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Exploring the Disconnect Between Mathematics Ability and Mathematics Efficacy Among Preservice Agricultural Education Teachers

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Abstract

STEM disciplines will continue to impact school-based agricultural education programs; thus, in order to produce secondary students proficient in science and mathematics, developing preservice agricultural education teachers who are competent in mathematics and teaching mathematics is essential. This study utilized data collected through a focus group of 10 preservice agricultural education teachers at the University of Tennessee in order to explore the disconnect between mathematics ability and mathematics efficacy of preservice agricultural education teachers. Five themes emerged, which help explain the disconnect between mathematics ability and mathematics efficacy: (a) review of mathematics, (b) misconceptions, (c) prior success, (d) use of guest lecturers/students, and (e) the importance of pedagogical knowledge. Based on the results of this study, we recommend the agricultural teacher education program at the University of Tennessee provide instruction on cross-referenced mathematics standards, methods of teaching contextualized mathematics, and the types of knowledge required for teaching contextualized mathematics. These efforts should better prepare preservice teachers for teaching contextualized mathematics and aid them in developing an accurate understanding of the mathematics found in the school-based curricula. Additionally, future research is warranted to determine the most effective means of providing instruction in the aforementioned areas.

Keywords: STEM; math; mathematics ability; mathematics efficacy; preservice teachers

Currently, the U.S. is behind other nations in mathematics and science achievement (National Center for Education Statistics, 2011), which is perplexing since the U.S. is considered by many other countries to be the world leader in science and mathematics (Kuenzi, 2008). Furthermore, increasing arrays of careers require knowledge in STEM (science, technology, engineering, and mathematics), and demand for STEM workers is outpacing supply – "16 of the 20 occupations with the largest projected growth in the next decade are STEM related" (National Research Council, 2011, p. 5). What is more, employers in many industries are reporting the necessary mathematics and problem solving skills needed to succeed are lacking from employees,

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which may have negative implications on health care, the environment, manufacturing, national security, and the economy (National Research Council, 2007; National Science and Technology Council, 2011). Complicating this issue further, is the fact a majority of 4th, 8th, and 12th grade students are not proficient in mathematics and many of their teachers have inadequate content knowledge (Kuenzi, 2008). As a result, STEM education in the U.S. is a growing concern (Kuenzi, 2008). In response to this concern, the National Governors Association (2007) called for the preparation of effective K-12 STEM teachers. In addition, the United States Department of Education's (2012) report, *Investing in America's Future: A Blueprint for Transforming Career and Technical Education*, indicated career and technical education programs should be held accountable for improving academic outcomes. The report also claimed effective programs have a "curriculum based on integrated academic and technical content and strong employability skills" (United States Department of Education, 2012, p. 2). Beyond these calls for change and accountability, Perkins IV required career and technical education to integrate core academic content into programs of study (Stachler, Young, & Borr, 2013).

This emphasis on the STEM disciplines has impacted and will continue to impact school-based agricultural education programs. According to Phipps, Osborne, Dyer, and Ball (2008), the greater emphasis on individual student success and the integration of core academics has resulted in school-based agricultural education becoming more science-based. Phipps et al. (2008) stated effective science-based instruction includes the teaching of mathematical concepts and skills. Supporting this, research in science education has found student achievement in science is associated with effective mathematics instruction (Gabel as cited in Phipps et al., 2008). Therefore, the aforementioned shift in focus and design magnifies the need for school-based agricultural educators to be proficient in mathematics and teaching contextualized mathematics. Correspondingly, Conroy, Trumbull, and Johnson (1999) proclaimed agricultural education is an affluent context for learning mathematics, and Shinn et al. (2003) stated there is great potential for improving the mathematic performance of students through school-based agricultural education. Moreover, agricultural education research has shown a math-enhanced curriculum improved mathematics achievement without diminishing technical skill development and attainment (Parr, Edwards, & Leising, 2008; Young, Edwards, & Leising, 2009).

Therefore, developing preservice agricultural education teachers who are competent in mathematics and teaching mathematics should be a priority in order to produce secondary students proficient in science and mathematics. However, prior research has shown a disconnect between preservice agricultural education teachers' mathematics ability and their mathematics efficacy (Stripling & Roberts, 2012a, 2012b, 2013a, 2013b). Stripling and Roberts (2012a, 2012b, 2013a, 2013b) found preservice teachers possessed low mathematics ability and moderate to high mathematics efficacy and suggested future research should examine the development of preservice teachers' mathematics efficacy. Therefore, this study will investigate this disconnect and seek to understand the development of mathematics efficacy.

