTM Sub-standards for Grades 9-12 and Example Topics

Content/Process Area	NCTM Sub-standards	Concepts/Processes	Example Topics
Number & Operations	1A. Understand numbers, ways of representing numbers, relationships among numbers, and number systems.	Development of the number systems: from whole numbers to integers to rational numbers to real and complex numbers Understanding of very large and small numbers	Reading a ruler/tape measure Scientific notation ○ pH ○ bacteria colonies Any agricultural problem that utilizes at least two different forms of numbers (i.e., whole numbers, fractions, decimals…)
	1B. Understand meanings of operations and how they relate to one another.	Judging the effects of multiplication, division, and computing powers and roots Understanding of permutations and combinations Understanding of vectors and matrices	Genetics Combinations and/or placement of flowers in a flower bed Combinations and/or placement of open and closed switches on an electrical circuit Determining the length of one side of a triangular rose garden based on the other two sides and the desired square footage Investments

Table A-2. Continued

Content/Process Area	NCTM Sub-standards	Concepts/Processes	Example Topics
			Any agricultural problem involving square roots such as enclosing an elliptical flower bed
	1C. Compute fluently and make reasonable estimates.	Fluency in operations with real numbers, vectors, and matrices Deciding if a problem calls for a rough estimate, an approximation, or an exact answer Judging the reasonableness of numerical computations and their results	Mixing fertilizer Farm equipment depreciation Estimating tree heights Determining basal area Using speed, torque and power measurements to improve efficiency in power transmission systems Agricultural mechanics project bids or estimation of materials Any agricultural problem that involves conversions

Table A-2. Continued

Content/Process Area	NCTM Sub-standards	Concepts/Processes	Example Topics
Algebra	2C. Use mathematical models to represent and understand quantitative relationships.	Understanding the suitability of linear, quadratic, exponential, and rational functions on the basis of data Drawing reasonable conclusions about a situation being modeled	Drug withdrawal in animals Interest-rate problems Growth problems such as bacteria growth Exploring relationships between two variables such as plant growth and temperature Using models to calculate a market hog's projected weight
	2D. Analyze change in various contexts.	Approximating and interpreting rates of change from graphical and numerical data	Determining land classes Constructing forms for concrete Analyzing bivariate graphs such as corn prices and ethanol production Any agricultural problems that involve slope or rate of change

Table A-2. Continued

Content/Process Area	NCTM Sub-standards	Concepts/Processes	Example Topics
Geometry	3A. Analyze characteristics and properties of two- and three dimensional geometric shapes and develop mathematical arguments about geometric relationships.	Analyzing properties and determining attributes of two- and three-dimensional objects Exploring relationship such as congruence and similarity among two- and three-dimensional objects and solve problems using them Establishing the validity of geometric conjectures using deduction, prove theorems, and critique arguments made by others Using trigonometric relationships to determine lengths and angles measures	Framing a barn or building Rerouting an underground pipe to avoid tree roots/cutting and repositioning – For example, a horticulturalist needs to raise the path of the pipe 23 inches over a distance of 86 inches and then continue on a path parallel to the original pipe. What angles should she cut the pipe? Using a blueprint and the scale to determine the dimensions of a swine feeder for construction in an agricultural mechanics lab Determining the perimeter of two triangular fields using angle-angle similarity and proportions

Table A-2. Continued

Content/Process Area	NCTM Sub-standards	Concepts/Processes	Example Topics
Measurement	4A. Understand measurable attributes of objects and the units, systems, and processes of measurement.	Making decisions about units and scales that are appropriate for problem situations involving measurement	Comparing the sound intensity or decibel levels in an agricultural mechanics shop Safety testing of agricultural machinery (e.i., determining how long it will take a tractor to stop based on deceleration rate and initial velocity) Using weights and measures to formulate and package food products Explaining principles of motion, including speed, velocity and acceleration Evaluating vehicle performance and then servicing as needed, including horsepower management, ballasting, soil compaction and fuel efficiency

Table A-2. Continued

Content/Process Area	NCTM Sub-standards	Concepts/Processes	Example Topics
	4B. Apply appropriate techniques, tools, and formulas to determine measurements.	Analyzing precision, accuracy, and approximation error in measurement situations Understanding and using formulas for the area, surface area, and volume of geometric figures, including cones, spheres, and cylinders Using unit analysis to check measurement computations	Determining the volume of a grain bin Determining the area of a field Calculating the protective wrap needed to wrap round bales of hay Calculating the volume of concrete needed for the floor of your greenhouse Calculating board feet Any problem that involves conversions
Data Analysis & Probability	5A. Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.	Understanding the differences among surveys, observational studies, and experiments and which types of inference can legitimately be drawn from each Knowing the characteristics of well-designed studies, including the role of randomization in surveys and experiments	Determining how to sample and the needed sample size for various types of agricultural studies Using a parallel box plot to analyze the calorie content of different types of hot dogs Analyzing a histogram of tilapia feeding rates and growth

