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Effects of Mathematics Integration in a Teaching Methods Course on Self-Efficacy of Preservice Agricultural Education Teachers

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Teachers who are efficacious persevere through challenges in the learning environment and put forth more effort in designing learning activities. The purpose of this study was to determine the effects of mathematics teaching and integration strategies (MTIS) on preservice agricultural teachers' personal mathematics efficacy, mathematics teaching efficacy, and personal teaching efficacy in a teaching methods course. The research design was quasi-experimental and utilized a nonequivalent control group. Data were collected at the following three collection points; (a) week 1 of the semester; (b) week 12 of the semester/after the preservice teachers in the treatment group delivered their first mathematics enhanced lesson; and (c) week 15 of the semester. Participants were moderately efficacious in mathematics teaching efficacy and efficacious in personal mathematics efficacy and personal teaching efficacy at all three data collection points. Furthermore, significant differences were not found in the mathematics teaching efficacy, personal mathematics efficacy, and personal teaching efficacy of the preservice agricultural teachers based upon the MTIS treatment.

Keywords: preservice teachers; math; mathematics; self-efficacy; teacher education; teaching methods

The American Association for Agricultural Education's national research priority area three calls for a "sufficient scientific and professional workforce that addresses the challenges of the 21st century" (Doerfert, 2011, p. 9), and according to the National Commission on Mathematics and Science Teaching for the 21st century (2000), mathematics and science will "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). Thus, there is a need for qualified teachers of mathematics and science. To that end, the National Governors Association (2007) called for K-12 teachers that were qualified in the STEM (science, technology, engineering, and mathematics) disciplines. Correspondingly, reform efforts in school-based agricultural education have emphasized the need for agricultural education programs to embrace the role of contributing to the STEM disciplines (Phipps, Osborne, Dyer, & Ball, 2008), and more specifically, the role of improving mathematics achievement of secondary students (Stripling & Roberts, 2012a, 2012b, 2013; Shinn et al., 2003). However, there is a gap in the literature on how preservice agricultural teacher education programs should prepare preservice teachers to contributing to the learning of core academic subjects (Myers & Dyer, 2004).

With that in mind, this study seeks to add to the literature of preparing preservice teachers for the role of teaching mathematics found naturally within the agricultural education curricula. This study will investigate the effects of incorporating mathematics teaching and integration strategies into the agricultural teaching methods course at the University of Florida on personal mathematics efficacy, mathematics teaching efficacy, and personal teaching efficacy with the goal of developing the preservice teachers' mathematics and teaching efficacy. The results of this study could provide valuable insight into improving the mathematics teaching of future school-based 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).

Theoretical Framework/Literature Review

Bandura's (1986) social cognitive theory was used to frame this study. According to Bandura, a reciprocal relationship exists between personal factors, environmental factors, and behavior. More specifically, this study was guided by the self-efficacy 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). According to Bandura (1997), self-efficacy is a personal factor that occupies a pivotal role in social cognitive theory, because self-efficacy influences the other determinants. In social cognitive theory,

> 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 from 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. (Bandura, 1997, p.35)

With that in mind, self-efficacy beliefs are developed from four sources of information: (a) mastery experiences, (b) vicarious experiences, (c) social influences, and (d) physiological or emotional states (Bandura, 1997).

This study focused on a more specific type of self-efficacy known as teacher or teaching efficacy. 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 students. 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). This is important because a "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" (Bandura, 1993, p. 1).

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) noted that "peer teaching significantly increased personal teaching efficacy after students had completed early field experience"

(p. 127) and as a result, hypothesized that observing teaching in a natural setting may aid future educators in becoming more efficacious. Knobloch (2006) compared students from two agricultural education programs: (a) University of Illinois and (b) The Ohio State University. Knobloch found 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. Knobloch also noted that "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" (p. 41).

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. A general trend emerged from the student engagement, instructional strategies, classroom management, and overall teaching efficacy 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 increased again by the conclusion of the experience" (Roberts et al., 2006, p 89). Consistent with Roberts et al., Harlin, Roberts, Briers, Mowen, and Edgar (2007) and Roberts, Mowen, Edgar, Harlin, and Briers (2007) reported the same general trend during the student teaching internship.

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. Stripling et al. found that instructional strategies, student engagement, classroom management, and overall teaching efficacy increased from before the teaching methods course to after the teaching methods course and from after the teaching methods course/before student teaching to after student teaching.

Roberts, Harlin, and Briers (2008) studied the effect that placing two student teachers at the same student teaching internship site had on teaching efficacy, and a statistically significant difference in teaching efficacy was not found between being placed alone or in a pair. 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 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 teaching efficacy. A significant change in teaching efficacy scores was not found related to 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 slight lowering of teaching efficacy as compared to the control group.

