

Preservice Agricultural Education Teachers' Mathematics Ability

Christopher T. Stripling, Assistant Professor
University of Tennessee

T. Grady Roberts, Associate Professor
University of Florida

The purpose of this study was to examine the mathematics ability of the nation's preservice agricultural education teachers. Based on the results of this study, preservice teachers were not proficient in solving agricultural mathematics problems, and agricultural teacher education programs require basic and intermediate mathematics as their minimum mathematics coursework requirements. Furthermore, preservice teachers that completed an advanced mathematics course in high school and/or college obtained higher mathematics ability scores. However, a small percentage completed an advanced mathematics course. In addition, preservice teachers that received an A in their highest completed college mathematics course also obtained higher mathematics ability scores. Moreover, 39% of the variance in mathematics ability was explained by completion of an advanced mathematics course in college, a grade of an A in highest level of mathematics completed in college, and being a preservice teacher at University 7, 8, and 9. Based on the data collected in this study, the nation's teacher education programs may need to further evaluate their mathematics coursework requirements.

Keywords: preservice teachers; mathematics; agricultural education; teacher education

Introduction

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). To that end, there is a plethora of research documenting the lack of mathematics proficiency among U.S. students (Michigan State University Center for Research in Mathematics and Science Education, 2010; National Center for Educational Statistics, 2000a, 2000b, 2004, 2009a, 2009b, 2010; 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, a report by Michigan State University Center for Research in Mathematics and Science Education (2010) stated 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. For that reason, a charge was given by the Michigan State University Center 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)

However, the solution for breaking the aforementioned cycle may not fall just on mathematics teachers and mathematics teacher education programs. In 1988, the National Research Council called for secondary agricultural education to equip agricultural students for careers in science and mathematics and purported that “teacher preparation and in-service education programs must be revised and expanded to develop more competent teachers” (pp. 6-7). Correspondingly, Jansen and Thompson (2008) described a need for a “closer examination of [agricultural teacher education] program requirements related to the level of mathematics exposure and proficiency in mathematics” (p. 26). Jansen and Thompson (2008) also professed 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). Likewise, Shinn et al. (2003) called for the agricultural education profession to seize the opportunity to

aid in improving secondary students’ mathematics achievement.

With that in mind, are agricultural teacher education programs and their preservice teachers capable of answering the challenges mentioned above? Based on limited research (Miller & Gliem, 1996; Stripling & Roberts, 2012) and the above mentioned findings, it is probable that preservice agriculture teachers are inadequately prepared to effectively teach agricultural mathematics concepts, and are therefore, ill-prepared to answer the numerous calls mentioned above. This study will examine this issue by investigating the mathematics ability of the nation’s preservice agricultural education teachers.

Theoretical Framework

The theoretical framework for this study was Dunkin and Biddle’s (1974) model for the study of classroom teaching, which is based on the original work of Mitzel (1960). Dunkin and Biddle’s model for the study of classroom teaching is classified into the following four categories of variables: presage, context, process, and product. According to Dunkin and Biddle, presage and context variables have a causative relationship with process variables and process variables have a causative relationship with product variables (Figure 1).

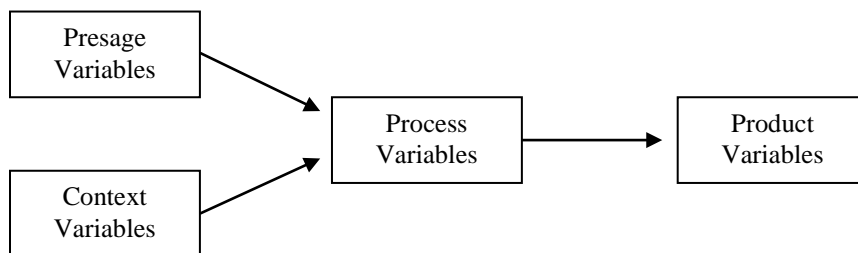


Figure 1. Adapted model for the study of classroom teaching.

