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Florida Preservice Agricultural Education Teachers' Mathematics Ability and Efficacy

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The purpose of this study was to examine the mathematics ability and efficacy of Florida preservice agricultural education teachers. Results indicated that the preservice teachers were not proficient in solving agricultural mathematics problems. On the other hand, the preservice teachers were efficacious in personal teaching efficacy and personal mathematics efficacy, and moderately efficacious in their mathematics teaching efficacy. Additionally, the associations between mathematics ability and mathematics coursework suggest that preservice teachers that completed an advanced mathematics course in high school and/or college scored higher on the mathematics assessment than preservice teachers that completed a basic or intermediate mathematics course in high school and/or college. However, only a small percentage of the preservice teachers completed an advanced mathematics course in high school and/or college. Based on the data collected in this study, the teacher education program at the University of Florida may need to further evaluate its mathematics coursework requirements.

Keywords: preservice teachers; mathematics; self-efficacy; agricultural education; teacher education

Introduction

Why are 66% of Florida 9th grade students experiencing little to partial success in mathematics (Florida Department of Education, 2010)? 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)? During the past decade, the lack of mathematics proficiency among Florida students is well documented (Florida Department of Education, 2010), and according to the Michigan State University Center for Research in Mathematics and Science Education (2010), a lack of mathematics proficiency 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.

However, the solution to improving mathematics proficiency may not fall just on mathematics teachers. To that end, Shinn et al. (2003) 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 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" (p. 6-7). Similarly, Jansen and Thompson (2008) called for a "closer examination of program requirements related to the level of mathematics exposure and proficiency in mathematics" (p. 26). Jansen and Thompson (2008) also purported that "as agricultural education becomes a viable avenue for increasing the rigor and relevance of core-academic connections, pre-service teaching requirements in mathematics may need to be increased to meet the demands of interdisciplinary instruction" (p. 26).

Based on the aforementioned findings, the fundamental problem this study investigated is the lack of mathematics success among Florida's secondary students and potentially, Florida's preservice agricultural teachers. It is possible, and perhaps probable that Florida's preservice agriculture teachers may be ill-prepared to effectively teach agricultural mathematics concepts. This study will examine this issue by describing Florida preservice agricultural teachers' mathematics subject matter knowledge, perceptions of their subject matter knowledge, perceptions of their pedagogical knowledge, and perceptions of their mathematics pedagogical content knowledge.

Theoretical Framework

Dunkin and Biddle's (1974) model for the study of classroom teaching was used to frame this study. The aforementioned authors differentiated between four categories of variables: presage, context, process, and product. Dunkin and Biddle theorized that presage and context variables have a causative relationship with process variables and process variables have a causative relationship with product variables (Figure 1).

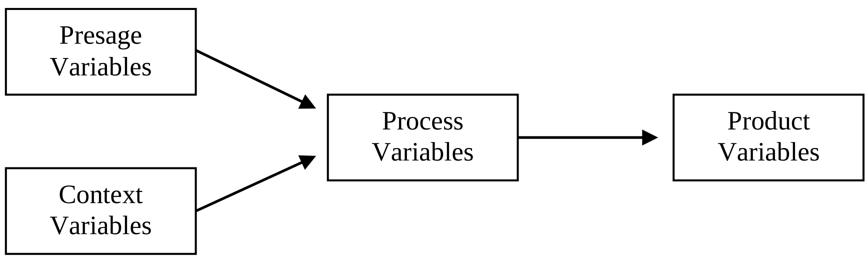

Figure 1. Adapted model for the study of classroom teaching.

According to Dunkin and Biddle (1974), presage variables "concern the characteristics of teachers that may be examined for their effects on the teaching process–thus, teacher formative experiences, teacher-training experiences, and teacher properties" (Dunkin & Biddle, 1974, p. 39). Context variables are "characteristics of the environment about which teachers, school administrators, and teacher-educators can do very little" (Dunkin & Biddle, 1974, p. 41). Examples of context variables are community, school, and classroom contexts, student populations, and student formative experiences. Process variables are "the actual activities of classroom teaching – what teachers and pupils do in the classroom" (p. 44), and the interaction of teacher and student classroom behaviors yields observable positive or negative changes in a student's academic learning. Thus, changes in student learning that result from the interaction of the student with classroom activities, the teachers, and other students comprise the final category of variables, product variables.

Moreover, Dunkin and Biddle (1974) purported that decisions made by teacher education programs concerning the "relationship between presage conditions and teaching processes" (p. 49) should be based on evidence. With that in mind, this study focused on the following presage variables of preservice agricultural education teachers: mathematics ability, mathematics teaching efficacy, personal mathematics efficacy, and personal teaching efficacy.