Personal mathematics efficacy and mathematics teaching efficacy are also measures of self-efficacy and teacher efficacy. Personal mathematic efficacy is the self-belief in one's capabilities to solve mathematics problems (Stripling & Roberts, 2013). Mathematics teaching efficacy is a person's self-belief about their capabilities to teach mathematics (Stripling & Roberts, 2013). To that end, only two studies were found in the agricultural education literature investigating the mathematics efficacy and mathematics teaching efficacy of preservice agricultural education teachers. Stripling and Roberts (2012a, 2013) reported that preservice teachers at the University of Florida were efficacious in personal teaching efficacy and personal mathematics efficacy, and moderately efficacious in mathematics teaching efficacy.

Purpose and Hypotheses

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

Three null hypotheses were used to guide this inquiry, and the significance level of .05 was established *a priori*.

H_{01} – There is no significant difference in the personal mathematics efficacy of preservice agricultural education teachers based upon the MTIS treatment.

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

H_{03} – There is no significant difference in the personal teaching efficacy of preservice agricultural education teachers based upon the MTIS treatment.

Methodology

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 the teaching methods course at the University of Florida that best fit their schedule of classes. To that end, the students self-registered for one of three sections of the teaching methods course, and the MTIS treatment was randomly assigned to two of the sections, which resulted in an experimental group of 13 preservice teachers and a control group of 6 preservice teachers. The authors recognize that sample size is a limitation of this study. Also, 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.

The agricultural education teaching methods course at the University of Florida is organized into lectures and labs and 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). 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 Enhancement Teaching Efficacy Instrument* (Jansen, 2007) was used to compare self-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 1:

$$\begin{array}{ccccc} O_1 & X & O_2 & X & O_3 \\ \hline O_1 & & O_2 & & O_3 \end{array}$$

Figure 1: Research Design.

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). 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).

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. The aforementioned variables were examined to determine if differences were present between the control and experimental groups. Chi-square tests were used to determine if significant differences existed between the groups for categorical data, and independent samples t-tests 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.

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 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 (Stone, Alfeld, Pearson, Lewis, & Jensen, 2006; Figure 2) 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. For this study, a math-enhanced lesson is defined as an agricultural lesson that incorporates Stone et al.'s (2006) seven components of a math-enhanced lesson. For all required micro-teachings of the teaching methods course, the preservice teachers could seek help from their lab instructor to aid in the preparation of their lesson plans for the various microteachings; however, none of these preservice teachers sought help from their lab instructor during the preparation of their math-enhanced lessons/microteachings.

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

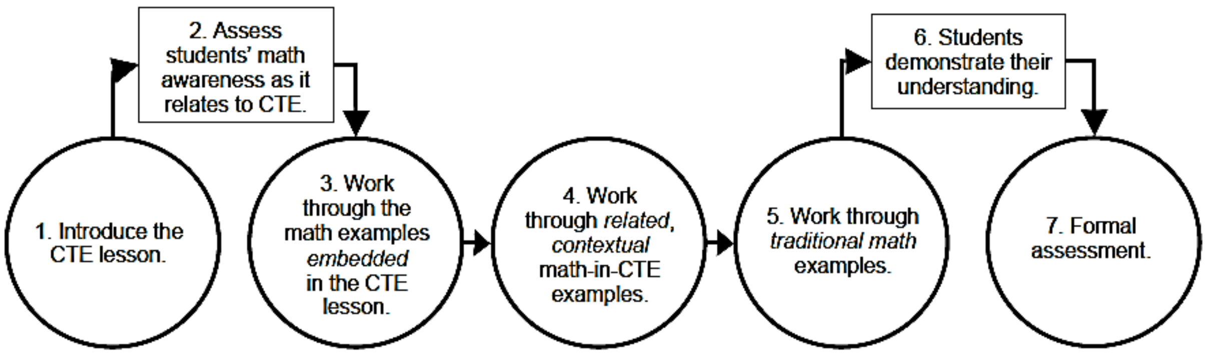

Figure 2. The National Research Center for Career and Technical Education: 7 Elements of a Math-Enhanced Lesson model (Stone et al., 2006, p. 13).

Population and Sample

The target population for this study was Florida preservice agricultural education teachers. The accessible population for this study was present undergraduate 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' (2012a, 2013) studies, which found that Florida preservice teachers were not proficient in mathematics.

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 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 one to five 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. Thus, 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 mathematics course most often completed during college was introductory statistics.