First in Dunkin and Biddle’s (1974) model for the study of classroom teaching are presage and context variables. Presage variables are described as “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 described as

“characteristics of the environment about which teachers, school administrators, and teacher-educators can do very little” (Dunkin & Biddle, 1974, p. 41). Community, school, and classroom contexts, student populations, student formative experiences, and school and classroom budgets are examples of context variables. Presage and context variables influence process variables. Process variables

are described as “the actual activities of classroom teaching – what teachers and pupils do in the classroom” (Dunkin & Biddle, 1974, p. 44). Furthermore, in the classroom, teacher and student behaviors interact and result in observable positive or negative changes in a student’s behavior or academic learning. The changes that result from the interaction of student and teacher behaviors are described by Dunkin and Biddle (1974) as product variables or as “the outcomes of teaching” (p. 46).

What is more, Dunkin and Biddle (1974) stated that the “entire business of teacher

education is founded on the assumption that we can ‘improve’ teaching practices by providing appropriate educational experiences for young teachers” (p. 49), and thus, decisions made by teacher education programs concerning the “relationship between presage conditions and teaching processes” (p. 49) should be based on evidence. To that end, this study focused on two presage variables of agricultural teacher education: preservice teachers’ mathematics ability and the mathematics requirements of the preservice teachers’ teacher education programs (Figure 2).

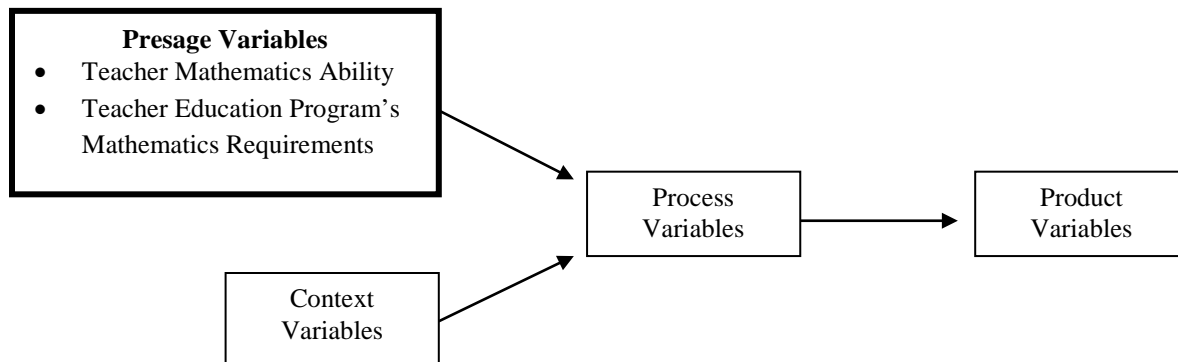


Figure 2. Conceptual framework of presage variables under investigation.

Literature Review

Agricultural Educators’ Mathematics Ability

After an extensive literature search, only four studies were found that specifically looked at the mathematics ability of agricultural educators: Persinger and Gliem (1987), Miller and Gliem (1994, 1996), and Stripling and Roberts (2012). In a 1987 study, Persinger and Gliem sampled 54 secondary agricultural teachers and 656 of their most advanced agricultural students. Persinger and Gliem reported that the agricultural teachers’ average on a 20 item mathematics problem solving test was 61.8% and that 28.0% of the teachers answered 50% or less of the mathematics problems correctly. Furthermore, the study found that the agricultural teacher’s score had a significant effect on the agricultural students’ scores on the mathematics problem solving test, which is consistent with the Michigan State University Center for Research in Mathematics and Science Education (2010). Consequently, Persinger and Gliem reported that the

agricultural students averaged 28.2% on the same instrument their teachers completed and that 82.3% of the agricultural students solved 50% or less of the mathematics problems correctly.