Building upon Dunkin and Biddle (1974), recent literature further defines characteristics of effective teachers, and more specifically, the types of knowledge teachers must obtain to teach effectively (Darling-Hammond & Bransford, 2005). To that end, Darling-Hammond and Bransford (2005) described three types of knowledge required for effective teaching: subject matter knowledge, pedagogical knowledge, and pedagogical content knowledge. Subject matter knowledge is knowledge of discipline-specific content; pedagogical knowledge is knowledge of universal teaching and learning principles; pedagogical content knowledge is knowledge of teaching and learning principles specific to the content and discipline (Roberts & Kitchel, 2010). Hence, in the context of this study, mathematics ability and personal mathematics efficacy are measures of subject matter knowledge, personal teaching efficacy is a measure of pedagogical knowledge, and personal mathematics efficacy is a measure of pedagogical content knowledge (Figure 2).

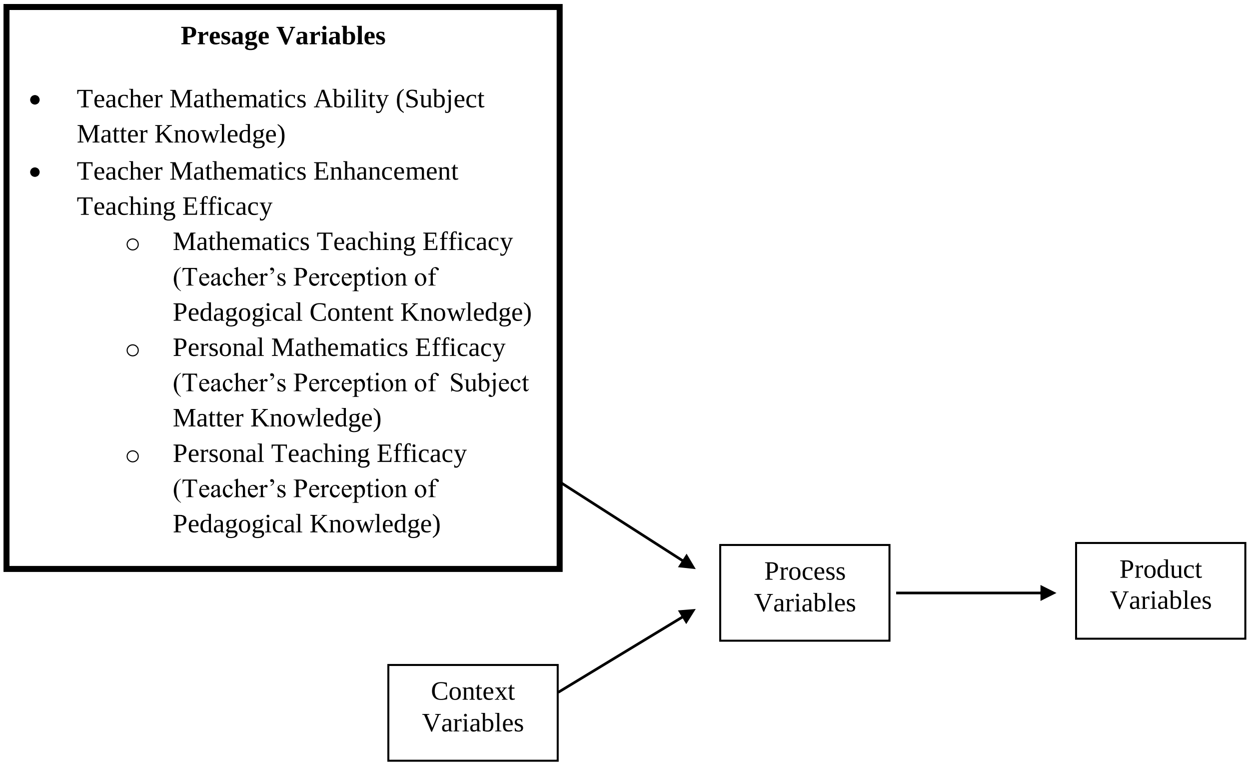

Figure 2. Conceptual framework of presage variables under investigation.

Literature Review

Agricultural Educators' Mathematics Ability

A comprehensive literature search revealed only a few studies that investigated the mathematics ability of agricultural educators. Miller and Gliem (1994) utilized a 15-item mathematics problem-solving test to examine the mathematics problem-solving ability of agricultural educators in Ohio. Based on a mean score of 66.47%, Miller and Gliem concluded that the teachers in the study were not proficient in solving agriculturally related mathematics problems. Additionally, the researchers reported that the relationships between mathematics problem-solving ability and the following variables were not significant: age and highest level of college mathematics coursework completed. However, the relationships between mathematics 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.