Instrumentation

The *Mathematics Enhancement Teaching Efficacy Instrument* (Jansen, 2007) was utilized in this study. The instrument was developed and validated during a doctoral dissertation at Oregon State University and is divided into the following three constructs: (a) mathematics teaching efficacy, (b) personal mathematics efficacy, and (c) personal teaching efficacy. 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 (2007) 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 agreed to participate and take 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. Participants were informed that the researcher would protect their privacy rights by ensuring anonymity and appropriate storage of data. Also, since students received and completed the instrument during an agricultural education course, they were informed that participation in the study would not have an impact on their course grades. A script was also developed and read to standardize administration, minimize error variance, and experimenter effects.

The *Mathematics Enhancement Teaching Efficacy Instrument* (Jansen, 2007) took the participants approximately 8 minutes to complete and was administered three times: (a) week 1 of the semester; (b) week 12 of the semester/after the preservice teachers in the treatment group delivered their first mathematics enhanced lesson; and (c) week 15 of the 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, and personal teaching efficacy 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.

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 et al. (2003) justified the use of inferential statistics with a convenience sample. Gall et al. 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.

Findings

Personal Mathematics Efficacy

The rating scale for the personal mathematics efficacy construct was 1 = *not at all confident* to 4 = *very confident*. The control group's personal mathematics efficacy scores increased from week 1 to week 15 of the teaching methods course (Table 1). The control group's personal mathematics efficacy scores week one 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).

The experimental group's personal mathematics efficacy scores increased at each data collection point (Table 1). The week 1 teaching methods course average was 3.39 (*SD* = 0.49). After delivering their first mathematics enhanced lesson or week 12, 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).

Table 1

Personal Mathematics Efficacy

	Control group		Experimental group	
Time	*M*	*SD*	*M*	*SD*
Week 1	3.52	0.43	3.39	0.49
Week 12	3.67	0.49	3.46	0.37
Week 15	3.67	0.38	3.50	0.44

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

In addition, the mean differences in personal mathematics efficacy scores from week 1 to week 15 of the teaching methods course (data collection points 1 and 3) are presented in Table 2. Also presented in Table 2 are the mean differences in personal mathematics efficacy scores from week 1 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).

Table 2

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

The analysis of hypothesis one did not reveal a significant difference in the preservice teachers' personal mathematics efficacy based upon the MTIS treatment, $T = .02$, $F(2, 16) = 0.15$, $p > .05$ (Table 3). Therefore, the researchers failed to reject the null hypothesis.

Table 3

MANOVA Personal Mathematics Efficacy

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

Mathematics Teaching Efficacy

The rating scale for the mathematics teaching efficacy construct was 1 = *strongly disagree* to 5 = *strongly agree*. As depicted in Table 4, the control group's mathematics teaching efficacy scores increased from week 1 to week 15 of the teaching methods course. The week 1 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).

The experimental group's mathematics teaching efficacy scores decreased from week 1 to week 15 of the teaching methods course (Table 4). The experimental group's mathematics teaching efficacy scores week 1 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).

Table 4

Mathematics Teaching Efficacy

	Control group		Experimental group	
Time	*M*	*SD*	*M*	*SD*
Week 1	3.40	0.47	3.69	0.61
Week 12	3.37	0.67	3.41	0.97
Week 15	3.50	0.56	3.50	0.98

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

The mean differences in mathematics teaching efficacy scores from week 1 to week 15 of the teaching methods course (data collection points 1 and 3) are presented in Table 5. Mean differences in mathematics teaching efficacy scores from week 1 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 also presented in Table 5.

Table 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

An analysis of hypothesis two did not reveal a significant difference in the preservice teachers' mathematics teaching efficacy based upon the MTIS treatment, T = .06, $F(2, 16) = 0.50$, p > .05 (Table 6). Therefore, the researcher failed to reject the null hypothesis.

Table 6

MANOVA Mathematics Teaching Efficacy

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

Personal Teaching Efficacy

The rating scale for the personal teaching efficacy construct was 1 = *nothing* to 9 = *a great deal of influence*. As depicted in Table 7, the control group's personal teaching efficacy scores week 1 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).

The experimental group's personal teaching efficacy scores decreased at each data collection point (Table 7). The experimental group's personal teaching efficacy scores week 1 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).

Table 7

Personal Teaching Efficacy

	Control group		Experimental group	
Time	*M*	*SD*	*M*	*SD*
Week 1	7.32	0.62	7.67	0.61
Week 12	7.00	0.73	7.57	0.72
Week 15	7.03	0.42	7.46	1.04

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

The mean differences in personal teaching efficacy scores from week 1 to week 15 of the teaching methods course (data collection points 1 and 3) are presented in Table 8. Also presented in Table 8 are the mean differences in personal teaching efficacy scores from week 1 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).

Table 8

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

The analysis of hypothesis three did not reveal a significant difference in the preservice teachers' personal teaching efficacy based upon the MTIS treatment, $T = .06$, $F(2, 16) = 0.49$, $p > .05$ (Table 9). Therefore, the researchers failed to reject the null hypothesis.