Table A-2. Continued

Content/Process Area	NCTM Sub-standards	Concepts/Processes	Example Topics
		Understanding of the meaning of measurement data, categorical data, and the term variable Understanding histograms, parallel box plots, and scatterplots and using them to display data Computing basic statistics and understanding the distinction between a statistic and a parameter	Conduct a field study of an ecosystem, and record and document observations of species interactions Surveying consumer perceptions of lactose free milk Testing the effects of wind on coleus transpiration Randomly sampling peanut butter for quality control and food safety purposes Maintain accounting information needed to prepare an income statement, balance sheet and cash-flow analysis for an agribusiness Computing mean, median, mode, range, and frequency in various agricultural context

Table A-2. Continued

Content/Process Area	NCTM Sub-standards	Concepts/Processes	Example Topics
			Monitor inventory to maintain optimal levels and calculate costs of carrying input and output inventory of an agribusiness
	5B. Select and use appropriate statistical methods to analyze data.	Univariate data: Be able to display the distribution, describe its shape, and select and calculate summary statistics Bivariate data: Be able to display a display a scatterplot, describe its shape, and understand regression coefficients, regression equations, and correlation coefficients Display and discuss bivariate data where at least one variable is categorical Identify trends in bivariate data and find functions that model the data	Construct a histogram of birth weights of cattle Using a parallel box plot to analyze the calorie content of different types of hot dogs Analyzing a histogram of tilapia feeding rates and growth Examine the scatterplot of rainfall and erosion and determine the type of function (e.g., linear, exponential, quadratic) that might be a good model for the data Computing mean, median, mode, range, and frequency in various agricultural context

Table A-2. Continued

Content/Process Area	NCTM Sub-standards	Concepts/Processes	Example Topics
			Examine crop yields and nitrogen application rates and determine the type of function (e.g., linear, exponential, quadratic) that might be a good model for the data
	5C. Develop and evaluate inferences and predictions that are based on data.	Using a model of a data set to make predictions and recognize and explain the limitations of those predictions Constructing sampling distributions Understanding how sample statistics reflect the values of population parameters and using sampling distributions as the basis for informal inference	Conduct natural resource inventories and population studies to assess resource status Interpret and evaluate financial statements, including income statements, balance sheets and cash-flow analyses Conducting breakeven analysis for an agribusiness. Interpret agribusiness performance data

Table A-2. Continued

Content/Process Area	NCTM Sub-standards	Concepts/Processes	Example Topics
		Evaluating published reports that are based on data by examining the design of the study, the appropriateness of the data analysis, and the validity of conclusions	Predict the consequences of delayed payment of expenses, prepayment of expenses and delayed receipts on a financial statement Recognize how changes in prices of inputs and/or outputs influence the financial statements of an agribusiness Analyze records (e. g., budgets, net worth, assets, liabilities) to improve efficiency and profitability of an agribusiness Manage resources to minimize liabilities and maximize profit

Table A-2. Continued

Content/Process Area	NCTM Sub-standards	Concepts/Processes	Example Topics
Problem Solving	6B. Solve problems that arise in mathematics in other contexts.	Be able to solve mathematics problems in an agricultural context	Fertilizer rates Mixing feed rations Use speed, torque and power measurements to improve efficiency in power transmission systems Any agricultural mathematics problem
	6C. Apply and adapt a variety of appropriate strategies to solve problems.	Formulate and refine problems Solve problems in multiple ways Making connections among various ways of thinking about the same mathematical content	Any agricultural mathematics problem

APPENDIX B
MATHEMATICS ABILITY TEST

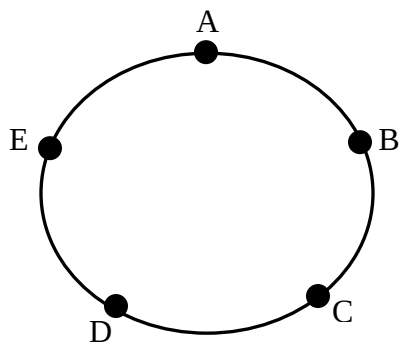
Instructions: Please write your answers in the space provided. If you need additional space, please use the blank sheets of paper that are attached to the instrument and include the problem number beside your work.

1. Mr. Robinson is converting 935 acres of his farm to timber. Using a calculator, he calculated the number of pine seedlings he would need to plant the 935 acres to be 5.112×10^5. Mr. Robinson does not know how to read scientific notation and needs your help. How many pine seedlings does Mr. Robinson need to plant to convert his 935 acres to timber?