A similar study was conducted by Miller and Gliem (1996), however the participants 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%. Miller and Gliem reported that the preservice teachers averaged 37% and that 87.8% of the preservice teachers scored lower than 60%. Grade point average, level of mathematics courses taken, and gender were found to have negligible relationships with mathematics problem solving ability. A moderate relationship was found between mathematics ability and the 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).

Before Miller and Gliem (1994, 1996), Persinger and Gliem (1987) investigated the mathematics ability of secondary agriculture teachers and their students. Persinger and Gliem's study consisted of 54 teachers and 656 students. The agriculture teachers' mean score on the 20 question mathematics ability test was 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 be lacking in mathematics competence, which supports the findings of Michigan State University Center for Research in Mathematics and Science Education (2010). Moreover, the researchers reported that the students' test scores were significantly related to the scores of their teacher.

Agricultural Educators' Mathematics Enhancement Teaching Efficacy

Mathematics enhancement teaching efficacy is defined by the following three constructs: mathematics teaching efficacy, personal mathematics efficacy, and personal teaching efficacy (Jansen, 2007). Personal teaching efficacy or teacher efficacy is the "belief that one can bring about desired outcomes in one's student" (Soodak & Podell, 1996, p. 401). According to Tschannen-Moran, Woolfolk Hoy, and Hoy (1998), "teacher efficacy is the teacher's belief in his or her capability to organize and execute courses of action required to successfully accomplish a specific teaching task in a particular context" (p. 233). Guskey and Passaro (1994) defined teacher efficacy as a teacher's belief in their ability to have an effect on student learning for all types of students. What is more, teachers with high teaching efficacy exert more effort in planning and organization (Allinder, 1994) and persevere though 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.

> 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. (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).

Furthermore, there is a plethora of recent research in agricultural education investigating teaching efficacy. Knobloch (2006) compared preservice teachers from the University of Illinois and The Ohio State University and 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 (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. Roberts et al. reported that a general trend emerged from the data for all three constructs (student engagement, instructional strategies, and classroom management) 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 increased 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. Consistent with Roberts et al. (2006), the data of Harlin et al. (2007) revealed the same general aforementioned trend.

Stripling, Ricketts, Roberts, and Harlin (2008) extended the research of Roberts et al. (2006) and Harlin et al. (2007) to include examining the impact of the teaching methods course on teaching efficacy. The study consisted of 102 preservice agricultural education teachers from the University of Georgia and Texas A&M University. The researchers reported that the overall teaching efficacy mean increased at each of the following data collection points: before the teaching methods course, after-the-methods course/before student teaching, and after-student-teaching. Likewise, the instructional strategies, student engagement, and classroom management scores increased at each data collection point. Stripling et al. reported that a significant difference existed for mean student engagement and classroom management scores over time and the effect sizes were medium. Significant differences were also reported for the mean instructional strategies scores over time and the effect size was large. Post hoc analysis revealed a significant difference for student engagement from before the methods course to after the methods course/before student teaching. Stripling et al. also reported a significant difference between the instructional strategies score from before the methods course and after the methods course/before student teaching.

Research that specifically investigates the mathematics teaching efficacy and mathematics efficacy of secondary and preservice agricultural education teachers is limited. Jansen and Thompson (2008) investigated the teacher efficacy beliefs that Oregon and Washington secondary agricultural teachers have toward enhancing mathematics in their curricula and reported that the participants in the study perceived themselves as very efficacious in personal mathematics and teaching ability. The teachers were also very confident with teaching mathematics. Jansen and Thompson (2008) purported that "content knowledge specifically related to mathematics seems to have a greater influence on mathematics teaching than pedagogical techniques and strategies…,[and this] should influence the selection of programming for future professional development activities aimed to enhance mathematics in agricultural education lessons" (p. 26).

Similarly, Swan, Moore, and Echevarria (2008) sought to assess the confidence of Idaho agricultural mechanics teachers (*n* = 54) "in their own mathematics skills and their ability to teach mathematics skills" (p. 29). The researchers reported that the teachers had complete confidence in passing basic mathematics with an A or B, much confidence in passing 11 courses, some confidence in passing three courses, and very little confidence in passing advanced calculus with a grade of A or B. However, the participants indicated that "they had complete confidence in their own ability to complete mathematics related tasks" (Swan et al., 2008, p. 36), and were completely confident in their ability to teach mathematics found within agricultural mechanics courses. Swan et al. (2008) also reported that a strong relationship was found "between teacher's confidence in their own mathematic skills and their confidence to teach mathematic skills" (p. 38).

Secondary Mathematics Integration

The mathematics integration literature specific to agricultural education is limited. However, several studies have been conducted to test the effectiveness of Stone, Alfeld, Pearson, Lewis, and Jensen's (2006) Math-in-CTE model on various product variables (Dunkin & Biddle, 1974).