Table 9

MANOVA Personal Teaching Efficacy

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

Conclusions and Implications

Personal Mathematics Efficacy

The MTIS treatment did not have an effect on the personal mathematics efficacy scores of the preservice teachers, and this finding is consistent with Stripling and Roberts (2013). Even though the MTIS treatment did not have an effect on personal mathematics efficacy, the researchers find the preservice teachers' mathematical confidence encouraging, because the MTIS did not negatively affect the personal mathematics efficacy of the preservice teachers. Moreover, the treatment has been shown to significantly improve the mathematics ability or mathematics subject matter knowledge of preservice agricultural education teachers in prior research (Stripling & Roberts, 2013). Personal mathematics efficacy is a measure of the preservice teacher's perception of their mathematics content knowledge, and according to Darling-Hammond and Bransford (2005) content knowledge or subject matter knowledge is an essential type of knowledge for effective teaching. In addition, 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; and (d) the acquisition of knowledge (Bandura, 1997) related to mathematics.

Mathematics Teaching Efficacy

The MTIS treatment did not have an effect on the mathematics teaching efficacy scores of the preservice teachers, and this is also consistent with Stripling and Roberts (2013). 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. Furthermore, prior research has shown the treatment to have a positive influence on mathematics ability (Stripling & Roberts, 2013). This fact the preservice teachers were moderately efficacious in mathematics teaching efficacy 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 and this may negatively affect their future teaching of contextualized mathematics and their future secondary students' mathematics content knowledge. Therefore, further inquiry is needed.

Personal Teaching Efficacy

The MTIS treatment did not have an effect on the personal teaching efficacy scores of the preservice teachers. To that end, 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 (2013). In the context of Bandura's (1986) social cognitive theory, personal teaching efficacy should impact the teacher education program, the agricultural teaching methods course, and the preservice teachers' teaching. With that in mind, the researchers are 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. As with personal mathematics efficacy and mathematics teaching efficacy, this is encouraging because the treatment has been shown to improve the mathematics ability of preservice agricultural education teachers (Stripling & Roberts, 2013).

Discussion

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 prior research (Stripling & Roberts, 2012a, 2013) has shown a lack of proficiency in mathematics among Florida preservice agricultural education teachers. 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 a disconnect between *perceived* and *actual ability*. 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.

While there was not a significant difference between the experimental and control groups on the self-efficacy measures, the experimental group generally had slightly lower self-efficacy scores after the MTIS treatment. This may be due to the fact the experimental group was exposed to the NCTM sub-standards that are cross-referenced to the National Agriculture, Food and Natural Resources Career Cluster Content Standards. This exposure may have provided the experimental group with a reference the control group did not have to judge their self-efficacy related to mathematics and teaching mathematics. The authors believe the exposure to the NCTM sub-standards is important and should be included in the agricultural teacher preparation curriculum. How can preservice teachers be expected to teach mathematical concepts within the agricultural education curricula if they are not familiar with the contextualized concepts? Furthermore, if needed, knowledge of the contextualized mathematical concepts may spur preservice teachers to seek professional development related to mathematics and mathematics teaching. On the other hand, knowledge of the contextualized concepts may discourage preservice teachers from teaching mathematical concepts or from continuing in the profession because of a lack of expected success.

Recommendations

Myers and Dyer (2004) reported a gap in the literature on how preservice agricultural teacher education programs should prepare preservice teachers to contribute to the learning of core academic subjects. Since the MTIS treatment did not have a negative effect on personal mathematics efficacy, mathematics teaching efficacy, and personal teaching efficacy and based on research supporting the effectiveness of the seven components of a math-enhanced lesson (Stone et al., 2006), the authors recommend that the agricultural teacher education program at the University of Florida consider integrating the seven components of a math-enhanced lesson into the teaching methods course to be used by future school-based agricultural educators as an instructional strategy for teaching contextualized mathematics. In addition the following recommendations are given for future research:

1. 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' personal mathematics efficacy, mathematics teaching efficacy, and personal teaching efficacy.
2. Consistent with prior research, the preservice teachers in this study were moderately efficacious in mathematics teaching efficacy. Therefore, future research should seek to improve and seek to understand the development of mathematics teaching efficacy.
3. The MTIS treatment included instruction on how to develop and teach a math-enhanced lesson. Therefore, 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.
4. Preservice agricultural teacher education has been called upon to support the learning of core academic subjects. Therefore, future research should examine the mathematics and mathematics teaching efficacy of agricultural teacher educators.
5. 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 instead of an agricultural teacher educator.
6. This study should be replicated in other populations of preservice agricultural teachers.

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