Similarly, Miller and Gliem (1994) investigated the mathematical problem solving ability of Ohio secondary agricultural educators. Miller and Gliem’s sample consisted of teachers from 34 agricultural education programs in Ohio. The participants correctly solved 66.5% of the mathematics problems on a 15 item mathematics problem solving test developed by the researchers. In addition, Miller and Gliem reported that 47.1 percent of the participants correctly solved 60% or less. Therefore, the researchers posited that the agricultural teachers “attained lower scores than would be expected of persons teaching secondary students how to solve agricultural related mathematics problems” (Miller & Gliem, 1994, p. 28). Based on their findings, Miller and Gliem (1994) concluded that the agriculture teachers in the study “were not proficient in solving agricultural

related mathematics problems” (p. 28). Additionally, Miller and Gliem found a low relationship between teachers’ problem-solving ability and two variables: age and years of teaching experience. A moderate relationship was reported “between teacher’s problem-solving ability and highest level of college mathematics coursework completed, final college grade point average, and attitude toward including mathematics concepts in the curriculum and instruction of secondary agriculture programs” (Miller & Gliem, 1994, p. 27).

Miller and Gliem (1996) replicated the Miller and Gliem (1994) study with 49 preservice agricultural education teachers from The Ohio State University. The preservice teachers’ average mathematics score was 37.1% and 87.8% solved fewer than 60% of the mathematics problems correctly. Miller and Gliem reported a low negative association between mathematics ability of the preservice teachers and completion of an intermediate mathematics courses and a low positive association between mathematics ability and advanced mathematics courses. Also, a substantial negative association was found between mathematics ability and students that had completed basic mathematics courses. Miller and Gliem (1996) found that “preservice educators with higher scores on the problem-solving test had taken advanced mathematics courses in addition to or instead of basic and intermediate math” (p. 18). In conclusion, the researchers stated that “preservice agricultural educators were not capable of applying basic mathematics skills to agricultural problems” (Miller & Gliem, 1996, p. 19) and that considerable attention should be given to improving the mathematics ability of preservice agricultural education teachers.

In a more recent study, Stripling and Roberts (2012) investigated the mathematics ability of preservice agricultural education teachers in their final year of a teacher education program at the University of Florida. Stripling and Roberts reported that University of Florida 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. The aforementioned average is consistent with preservice teachers in Miller and Gliem (1996).

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.

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 ($r = .03$). (Stripling & Roberts, 2012, p. 118)

Therefore, Stripling and Roberts concluded that the aforesaid associations suggest that advanced mathematics coursework resulted in higher scores on the mathematics assessment, which is also consistent with Miller and Gliem (1996). Moreover, the direction and strength of the associations between mathematics ability and mathematics coursework are similar to those reported above by Miller and Gliem (1996).

Agriculture Teacher Education – Mathematics

The *National Standards for Teacher Education in Agriculture* (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 pursuing 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. However, the National Agriculture, Food and Natural Resources Career Cluster Content Standards (National Council for Agricultural Education, 2009), which are the national secondary agricultural education standards, require mathematics proficiency in the following mathematics content and process areas: number and operations, algebra, geometry, measurement, data analysis and probability, and problem solving.

Purpose and Objectives

The purpose of this study was to examine the mathematics ability of preservice agricultural teachers during the final year of an agricultural education program. The following objectives framed this study:

1. Determine the highest category of mathematics completed in high school and college by preservice teachers.
2. Describe the mathematics ability of preservice teachers.
3. Describe differences in mathematics requirements of the teacher education programs and math ability of preservice teachers from each university.
4. Determine the magnitudes of the associations between mathematics ability of the preservice teachers and the type of mathematics the preservice teachers completed in high school

and college and the grade received for their highest level of mathematics completed in college.

5. Determine the amount of variance in mathematics ability that can be explained by the other variables examined in this study.