To that end, in a study of 38 secondary agricultural classes, Parr, Edwards, and Leising (2006) sought to determine if students that participated in contextualized agricultural mathematics lessons "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 students who took part in the math-enhanced curriculum were less likely to need postsecondary remediation, and the practical significance of the finding was reported to be a large effect. 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 course in their technical skill acquisition. The findings revealed no significant difference, thus the math-enhanced curriculum did not lessen technical skills. In a third study investigating the effects of a math-enhanced 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).

Young, Edwards, and Leising's (2008, 2009) inquiries were very similar to the studies of Parr et al. (2006, 2008, 2009). Young et al. (2008) sought to determine if math-enhanced agricultural power and technology curriculum would significantly increase the mathematics ability of the participants compared to a traditional 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 results revealed practical significance. In 2009, Young et al. published a second study that mirrored Parr et al. (2008). However, this investigation was a one year analysis versus a semester long analysis. The results also mirrored the results of Parr et al. (2008) in which technical competence was not diminished.

Purpose and Objectives

The purpose of this study was to examine mathematics ability, mathematics teaching efficacy, personal mathematics efficacy, and personal teaching efficacy of preservice agricultural teachers during the final year of an agricultural education program at the University of Florida. The following objectives framed this study:

1. Determine the highest category of mathematics completed in high school and college by preservice teachers at the University of Florida.
2. Describe the mathematics ability of preservice teachers at the University of Florida.
3. Describe the mathematics teaching efficacy, personal mathematics efficacy, and personal teaching efficacy of preservice teachers at the University of Florida.
4. Determine the magnitudes of the associations between mathematics ability of University of Florida preservice teachers and the type of mathematics the preservice teachers completed in high school and college.

Methods and Procedures

The following terms were operationally defined for this study:

- *Mathematics ability* is defined as the students' scores on the *Mathematics Ability Test*.
- *Personal mathematics efficacy* is the self-belief in one's capabilities to solve mathematics problems. Personal mathematics efficacy was defined as the student's score on 8 items contained in the *Mathematics Enhancement Teaching Efficacy Instrument* by Jansen (2007).
- *Mathematics teaching efficacy* is a person's self-belief about their capabilities to teach mathematics. Mathematics teaching efficacy was defined as the student's score on 13 items contained in the *Mathematics Enhancement Teaching Efficacy Instrument* by Jansen (2007).
- *Personal teaching efficacy* is a person's self-belief about their capabilities to teach. Personal teaching efficacy was defined as the student's score on 12 items contained in the *Mathematics Enhancement Teaching Efficacy Instrument* by Jansen (2007).

Research Design and Sample

The research design of this study was a one shot case study (Campbell & Stanley, 1963). The target population for this descriptive study was Florida preservice agricultural education teachers, and the accessible population was preservice teachers in their final year of the agricultural education program at the University of Florida's main campus. This purposive convenience sample was conceptualized as a slice in time (Oliver & Hinkle, 1981), since the target population consists of current and future students (Huck, 2008). 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. Thus, the purposive sample was selected because of the need to assess the mathematics ability and efficacy of Florida preservice agricultural education teachers.

The sample consisted of 25 preservice agricultural education teachers, 19 females and 6 males. The average age of the sample was 22 years old (SD = 1.41) with a range of 20 to 27. Twenty-three of the participants described their ethnicity as white, one as African American, and one as other. The majority of the participants were seniors in an undergraduate program (n = 23, 92%), while the remaining two students were completing a graduate program. Twenty-three participants provided their college grade point average, and their mean GPA was 3.54 (SD = 0.44) on a 4-point scale. The number of college level mathematics courses completed by the participants ranged from 1 to 6 with a mean of 3.08 (SD = 1.17). In addition, the time since the participants' last math course ranged from the previous semester to 6 years prior, and 39.1% received an A, 8.7% a B+, 26.1% a B, 4.3% a B-, 17.4% a C, and 4.3% a D.

Instrumentation

Participants consented to take the *Mathematics Ability Test* and the *Mathematics Enhancement Teaching Efficacy Instrument* (Jansen, 2007) by signing an informed consent approved by the University of Florida's IRB, and the instruments were administered during the Fall 2010 teaching methods course. Preservice teachers were asked to complete the instruments during instructional time, thus to avoid coercion, they were informed that participation in the study would not have an impact on their course grades. A 100% response rate was achieved on both of the aforementioned instruments.