2. Lauren wants to purchase liquid fertilizer for her garden. Which fertilizer is cheaper per liter: 0.82 liters of fertilizer for $4.45, 1.27 liters of fertilizer for $6.55, or 1.79 liters of fertilizer for 8.95?

3. A rose garden will be planted as a border around two sides of a triangular shaped lawn. Two of the vertices of the triangle have coordinates (-2, 4) and (3,-5). The landscape designer needs to locate the third vertex so that the area of the lawn is 25 square feet. Find the value of *k* if the coordinates of the third vertex are (3, *k*). All coordinates are represented in feet.

4. The figure below represents the arrangement of five different flowers around a flag pole, and the labeled points represent the placement of each flower. How many arrangements of flowers are possible?



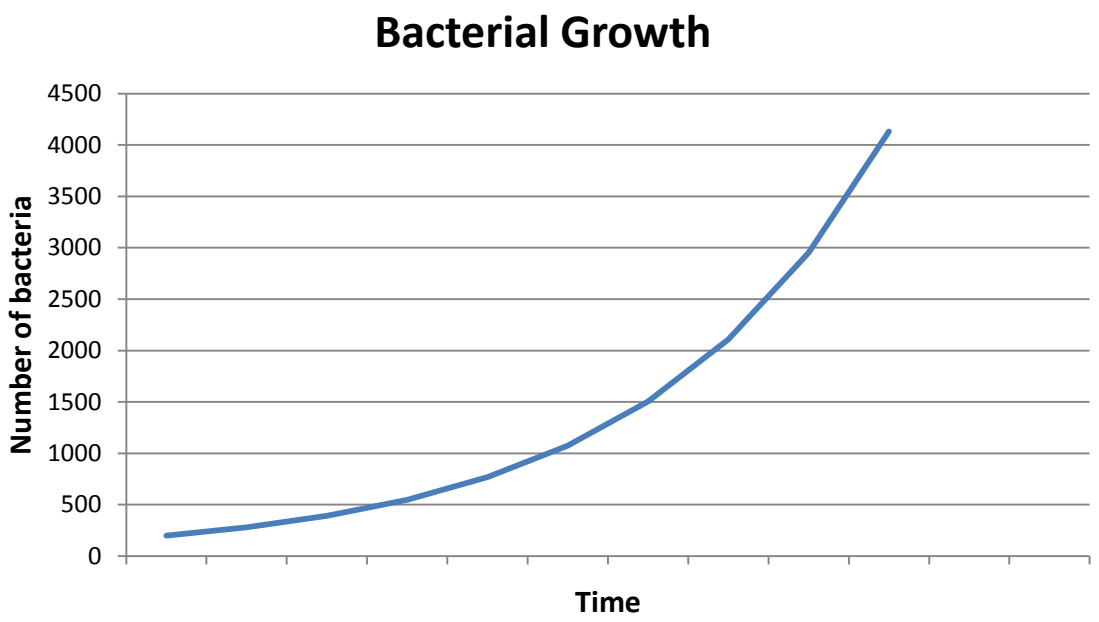
5. Jason has a 200 gallon spray tank and needs a mixing rate of 2.3 pounds of wettable powder per 12 gallons of water for the proper application rate. How many pounds of powder should Jason add to the tank?

6. The recommended floor space per broiler chicken is 0.75 square feet. How long would a 40 foot wide house need to be to accommodate a flock of 20,000 chickens?

7. Luke raised two goats during his senior year as part of his SAE project. He sold the goats before going to college for $132 each and invested the money in a savings account that has a 6% interest rate that is compounded annually. Assuming that he does not withdraw any money, what will be Luke's saving account balance after four years?