Methods and Procedures

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 preservice agriculture teachers in their final year of a teacher education program, and based on Kantrovich’s (2007) agricultural education supply and demand study, the population of preservice teachers in the United States was determined to be approximately 800. Since a list of all members of the target population was not available, cluster random sampling was utilized to select a random sample (Fraenkel & Wallen, 2006). Hence, the preservice teachers in their final year at each institution were considered a cluster. For this reason, preservice teacher education programs were randomly selected until an adequate number of teacher education programs agreed to participate to meet the predetermined needed sample size of 89 (Table 1). According to Israel (1992), a sample size of 89 is needed for a population of 800, a ±10% precision level, and a 95% confidence level. Precision level is a limiting factor of this study. A precision level of ±10% was chosen based on the resources available to conduct this study.

Table 1
Randomly selected teacher education programs

University	<i>n</i>	AAAE region	Approximate university enrollment	Carnegie classification
1	8	Western	19,000	Research Universities (high research activity)
2	10	Southern	35,000	Research Universities (very high research activity)
3	16	North Central	29,000	Research Universities (high research activity)
4	12	North Central	12,000	Research Universities (high research activity)
5	2	Southern	29,000	Research Universities (very high research activity)
6	8	Western	29,000	Research Universities (very high research activity)
7	15	North Central	31,000	Research Universities (very high research activity)
8	2	Southern	10,000	Master's Colleges and Universities (larger programs)
9	25	Southern	51,000	Research Universities (very high research activity)

For this study, the random sample consisted of 98 preservice agricultural education teachers, 61 females and 34 males (three participants did not provide this data). The average age of the sample was 22 years old ($SD = 3.36$) with a range of 20 to 51. Ninety-one participants described their ethnicity as white, one as African American, one as Hispanic, one as American Indian, and one as other. Of the participants that reported their program level, the majority of the participants were in an undergraduate program ($n = 85, 89.47\%$), and the remaining were completing a graduate program ($n = 10, 10.53\%$). Ninety-one participants provided their college grade point average, and the mean GPA was 3.44 ($SD = 0.39$) on a 4-point scale. The number of college level mathematics courses completed by the participants ranged from 0 to 6 with a mode of 1. The timing when the participants took their last math course ranged from the previous semester to 15 years prior with a mean of 3.33 years ($SD = 1.85$). Additionally, in their highest category of mathematics in college, 34.8% received an A, 37.1% a B, 23.6% a C, 3.4% a D, and 1.1% a F.

Instrumentation

Participants consented to take the *Mathematics Ability Test* (Stripling & Roberts, 2012) by signing an informed consent approved by the University of Florida's IRB. The *Mathematics Ability Test* consist of 26 open-ended mathematical word problems and was

administered during the 2010-11 academic year at each of the randomly selected universities. At each university, the teaching methods course instructor or a graduate assistant administered the instrument and followed a script prepared by the researchers. Also, since the preservice teachers were asked to complete the instrument during instructional time, and to avoid coercion, participants were informed that participation in the study would not have an impact on their course grades. The *Mathematics Ability Test* took approximately 60 minutes to complete, and according to Stripling and Roberts (2012), the instruments 26 items were "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)" (p. 115). A list of the 13 sub-standards and the content/process areas are presented in Table 2. In addition, Stripling and Roberts (2012) stated that face and content validity of the *Mathematics Ability Test* was "established by a panel of experts consisting of agricultural education faculty and mathematics faculty from three universities and two secondary mathematics experts [and]...the reliability of the instrument was assessed post hoc using Cronbach's alpha coefficient" (p. 115). Stripling and Roberts reported the reliability to be .80.

Table 2
 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.

Data Analysis

Descriptive statistics were used to summarize demographics, mathematics requirements of the teacher education programs, highest category of mathematics completed, grade received in highest category of mathematics completed in college, and mathematics ability. Point Biserial correlation coefficients were used to describe the associations between mathematics ability and types of courses completed in high school and college, and grade received in highest type of mathematics completed in college. As well, Point Biserial correlation coefficients were used because the types of mathematics courses were coded as not completed (0) or completed (1), and the grade received was coded as not the grade received (0) or grade received (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, a one-way ANOVA

was utilized to determine if significant differences existed between the teacher education programs, and stepwise regression was utilized to examine the variance in mathematics ability. Mathematics ability was operationally defined for this study as the students' score on the *Mathematics Ability Test* (Stripling & Roberts, 2012). The *Mathematics Ability Test* was scored using a rubric that, according to Stripling and Roberts (2012), was developed by two secondary mathematics experts, and all items were scored as incorrect, partially correct, or correct. Lastly, missing data was excluded pairwise from the inferential statistics calculations.