The *Mathematics Ability Test* is a researcher-developed instrument that consists of 26 open-ended mathematical word problems, which are scored incorrect, partially correct (students set the problem up correctly but made a calculation error), or correct. The assessment took approximately 45 to 60 minutes to complete. Face and content validity of the instrument were established by a panel of experts consisting of agricultural education faculty and mathematics faculty from three universities and two secondary mathematics experts. The reliability of the instrument was assessed post hoc using Cronbach's alpha coefficient, and the alpha coefficient was found to be .80. Cronbach's alpha coefficient was used to assess reliability because the word problems were scored and coded as incorrect (0), partially correct (.5), or correct (1). In addition, one scorer was utilized to score the *Mathematics Ability Test,* and the scorer used a rubric that was developed by two secondary mathematics experts to score each item. The *Mathematics Ability Test* was developed based on the 13 National Council of Teachers of Mathematics (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). Shinn (2003) hypothesized "that the integration of curricular materials that meet state and national standards, including NCTM Curriculum and Evaluation Standards for School Mathematics, into an agricultural education curriculum will result in higher student achievement in mathematics" (p. 29). The 13 cross-referenced NCTM sub-standards and the corresponding content or process area are provided in Table 1.

Table 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.

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. The instrument utilizes a different rating scale for each construct – mathematics teaching efficacy (1 = *strongly disagree* to 5 = *strongly agree*), personal mathematics efficacy (1 = *not at all confident* to 4 = *very confident*), and personal teaching efficacy (1 = *nothing* to 9 = *a great deal of influence*) (Jansen, 2007). Jansen reported that face and content validity were established by a panel of experts. Jansen stated that 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. The *Mathematics Enhancement Teaching Efficacy Instrument* took 8-12 minutes to complete.

Data Analysis

Descriptive statistics were used to summarize demographics, mathematics teaching efficacy, personal mathematics efficacy, personal teaching efficacy, and mathematics ability of the preservice agricultural education teachers. Point Biserial correlation coefficients were used to determine the magnitude of the associations between mathematics ability and types of courses completed in high school and college. Thus, the types of mathematics courses were coded as not completed (0) or completed (1). The 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.

Findings

Objective 1. Determine the Highest Category of Mathematics Completed in High School and

College by Preservice Teachers at the University of Florida

Preservice teachers most commonly completed an intermediate mathematics course as their highest level of mathematics in high school (45.8%) and college (58.3%, Table 2). A basic mathematics course was completed as the highest level of mathematics by 33.3% in high school and 25.0% in college. An advanced mathematics course was completed as the highest level of mathematics by 20.8% in high school and 16.7% in college.

Table 2
Highest Category of Mathematics Courses Completed by the Preservice Agricultural Teachers

Type	*f*	%
High school mathematics courses completed		
Basic high school	8	33.3
Intermediate high school	11	45.8
Advanced high school	5	20.8
College mathematics courses completed		
Basic college	6	25.0
Intermediate college	14	58.3
Advanced college	4	16.7

Note. n = 24. One participant did not provide the mathematics course data.

Objective 2. Describe the Mathematics Ability of Preservice Teachers at the University of Florida

The preservice agricultural education teachers' scores on the 26 item *Mathematics Ability Test* ranged from 2.5 (9.6%) to 16.5 (63.5%), and a majority of the students (80%) answered less than 50% of the problems correctly. The mean number of correct responses was 9.26 (*SD* = 3.74) or 35.6%. Table 3 shows the distribution of scores on the *Mathematics Ability Test*.

Table 3
Preservice Agricultural Teachers' Scores on the Mathematics Ability Test

Score range	% correct range	*f*	%
2.5 to 5.0	9.6 to 19.2	5	20
6.0 to 9.0	23.1 to 34.6	9	36
9.5 to 12.5	36.5 to 48.1	6	24
13.0 to 16.5	50.0 to 63.5	5	20

Note. Mean Score 9.26 (*SD*= 3.74), out of 26 possible.

Objective 3. Describe the Mathematics Teaching Efficacy, Personal Mathematics Efficacy, and Personal Teaching Efficacy of Preservice Teachers at the University of Florida

As depicted in Table 4, the preservice teachers in this study were confident in their personal mathematics efficacy (M = 3.45, SD = .28). The preservice teachers also perceived themselves as having "Quite a Bit of Influence" in affecting student learning (personal teaching efficacy, M = 7.35, SD = .43). In addition, the preservice teachers were moderately efficacious in their mathematics teaching efficacy (M = 3.32, SD = .55).

Table 4
Means for Scales of the Mathematics Enhancement Teaching Efficacy Instrument

Measurement	*M*	*SD*
Personal Mathematics Efficacy	3.45	0.28
Mathematics Teaching Efficacy	3.32	0.55
Personal Teaching Efficacy	7.35	0.43

Note. Scales: mathematics teaching efficacy (1 = *strongly disagree* to 5 = *strongly agree*), personal mathematics efficacy (1 = *not at all confident* to 4 = *very confident*), and personal teaching efficacy (1 = *nothing* to 9 = *a great deal of influence*) (Jansen, 2007).