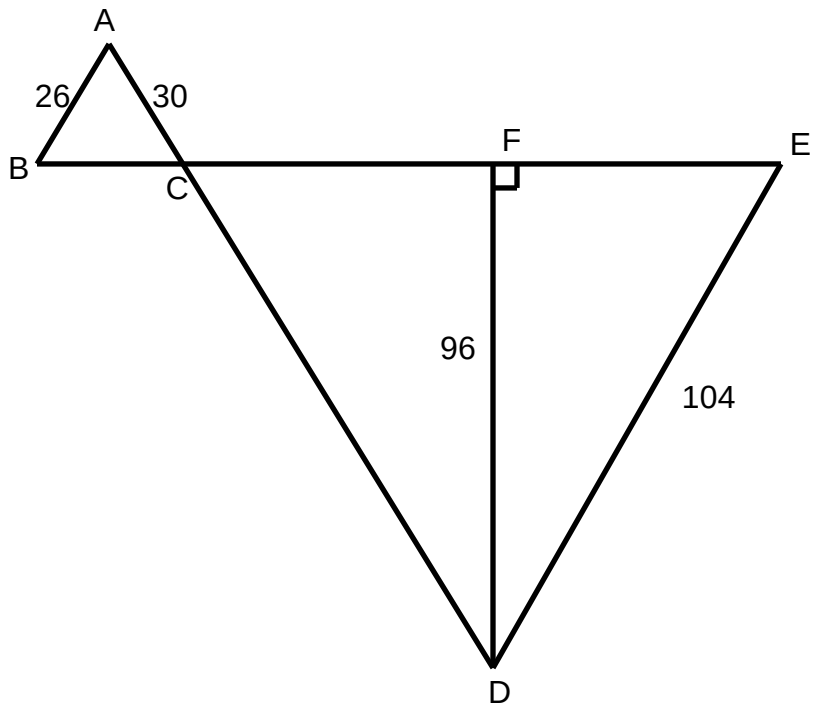
8. A local butcher purchased a 400 pound feeder steer. The butcher anticipates the steer to gain 20% of its body weight per month. If the weight after each month can be found by the function $w(x)= x(1.20)^n$, where x is the initial weight and n is the number of months from now, what will be the weight of the steer 5 months from now?

9. The graph below represents growth verses time for a colony of bacteria grown for an SAE project. Assume the colony's population increases by 40% each hour. Why is the growth each hour not linear or constant?



10. John Doe put a pit scraper in his hog house. Slats are 14 inches above the floor at one end of the building and 26 inches above the floor at the other end of the building (the end where wastes are emptied by the scraper). What is the slope of the floor in percent if the building is 152 ft. long?

11. In the figure below, segment AB is parallel to segment DE and segment DF is perpendicular to segment CE. Also, segment AD is a straight line. A rancher wants to fence the perimeter of the fields shown below. Assuming that all of the measurements are in feet, how many feet of fence will the rancher have to purchase?



12. A barn roof has a 30 degree rise, and the barn is 40 feet wide. How many feet does the roof rise? (Hint: the tangent of 30 degrees is 0.58)

13. In the table below, an agriscience student is measuring the intensity of common sounds in an agricultural mechanics lab. If the student discovers that a welding machine produces a sound of 70 decibels and a table saw produces a sound of 110 decibels, how many times greater is the sound intensity of the table saw than the welding machine?

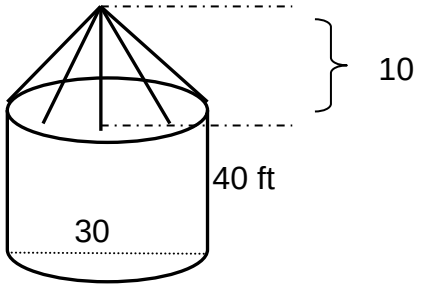
Decibels	70	80	90	100	110	120	130	140
Sound intensity in newtons per m^2	10^2	10^3	10^4	10^5	10^6	10^7	10^8	10^9

14. If a tractor has an initial speed of 5 mph and a constant acceleration of 1 mph/s^2, how long will it take for the tractor to cross a pond dam that is 164 feet long? The following formulas may be helpful:

$d(t) = v_i t + 1/2at^2$ and $t = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

15. An agribusiness that is located on the border of the United States and Canada is trying to cut fuel cost. On average, the agribusiness purchases 5,000 gallons of fuel per month. The current price of fuel in Canada is Can$1.50 a liter (Can$ stands for Canadian dollars). The current exchange rate is Can$1.49 for each US$1.00 (US$ stands for United States dollar). The current price of fuel in the United States is US$2.97 a gallon. In which country is fuel cheaper? If the agribusiness bought fuel from the cheaper source, how much money (in United States dollars) would the agribusiness save in one month?
1 gallon = 3.785 liters

16. Sarah just purchased a farm. The figure below is a diagram of a grain bin that is on the farm Sarah purchased. Sarah would like to know the volume of the grain bin. Help Sarah determine the volume of the grain bin. The following are two formulas that may be helpful: $V_{cylinder} = \pi r^2 h$ and $V_{cone} = 1/3\ \pi r^2 h$