Findings

Objective 1. Determine the Highest Category of Mathematics Completed in High School and College by the Preservice Teachers

Nearly half of the preservice teachers (48.4%) completed an intermediate mathematics course as their highest level of mathematics in high school (Table 3). However in college, the most commonly completed level of mathematics was basic mathematics (45.7%). In addition, advanced mathematics courses were the least

completed among the preservice teachers in high school (15.1%) and college (14.9%). Moreover,

3.2% had not taken a mathematics course in college.

Table 3
Highest Category of Mathematics Courses Completed by the Preservice Agricultural Teachers

Type	<i>f</i>	%
High school mathematics courses completed		
Basic high school	34	36.6
Intermediate high school	45	48.4
Advanced high school	14	15.1
College mathematics courses completed		
Basic college	43	45.7
Intermediate college	34	36.2
Advanced college	14	14.9
No college course	3	3.2

Note. Not all of the participants provided mathematics course data: $n = 93$ for high school mathematics and $n = 94$ for college mathematics.

Objective 2. Describe the Mathematics Ability of Preservice Teachers

The preservice agricultural education teachers' scores on the 26 item *Mathematics Ability Test* (Stripling & Roberts, 2012) ranged from 2.0 (7.7%) to 19.0 (73.1%), and a majority of the students (80.6%) answered less than 50%

of the problems correctly (Table 4). The mean number of correct responses was 10.02 ($SD = 3.91$) or 38.5%. Thus, based on our sampling criteria, the true value of the population mean is estimated to be in the following range with 95% confidence: 28.5% to 48.5%.

Table 4
Preservice Agricultural Teachers' Scores on the Mathematics Ability Test

Score range	% correct range	<i>f</i>	% of students
2.0 to 6.0	7.7 to 23.1	21	21.4
6.5 to 10.5	25.0 to 40.4	38	38.8
11.0 to 15.0	42.3 to 57.7	28	28.6
15.5 to 19.0	59.6 to 73.1	11	11.2

Note. Mean score 10.02 ($SD = 3.91$), out of 26 possible.

Objective 3. Describe Differences in Mathematics Requirements of the Teacher Education Programs and Math Ability of Preservice Teachers from Each University.

Five or 55.6% of the teacher education programs in this study required one mathematics

course as their minimum mathematics requirements (Table 5). Three programs or 33.3% required two mathematics courses, and the remaining teacher education program required three mathematics courses.

Table 5
Teacher Education Program Mathematics Requirements

University	Minimum mathematics requirements
1	Math appreciation, college algebra, or calculus for the biological and management sciences
2	Pre-calculus
3	College algebra
4	College algebra
5	College algebra and nature of mathematics or calculus with business and economic application
6	College algebra in context I, college algebra in context II, and logarithmic and exponential functions
7	College algebra and a 2nd intermediate mathematics course (i.e., introductory statistics, trigonometry)
8	College algebra or introductory statistics
9	College algebra and introductory statistics

Sixty-seven percent of the teacher education programs' mean mathematics ability scores were below 42% (Table 6). The highest mean mathematics ability score was observed in University 5 ($M = 60.6$, $SD = 17.68$), and the lowest mean mathematics ability score was observed in University 8 ($M = 23.1$, $SD = 0.00$). Furthermore, the two teacher education programs (Universities 5 and 6) that possessed the highest mathematics ability scores required

their preservice teachers to complete an applied mathematics course. Also, as shown in Table 7, a significant difference existed for mean mathematics ability between the teacher education programs ($F_{(8,89)} = 4.29$, $p = .00$). Bonferroni multiple comparisons *post hoc* corrections were utilized to examine the aforementioned mean difference. Significant mean differences ($p < .05$) are reported in Table 8.