Objective 4. Determine the Magnitudes of the Associations between Mathematics Ability of University of Florida Preservice Teachers and the Type of Mathematics the Preservice Teachers Completed in High School and College

As seen in Table 5, moderate correlations were discovered 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). A low correlation was observed between mathematics ability and intermediate college mathematics (r = .10) and a negligible correlation was observed between mathematics ability and intermediate high school mathematics (r = .03). The above correlations were described using guidelines from Davis (1971).

Table 5
Point Biserial Correlations between Highest Math Course Completed and Math Ability

	Basic high school	Intermediate high school	Advanced high school	Basic college	Intermediate college	Advanced college
Math Ability	-.43	.03	.47	-.46	.10	.40

Note. Mathematics level variables were coded as 0 = not highest type of mathematics completed; 1 = highest type of mathematics completed

Conclusions

More preservice teachers completed an intermediate mathematics course as their highest level of mathematics than basic or advanced mathematics in high school and/or college. Results also indicated that the preservice teachers were not proficient in solving agricultural mathematics problems that were based on the 13 cross-referenced NCTM sub-standards, and this lack of proficiency was consistent with Miller and Gliem (1996). However, the preservice teachers were efficacious in personal teaching efficacy and personal mathematics efficacy, and moderately efficacious in their mathematics teaching efficacy, mirroring the results of Jansen and Thompson (2008). Lastly, the associations between mathematics ability and mathematics coursework suggest that preservice teachers that completed an advanced mathematics course in high school and/or college scored higher on the mathematics assessment than preservice teachers that completed a basic or intermediate mathematics course in high school and/or college, which supports Miller and Gliem (1996).

Recommendations and Implications

Based on the results of this study, there is a disconnect between preservice agricultural education teachers' mathematics ability (subject matter knowledge) and efficacy (perceptions of their subject matter knowledge, pedagogical knowledge and pedagogical content knowledge). The *Mathematics Ability Test* revealed that preservice teachers were not proficient in a substantial number of high school mathematics competencies; yet, the preservice teachers' efficacy scores indicated that they felt competent in their mathematics ability and moderately competent in their mathematics teaching efficacy. Bandura's (1986) social cognitive theory and Bandura's (1997) self-efficacy theory posited that personal factors influence behavior. So, in this case, mathematics ability and mathematics teaching efficacy should impact a teacher's ability to teach mathematics. If preservice teachers have low ability, why are they moderately efficacious about teaching mathematics? Future research should seek to explain this disconnect between mathematics ability and efficacy. Furthermore, why do preservice teachers have such low mathematics ability? This is troubling since Dunkin and Biddle (1974) theorized that presage variables (e.g., teacher mathematics ability) influence classroom activities, which then affects student achievement. Similarly, Darling-Hammond and Bransford (2005) stated that subject matter knowledge is an essential type of knowledge for effective teaching. Also, this is troubling since Persinger and Gliem (1987) reported that agricultural teachers' mathematics ability scores were significantly related to the scores of their students, which supports Dunkin and Biddle and Michigan State University Center for Research in Mathematics and Science Education (2010). Therefore, future research should seek to determine factors that can improve the mathematics ability of preservice teachers.

To that end, the moderate association found between mathematics ability and advanced mathematics coursework may suggest that the teacher education program at the University of Florida should evaluate its mathematics coursework requirements. To meet the minimum requirements at the University of Florida, a preservice teacher could complete college algebra and an introductory statistics course. Based on the data collected in this study, a majority of the students are not exceeding the minimum requirements. In addition, it is interesting to note that a portion of the preservice teachers had not completed a mathematics course since their freshman year of college. Furthermore, if high school mathematics and national agricultural standards require secondary students to develop mathematics subject matter competencies beyond basic mathematics (National Council for Agricultural Education, 2009), it would seem reasonable to expect preservice teachers to complete higher levels of mathematics. To that end, research has shown that higher levels of mathematics are associated with higher mathematics ability scores or subject matter knowledge among preservice agricultural teachers (Miller & Gliem, 1996), thus supporting Darling-Hammond and Bransford (2005)'s statement that subject matter knowledge is an essential component in preparing effective teachers. Therefore, how can one expect preservice teachers to teach higher level mathematics that are embedded in the high school agriscience curricula, when they are not proficient in high school mathematics or completing higher level mathematics coursework in college?