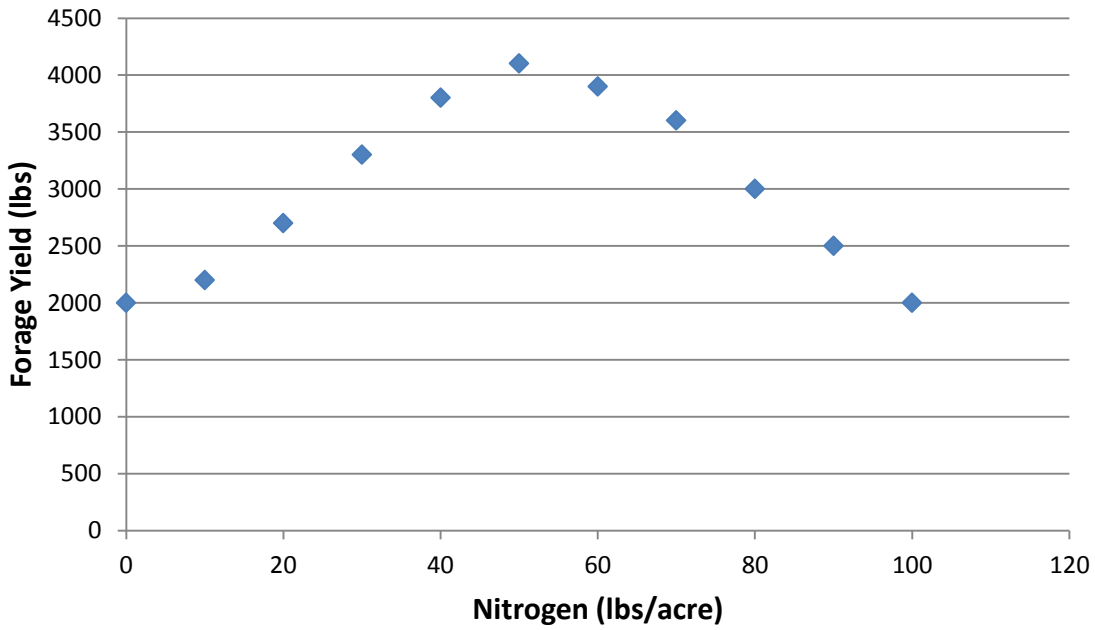
Use the scenario below to answer questions 17 and 18.

Rachel attends Ola High School and is conducting a food science study. Rachel needs to select a random sample of the student body in her high school. She decides to survey students in the agriscience classes, because she believes they will have a better understanding of food science. She then places the names of all students enrolled in the agriscience classes into a hat and draws to determine a random sample of high school students in her school.

17. Did Rachel select a random sample of the student body in her high school? Explain your answer.

18. Based on Rachel's actions to select a random sample, what is the population of the study Rachel conducted?

19. An agriscience student at Irwin County High School was interested in studying the bivariate relationship of forage yields and nitrogen application rates. The agriscience student decided to conduct a study to gather data on the relationship. According to the data gathered below, what type of function might be a good fit for the data model?



20. In raising alfalfa, the harvest removes P_2O_5 and K_2O from the soil. To ensure top yields for all harvest, it is recommended that the land be top dressed annually with 55 pounds of P_2O_5 and 180 pounds of K_2O for every 4.5 tons of yields. How much K_2O should be used if the expected harvest is 75 tons?

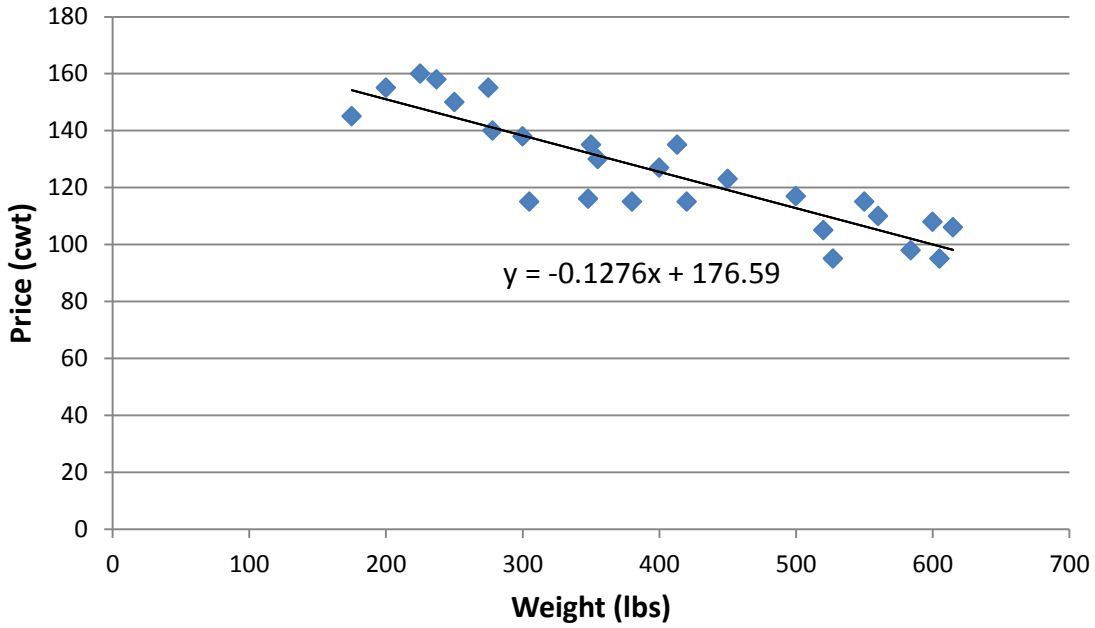
21. You have purchased a hog feeder at a discount for $75. If the discount was 33%, what was the original cost of the feeder rounded to the nearest penny?