Table 6
Teacher Education Program Descriptive Statistics – Mathematics Ability Test

University	<i>n</i>	% Mean correct	<i>SD</i>	% correct range
1	8	41.6	15.82	23.1 to 71.2
2	10	39.4	11.40	19.2 to 50.0
3	16	35.9	11.40	21.2 to 61.5
4	12	46.2	11.74	30.8 to 67.3
5	2	60.6	17.68	48.1 to 73.1
6	8	54.6	13.24	36.5 to 73.1
7	15	28.6	14.52	7.69 to 65.4
8	2	23.1	0.00	23.1 to 23.1
9	25	35.5	14.40	9.6 to 63.5

Table 7
Analysis of Variance (ANOVA) of Teacher Education Program's Mean Math Ability Scores

	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>p</i>
Between Groups	6112.54	8	764.07	4.29	.000
Within Groups	15857.87	89	178.18		
Total	21970.42	97			

Table 8
Post Hoc Pairwise Comparisons Using Bonferroni Corrections

	Mean difference	SE	p
University 6 & 9	19.11	5.42	.024
University 6 & 7	25.98	5.84	.001
University 4 & 7	17.56	5.17	.037

Objective 4. Determine the Magnitudes of the Associations between Mathematics Ability of the Preservice Teachers and the Type of Mathematics the Preservice Teachers Completed in High School and College and the Grade Received for the Highest Level of Mathematics Completed in College

Guidelines from Davis (1971) were used to describe the magnitudes of the associations in this study. As depicted in Table 9, a substantial correlation was observed between mathematics

ability and advanced college mathematics ($r = .50$). Low correlations were observed 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 was observed between mathematics ability and intermediate high school mathematics ($r = .06$).

Table 9
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	-.24	.06	.25	-.23	-.14	.50

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

Additionally, as reported in Table 10, a low correlation was observed 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. Negligible

correlations were observed 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.

Table 10
Point Biserial Correlations Between Grade Received in Highest Math Course Completed in College and Math Ability

	Grade				
	A	B	C	D	F
Math ability	.22	-.11	-.09	-.04	.01

Note. Grade received variables were coded as 0 = not the grade received; 1 = grade received

Objective 5. Determine the Amount of Variance in Mathematics Ability that can be Explained by the Other Variables Examined in This Study

Stepwise multiple regression was utilized to examine the variance in mathematics ability that could be explained by type of mathematics course completed in high school and college, grade received in highest mathematics course completed in college, and preservice teacher

education program. Five variables, shown in Table 11, explained 39% of the variance in mathematics ability. Preservice teachers that completed an advanced mathematics course scored 19.48 percentage points higher than those that did not complete an advanced mathematics course. Moreover, preservice teachers that received an A in their highest college mathematics course scored 6.40 percentage

points higher than those that did not receive an A.

Table 11

Summary of Stepwise Regression Analysis for Variables Explaining Mathematics Ability

Variable	<i>B</i>	<i>SE B</i>	<i>p</i>
Advanced college math	19.48	3.50	.000
University 7	-13.32	3.57	.000
University 9	-8.04	2.94	.008
Grade of an A in highest college math	6.40	2.61	.016
University 8	-17.94	8.83	.045

Note. Full Model: $R^2 = .42$; Adjusted $R^2 = .39$

All variables were coded as 0 = no; 1 = yes

Conclusions

Based on the results of this study, a majority of the preservice teachers completed basic or intermediate mathematics as their highest level of mathematics in high school and college, which is consistent with Stripling and Roberts (2012). Additionally, the preservice teachers were not proficient in solving agricultural mathematics problems and this supports the findings of Miller and Gliem (1996) and Stripling and Roberts. What is more, agricultural teacher education programs require basic and intermediate mathematics as their minimum mathematics requirements, and the two teacher education programs with the highest mathematics ability mean scores required preservice teachers to complete an applied mathematics course. Furthermore, preservice teachers that completed an advanced mathematics course in high school and/or college obtained higher mathematics ability scores, which are also consistent with Miller and Gliem and Stripling and Roberts. In addition, preservice teachers that received an A in their highest completed college mathematics course also obtained higher mathematics ability scores. Lastly, 39% of the variance in mathematics ability was explained by completion of an advanced mathematics course in college, a grade of an A in highest level of mathematics completed in college, and being a preservice teacher at University 7, 8, and 9. Miller and Gliem also found that the highest level of mathematics completed in college significantly explained the variance in mathematics ability.