That being said, is the agricultural education profession willing to require preservice teachers to complete higher levels of mathematics? If the agricultural education profession is not willing to require preservice teachers to complete higher levels of mathematics, the profession may need to reconsider the mathematics requirements that are found within the secondary National Agriculture, Food and Natural Resources Career Cluster Content Standards (National Council for Agricultural Education, 2009). However, lowering the mathematics requirements for secondary students would prevent the profession from answering the numerous calls for agricultural education to support core academic coursework and from welcoming the role of improving mathematics competencies of secondary students. Based on the aforementioned implications and literature review, future research should seek to determine the amount of variance in mathematics ability that can be explained by subject matter knowledge and the level of mathematics coursework completed in college. Therefore, future research should build upon the results of this study and seek to determine the mathematics ability and efficacy of the nation's preservice agricultural education teachers. Moreover, future research should seek to develop an intervention to increase the mathematics ability and efficacy of preservice agricultural education teachers, since subject matter knowledge, pedagogical knowledge, and pedagogical content knowledge effect student achievement (Darling-Hammond & Bransford, 2005). What is more, there is a gap in the literature on the extent to which secondary agricultural education teachers are providing instruction on mathematics concepts or the cross-referenced

NCTM sub-standards. Future research should seek to fill the aforementioned gap.

References

Allinder, R. M. (1994). The relationship between efficacy and the instructional practices of special education teachers and consultants. *Teacher Education and Special Education*, *17*, 86-95.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Englewood Cliffs, NJ: Prentice Hall.

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist*, *28*(2), 117-148.

Bandura, A. (1997). *Self-efficacy: The exercise of control.* New York, NY: Freeman.

Campbell, D. T., & Stanley, J. C. (1963). *Experimental and quasi-experimental designs for research.* Boston, MA: Houghton Mifflin.

Carpenter, J., & Gorg, S. (Eds.). (2000). *Principles and standards for school mathematics*. Reston, VA: The National Council of Teachers of Mathematics.

Darling-Hammond, L., & Bransford, J. (2005). *Preparing teachers for a changing world*. San Francisco, CA: Jossey-Bass.

Davis, J. A. (1971). *Elementary survey analysis*. Englewood, NJ: Prentice-Hall.

Dunkin, M. J., & Biddle, B. J. (1974). *The study of teaching*. Washington, DC: University Press of America.

Florida Department of Education. (2010). *Mathematics scores statewide comparison for 2001 to 2010*. Retrieved from http://fcat.fldoe.org/mediapacket/2010/pdf/2010MathComparison.pdf

Gall, M. D., Borg, W. R., & Gall, J. P. (1996). *Educational research: An introduction* (6th ed.). New York, NY: Longman.

Goddard, R. D., Hoy, W. K., & Woolfolk Hoy A. (2004). Collective efficacy beliefs: Theoretical developments, empirical evidence, and future directions. *Educational Researchers, 33*(3), 3-13.

Gusky, T. R., & Passaro, P. D. (1994). Teacher efficacy: A study of construct dimensions. *American Educational Research Journal, 31*, 627-643.

Harlin, J. F., Roberts, T. G., Briers, G. E., Mowen, D. L., & Edgar, D. W. (2007). A longitudinal examination of teaching efficacy of agricultural science student teachers at four different institutions. *Journal of Agricultural Education, 48*(3), 78-90. doi: 10.5032/jae.2007.03078

Huck, S. W. (2008). *Reading statistics and research*. Boston, MA: Allyn and Bacon.

Jansen, D. J. (2007). *Validation of an instrument for mathematics teaching efficacy of Pacific Northwest agricultural educators* (Doctoral dissertation). Retrieved from http://ir.library.oregonstate.edu/jspui/handle/1957/7689

Jansen, D. J., & Thompson, G. W. (2008). Pacific Northwest agricultural educators' perceived teacher efficacy toward enhancing mathematics. *Proceedings of the 2008 Western Region American Association of Agricultural Educators Research Conference, 27*, 16-28.

Knobloch, N. A. (2006). Exploring relationships of teachers' sense of efficacy in two student teaching programs. *Journal of Agricultural Education, 47*(2), 36-47. doi: 10.5032/jae.2006.02036

Michigan State University Center for Research in Mathematics and Science Education. (2010). *Breaking the cycle: An international comparison of U. S. mathematics teacher preparation.* Retrieved from http://www.educ.msu.edu/content/sites/usteds/documents/Breaking-the-Cycle.pdf

Miller, G., & Gliem, J. A. (1994). Agricultural education teachers' ability to solve agriculturally related mathematics problems. *Journal of Agricultural Education, 35*(4), 25-30. doi: 10.5032/jae.1994.04025

Miller, G., & Gliem, J. A. (1996). Preservice agricultural educators' ability to solve agriculturally related mathematics problems. *Journal of Agricultural Education, 37*(1), 15-21. doi: 10.5032/jae.1996.01015

National Center for Education Statistics. (2004). *The condition of education 2004* (NCES 2004-077). Retrieved from http://nces.ed.gov/programs/coe/

National Council for Agricultural Education. (2009). *National agriculture, food and natural resource career cluster content standards.* Retrieved from http://www.teamaged.org/council/

National Research Council. (1988) *Understanding agriculture: New directions for education*. Washington, DC: National Academy Press.