22. Suppose that you are using a landscape plan which calls for covering an area of 4,600 square feet with mulch. If you are required to cover the mulched area to a depth of 4 inches, how many cubic yards of mulch will you need? Round your answer to the nearest hundredth of a yard.

23. Assume that you have previously determined the protein requirement for your cow is 15.17%. You wish to feed this cow a ration consisting of 50% roughage and 50% concentrate. Use the following table to determine what percent protein must be in the concentrate mix.

Roughage	**Crude Protein**
Corn silage	2.67%

Use the following scenario and graph to answer questions 24 – 26.
The data below represents feeder steer prices from a livestock market in Oklahoma. An agriscience student at a local high school computed the least-squares regression line for the data.



24. If the regression line for the feeder steer was found to be y = –0.1276x + 176.59, predict the price of a feeder steer that is 375 lbs.

25. What information could the agriscience student gain by computing the correlation coefficient for the data points of price and weight?

26. Explain why the y-intercept of the regression line does not have meaning in the feeder steer price verses weight context.

APPENDIX C
MATHEMATICS ENHANCEMENT TEACHING EFFICACY INSTRUMENT

Mathematics Enhancement Teaching Efficacy Instrument

Mathematics Teaching Efficacy

11. Please indicate the degree to which you agree or disagree with each statement below.

	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
I will continually find better ways to enhance mathematics in my lessons.	1	2	3	4	5
Even if I try very hard, I will not teach mathematics as well as I will most subjects.	1	2	3	4	5
I know how to teach mathematical concepts effectively.	1	2	3	4	5
I will not be very effective in monitoring mathematics activities.	1	2	3	4	5
I will generally teach mathematical concepts ineffectively.	1	2	3	4	5
I understand mathematical concepts well enough to be effective in teaching elementary mathematics functions.	1	2	3	4	5
I will find it difficult to use manipulatives to explain to students why mathematics works.	1	2	3	4	5
I will typically be able to answer students" questions related to mathematics.	1	2	3	4	5
I wonder if I will have the necessary skills to enhance mathematics in my curriculum.	1	2	3	4	5
Given a choice, I will not invite the principal to evaluate my mathematics teaching.	1	2	3	4	5
When a student has difficulty understanding a mathematical concept, I will usually be at a loss as to how to help the student understand it better.	1	2	3	4	5
When teaching mathematics, I will usually welcome student questions.	1	2	3	4	5
I do not know what to do to turn students on to mathematics.	1	2	3	4	5

Personal Mathematics Efficacy

12. How confident do you feel about having to do the following calculations?

	Very Confident	Confident	Not Very Confident	Not At All Confident
Using a train timetable, calculate how long it would take to get from City A to City B.	4	3	2	1
Calculating how much cheaper a television would be after a 30 percent discount.	4	3	2	1
Calculating how many square feet of tiles you need to cover a floor.	4	3	2	1
Understanding graphs presented in newspapers.	4	3	2	1
Solving an equation like $3x + 5 = 17$.	4	3	2	1
Finding the actual distance between two places on a map using a 1:10,000 scale.	4	3	2	1
Solving a mathematical equation like the following: $2(x+3) = (x+3)(x-3)$.	4	3	2	1
Calculating the gasoline consumption rate of a car.	4	3	2	1

Personal Teaching Efficacy

13. Please indicate your opinion about each of the statements below.

	Nothing		Very Little Influence		Some Influence		Quite A Bit of Influence		A Great Deal of Influence
How much can you do to control disruptive behavior in the classroom?	1	2	3	4	5	6	7	8	9
How much can you do to motivate students who show low interest in school work?	1	2	3	4	5	6	7	8	9
How much can you do to get students to believe they can do well in school work?	1	2	3	4	5	6	7	8	9
How much can you do to help your students value learning?	1	2	3	4	5	6	7	8	9
To what extent can you craft good questions for your students?	1	2	3	4	5	6	7	8	9
How much can you do to get children to follow classroom rules?	1	2	3	4	5	6	7	8	9
How much can you do to calm a student who is disruptive or noisy?	1	2	3	4	5	6	7	8	9
How well can you establish a classroom management system with each group of students?	1	2	3	4	5	6	7	8	9
How much can you use a variety of assessment strategies?	1	2	3	4	5	6	7	8	9
To what extent can you provide an alternative explanation or example when students are confused?	1	2	3	4	5	6	7	8	9
How much can you assist families in helping their children do well in school?	1	2	3	4	5	6	7	8	9
How well can you implement alternative strategies in your classroom?	1	2	3	4	5	6	7	8	9