Implications and Recommendations

This study suggests that the nation's preservice teachers are ill-prepared to teach secondary agricultural mathematics concepts. Therefore, future research should seek to determine methods of improving the mathematics ability of the nation's preservice teachers. What is more, the findings of this study suggest that teacher education programs require basic and intermediate mathematics coursework, which were negatively associated with mathematics ability in this study. The aforementioned findings are troubling, since Dunkin and Biddle (1974) posited that presage variables (e.g., teacher mathematics ability and teacher education program's mathematics requirements) influence process variables or learning activities which then positively or negatively influences student achievement or product variables.

Moreover, how can the agricultural education profession expect preservice teachers to teach agricultural mathematics concepts when they are not proficient in agricultural mathematics? Therefore, what can agricultural teacher education programs do to improve the mathematics ability of preservice teachers? In this study, completion of an advanced mathematics course explained a significant portion of the variance in mathematics ability. Additionally, it is plausible that the significant mean differences observed between teacher education programs may be attributed to applied mathematics courses. Research has shown that applied coursework improved secondary students' mathematics achievement (Stone, Alfeld, Pearson, Lewis, & Jensen, 2006). Thus, it seems reasonable to require preservice teachers to complete advanced and/or applied

mathematics coursework. However, are agricultural teacher education programs willing to require advanced and/or applied mathematics coursework? The results of this study suggest that when advanced mathematics are not required preservice teachers are not willing to enroll in an advanced mathematics course. The data also indicated that preservice teachers are not exceeding their university's minimum mathematics requirements, and as a result, they are completing lower levels of mathematics in college than previously taken in high school. This may suggest that preservice teachers are more interested in taking an easier course than completing a course that has the potential to expand and deepen their mathematics content knowledge. In reference to applied mathematics, one might argue that agricultural teacher education programs do not have a sufficient number of faculty or means to provide applied mathematics coursework. One might also argue that not requiring applied mathematics coursework would be hypocritical, since our profession prides itself on being able to improve secondary academic achievement through an applied science.

Therefore, future research should examine the effect of applied college mathematics coursework on preservice teachers' mathematics

ability. Future research should also examine the current teacher education curricula and determine if mathematics instruction can be integrated into current coursework. For example, Burton, Daane, and Gieson (2008) reported that incorporating 20 minutes of mathematics instruction into an elementary preservice teaching methods course significantly improved mathematics content knowledge. Additionally, there is a gap in the literature describing the mathematics ability of current secondary agricultural teachers. Do current agricultural educators possess mathematical competencies similar to the nation's preservice teachers? Future research should seek to determine the mathematics ability of the nation's secondary teachers. Furthermore, to what extent are secondary agricultural educators providing instruction in agricultural mathematics concepts that occur naturally in the secondary agricultural education curricula? Future research should also examine this issue. In conclusion, failure to pursue the future research endeavors mentioned above may prevent the agricultural education profession from answering the numerous calls to aid in improving secondary students' mathematics achievement.

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CHRISTOPHER T. STRIPLING is an Assistant Professor in the Department of Agricultural Leadership, Education and Communications at the University of Tennessee, 320B Morgan Hall, 2621 Morgan Circle, Knoxville, TN 37996-4511, cstripling@utk.edu

T. GRADY ROBERTS is an Associate Professor of Agricultural Education in the Department of Agricultural Education and Communication at the University of Florida, PO Box 112060, Gainesville, FL 332611, groberts@ufl.edu