Oliver, J. D., & Hinkle, D. E. (1981, December). *Selecting statistical procedures for agricultural education researc*h. Paper presented at the 8th Annual National Agricultural Education Research Meeting, Atlanta, GA.

Parr, B. A., Edwards, M. C., & Leising, J. G. (2006). Effects of a math-enhanced curriculum and instructional approach on the mathematics achievement of agricultural power and technology students: An experimental study. *Journal of Agricultural Education*, *47*(3), 81-93. doi: 10.5032/jae.2006.03081

Parr, B. A., Edwards, M. C., & Leising, J. G. (2008). Does a curriculum integration intervention to improve the mathematics achievement of students diminish their acquisition of technical competence? An experimental study in agricultural mechanics. *Journal of Agricultural Education, 49*(1), 61-71. doi: 10.5032/jae.2008.01061

Parr, B. A., Edwards, M. C., & Leising, J. G. (2009). Selected effects of a curriculum integration intervention on the mathematics performance of secondary students enrolled in an agricultural power and technology course: An experimental study. *Journal of Agricultural Education, 50*(1), 57-69. doi: 10.5032/jae.2009.01057

Persinger, K. M., & Gliem, J. A. (1987). *Mathematical problem-solving skills of high school vocational agriculture teachers and students* (ERIC No. 289975). Retrieved from http://www.eric.ed.gov/ERICWebPortal/contentdelivery/servlet/ERICServlet?accno=ED289975

Roberts, T. G., Harlin, J. F., & Ricketts, J. C. (2006). A longitudinal examination of teaching efficacy of agricultural science student teachers. *Journal of Agricultural Education,47*(2), 81-92. doi: 10.5032/jae.2006.02081

Roberts, T. G., Kitchel, T. (2010). Designing professional knowledge curriculum and instruction. In R. M. Torres, T. Kitchel, & A. L. Ball (Eds.), *Preparing and advancing teachers in agricultural education* (pp. 100-111). Columbus, OH: Curriculum Materials Service.

Shinn, G. C., Briers, G. E., Christiansen, J. E., Edwards, M. C., Harlin, J. F., Lawver, D. E., Lindner, J. R., Murphy, T. H., & Parr, B.A. (2003). *Improving student achievement in mathematics: An important role for secondary agricultural education in the 21st Century*. Unpublished manuscript, Texas A&M University. College Station, TX

Soodak, L. C., & Podell, D. (1996). Teacher efficacy: Toward the understanding of a multi-faceted construct. *Teaching and Teacher Education, 12*(4), 401-411.

Stripling, C., Ricketts, J. C., Roberts, T. G., & Harlin, J. F. (2008). Preservice agricultural education teachers' sense of teaching self-efficacy. *Journal of Agricultural Education, 49*(4), 120-130. doi: 10.5032/jae.2008.04120

Stone, J. R. III, Alfeld, C., Pearson, D., Lewis, M. V., & Jensen, S. (2006). *Building academic skills in context: Testing the value of enhance math learning in CTE.* Retrieved from http://136.165.122.102/UserFiles/File/Math-in-CTE/MathLearningFinalStudy.pdf

Swan, B. G., Moore, L. L., & Echevarria, C. J. (2008). The relationship of agricultural mechanics teachers' confidence in their mathematic skills and confidence in their ability to teach mathematic skills. *Proceedings of the 2008 Western Region American Association of Agricultural Educators Research Conference, 27*, 29-41.

Tschannen-Moran, M., Woolfolk Hoy, A., & Hoy K.W. (1998). Teacher efficacy: Its meaning and measure. *Review of Educational Research, 68*, 202-248.

Young, R. B., Edwards, M. C., & Leising, J. G. (2008). Effects of a math enhanced curriculum and instructional approach on students' achievement in mathematics: A year-long experimental study in agricultural power and technology. *Journal of Southern Agricultural Education Research, 58*(1), 4-17.

Young, R. B., Edwards, M. C., & Leising, J. G. (2009). Does a math-enhanced curriculum and instructional approach diminish students' attainment of teaching skills? A year-long experimental study in agricultural power and technology. *Journal of Agricultural Education, 50*(1), 116-126. doi: 10.5032/jae.2009.01116

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