APPENDIX D
IRB APPROVAL AND INFORMED CONSENT

UF | Institutional Review Board
UNIVERSITY of FLORIDA

PO Box 112250
Gainesville, FL32611-2250
352-392-0433 (Phone)
352-392-9234 (Fax)
irb2@ufl.edu

DATE: June 29, 2011

TO: Christopher Stripling
PO Box 110540
Campus

FROM: Ira S. Fischler, PhD; Chair
University of Florida
Institutional Review Board 02

SUBJECT: **Approval of UFIRB # 2011-U-0675**
Math Ability and Efficacy

SPONSOR: None

I am pleased to advise you that the University of Florida Institutional Review Board has recommended approval of this protocol. Based on its review, the UFIRB determined that this research presents no more than minimal risk to participants. Your protocol was approved as an expedited study under category 7: *Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.*

Given this status, it is essential that you obtain signed documentation of informed consent from each participant. Enclosed is the dated, IRB-approved informed consent to be used when recruiting participants for the research. If you wish to make any changes to this protocol, *including the need to increase the number of participants authorized*, you must disclose your plans before you implement them so that the Board can assess their impact on your protocol. In addition, you must report to the Board any unexpected complications that affect your participants.

> It is essential that each of your participants sign a copy of your approved informed consent that bears the IRB approval stamp and expiration date.

Your approval is valid through **June 28, 2012**. If you have not completed the protocol by this date, please telephone our office (392-0433), and we will discuss the renewal process with you. It is important that you keep your Department Chair informed about the status of this research protocol.

ISF:dl

Informed Consent

Protocol Title: Math Ability and Efficacy

Please read this consent document carefully before you decide to participate in this study.

Purpose of the research study: The purpose of this study is to examine preservice agricultural teachers' mathematics ability, personal mathematics efficacy, mathematics teaching efficacy, and personal teaching efficacy.

What you will be asked to do in the study: You will be asked to complete the *Mathematics Ability Instrument* and the *Mathematics Enhancement Teaching Efficacy Instrument*. The *Mathematics Ability Instrument* will be administered twice: at the beginning of the agricultural education teaching methods course and at the end of the teaching methods course. The *Mathematics Enhancement Teaching Efficacy Instrument* will be administered three times: at the beginning of the agricultural education teaching methods course, the midpoint of the teaching methods course, the end of the teaching methods courses.

Time required: The *Mathematics Ability Instrument* will take 45-60 minutes to complete, and the *Mathematics Enhancement Teaching Efficacy Instrument* will take 8-12 minutes to complete.

Risks and Benefits: There are no anticipated risks or benefits to participating in the study.

Compensation: There is no compensation for participating in this study.

Confidentiality: Your answers will be kept confidential to the extent provided by law. You will not be asked to provide your name, and it will not be used in any report. Only the researcher and research assistants will have access to data that is collected during this study, and the data will be kept in a locked file.

Voluntary participation: Your participation in this study is voluntary and will not impact your course grade. There is no penalty for not participating. If you choose to participate, you do not have to answer any question that you do not wish to answer.

Right to withdraw from the study: You have the right to withdraw from the study at anytime without consequence.

Whom to contact if you have questions about the study: Christopher Stripling, Graduate Assistant, Department of Agricultural Education and Communication, 3127 McCarty Hall B P.O. Box 110540 Gainesville, FL 32611, (352) 392-1663, cstripling@ufl.edu

Whom to contact about your rights as a research participant in the study: UFIRB Office, Box 112250, University of Florida, Gainesville, FL 32611-2250; ph 392-0433.

Agreement: I have read the procedure described above. I voluntarily agree to participate in the procedure and I have received a copy of the informed consent.

Participant: _____ Date: _____
Principal Investigator: _____ Date: _____
Supervisor of Investigator: _____ Date: _____

Approved by
University of Florida
Institutional Review Board 02
Protocol # 2011-U-0675
For Use Through 06-28-2012

APPENDIX E
SCRIPT

Experimental Group

This semester AEC 4200 is taking part in a research project to help future agricultural education teachers teach mathematics that is found naturally in the agricultural education curricula. During this study you will be asked to complete a mathematics content knowledge instrument and a mathematics efficacy instrument at various times. In addition, you will be randomly assigned two agricultural mathematics standards to incorporate into labs six and eight. This research is being conducted by the Agricultural Education and Communication Department. Your participation in this study will in **no way influence your course grade and is completely voluntary**.

The instrument is anonymous, but does ask for an identification number to match the instruments that are completed by each participant. Data will be recorded as a group of students and not individually.

If you have agreed to participated, have signed the informed consent, and have received an instrument you may begin.

Thank you,

Christopher Stripling

Control Group

This semester AEC 4200 is taking part in a research project to help future agricultural education teachers teach mathematics that is found naturally in the agricultural education curricula. During this study you will be asked to complete a mathematics content knowledge instrument and a mathematics efficacy instrument at various times. This research is being conducted by the Agricultural Education and Communication Department. Your participation in this study will in **no way influence your course grade and is completely voluntary**.

The instrument is anonymous, but does ask for an identification number to match the instruments that are completed by each participant. Data will be recorded as a group of students and not individually.

If you have agreed to participated, have signed the informed consent, and have received an instrument you may begin.

Thank you,

Christopher Stripling

APPENDIX F
DEMOGRAPHIC INSTRUMENT

1. What is your age? _____ years

2. What is your grade point average (GPA)? _____

3. What is your gender?
   a. male
   b. female

4. How would you describe your ethnicity?
   a. American Indian or Alaska Native
   b. Asian
   c. Black or African American
   d. Native Hawaiian or Other Pacific Islander
   e. White
   f. Other

5. What was the highest level of mathematics that you successfully completed in high school?
   a. Algebra 1
   b. Algebra 2
   c. College Algebra
   d. Geometry
   e. Trigonometry
   f. Pre-calculus
   g. Statistics
   h. Calculus
   i. other; please provide course name _____

6. What is the highest level of mathematics that you have successfully completed in college?
   a. College Algebra
   b. Geometry
   c. Trigonometry
   d. Pre-calculus
   e. Statistics
   f. Calculus
   g. other; please provide course name _____

7. What grade did you receive for the highest level of mathematics that you have successfully completed in college? _____

8. When did you take your last math course? _____

9. How many college level mathematics courses have you completed? _____

10. What is your class level?
    a. freshman
    b. sophomore
    c. junior
    d. senior
    e. graduate student

11. Did you receive college credit for a math course in high school? Yes / No
    If so, what math course did you receive college credit for
_____.

APPENDIX F
EXPERTS

Lecture Reviewer

Brian A. Parr
Associate Professor and Program Coordinator of Agriscience Education
Department of Curriculum and Teaching
Auburn University
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Auburn, AL 36849-5212

Panel of Experts for the Mathematics Ability Test

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Candice Cobb, EdS
Secondary Mathematics Teacher
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Elizabeth Portier, EdS
Mathematics Department Head and Secondary Mathematics Teacher
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Developed the Mathematics Ability Test Rubric

Candice Cobb, EdS
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Elizabeth Portier, EdS
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Mathematics Ability Test Scorer

Candice Cobb, EdS
Secondary Mathematics Teacher
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Ocilla, GA 31774

Aligned Miller and Gliem's (1996) Instrument Items to the 13 NCTM Sub-Standards

Candice Cobb, EdS
Secondary Mathematics Teacher
Irwin County High School
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BIOGRAPHICAL SKETCH

Christopher T. Stripling grew up in Irwinville, Georgia, which is a small rural town in South Georgia. Having parents involved in various aspects of agriculture and education fostered his passion for agricultural education. Christopher graduated from Irwin County High School in 2001, where he was the Irwin County High School FFA President and was a member of the tennis team.

Upon his high school graduation, Christopher attended Abraham Baldwin Agricultural College and received his associate of science in biological and agricultural engineering with honors in 2003. He then transferred to the University of Georgia and received his Bachelor of Science in agricultural education in 2005.

Upon completing his bachelor of science, Christopher married Mindi Lee and accepted a teaching position at Ola High School in McDonough, Georgia as an agriscience teacher. He taught for three years and was named Ola High School's Teacher of the Year for the 2008-2009 school year. While teaching agriscience, Christopher completed a master's degree in agricultural leadership in 2006 and developed and delivered agriscience professional development for the agricultural teachers in Georgia.

In 2009, Christopher accepted a graduate teaching and research assistantship at the University of Florida and began work on a Ph.D. in the Department of Agricultural Education and Communication. As a graduate teaching and research assistant, Christopher taught various courses in agricultural education and conducted research related to contextualized mathematics teaching, college class attendance, behaviors of successful college instructors, teaching assistants, and experiential learning.

Furthermore, while at the University of Florida, Christopher received the 2010 University of Georgia's College of Agriculture and Environmental Sciences Young Alumni Award.