Purpose and Research Question

The purpose of this qualitative study is to investigate the disconnect between mathematics ability and mathematics efficacy of preservice agricultural education teachers. The following research question guided this study: What factors contribute to the development of preservice agricultural education teachers' mathematics efficacy?

Subjectivity Statement

Three researchers were involved in this study: (a) one agricultural leadership master's student, (b) one assistant professor of agricultural education, and (c) one associate professor of agricultural leadership and education. The master's student researcher has completed her undergraduate degree in psychology and is a former student-athlete. The assistant and associate professors are former school-based agricultural education teachers and have recently published works in the areas of leadership, STEM education, and college instruction. Both have prior experience with qualitative data collection techniques, including facilitating focus groups, and have published qualitative works.

Collectively, we believe students construct knowledge through prior knowledge and experiences. We believe preservice teachers enter a teacher preparation program with diverse backgrounds, and these prior experiences influence their mathematics self-efficacy. These beliefs influenced and provided the basis for the theoretical lens chosen for this study.

Theoretical Perspective

Constructivism served as the theoretical perspective of this study and asserts individuals construct their knowledge based on their experiences (Crotty, 1998). Crotty (1998) professed "constructivism describes the individual human subject engaging with objects in the world and making sense of them" (p. 79). Constructivism supports the notion that multiple truths or realities exist, thus experiences produce different meanings for each individual (Crotty, 1998). Therefore, each individual constructs truth as they interpret the world (Crotty, 1998). In the context of this study, the preservice teachers have constructed self-efficacy beliefs regarding performing mathematical tasks and the teaching of contextualized mathematics based upon their prior knowledge and experiences.

Theoretical Foundation/Literature Review

Social Cognitive Theory and Self-Efficacy

Bandura's (1986) social cognitive theory was used as the theoretical foundation for this study. According to Bandura, an individual's knowledge acquisition can be directly linked through a reciprocal relationship within the context of personal, social, and environmental determinants. This reciprocal process is multidirectional and suggests that these three factors are all interrelated and that cognitive skills are cultivated socially (Bandura, 1986, 1997). This study was also guided by the self-efficacy component of social cognitive theory. Perceived self-efficacy is the personal measure of an individual's ability to perform tasks or behaviors (Bandura, 1997). As defined by Bandura (1997), self-efficacy is a personal factor that occupies a vital role by influencing other internal personal factors, external environmental factors, and behavior, all of which are determinants in social cognitive theory. According to Bandura (1997),

> self-efficacy beliefs are constructed from four principle sources of information: enactive mastery experiences that serve as indicators of capability; vicarious experiences that alter efficacy beliefs through transmission of competencies and comparison with the attainments of others; verbal persuasion and allied types of social influences that one possesses certain capabilities; and physiological and affective states from which people partly judge their capableness, strength, and vulnerability to dysfunction. (p.79)

Additionally, the following motivational theories and processes may partially explain the development of self-efficacy: (a) attribution theory; (b) expectancy-value theory; (c) self-determination theory; (d) malleability of intelligence theory; (e) goal orientation theory; and (f) self-regulation (see Fong & Asera, 2010).

Teacher Efficacy

More specifically, this study focused on teacher or teaching efficacy, a distinct type of self-efficacy. Teacher efficacy is the extent to which the teacher believes they have the capacity to affect student performance (Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998). According to Soodak and Podell (1996), teacher efficacy is one's belief in their ability to initiate preferred outcomes in one's students. Hoy (2000) defined teacher efficacy as teachers' confidence in their ability to promote students' learning. Moore and Esselman (1992) stated teacher efficacy is a predictor in student achievement. Teacher efficacy is directly related to students' individual sense of self-efficacy (Anderson, Greene, and Loewen, 1988) and student motivation (Midgley, Feldlaufer, & Eccles, 1989). Teachers with high teaching efficacy put more effort into the planning and organization of a class (Allinder, 1994) and despite challenges or undesired results, they are more likely to persevere when faced with instructional challenges (Fong & Asera, 2010). Furthermore, when teaching efficacy beliefs are solidified within the teacher, they are difficult to change (Bandura 1997; Tschannen-Moran et al., 1998). This is important to take into consideration 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). According to Ross, Cousins, and Gadalla (1996), teacher efficacy differs within teachers, and teachers with higher teaching efficacy tend to set higher standards for themselves and their students by focusing on the individual development of students rather than content coverage. In addition, research has suggested teaching efficacy can be improved when a teacher has observed a modeler of effective teaching, and thus has a standard or benchmark in which to gauge their own teaching efficacy beliefs (Ebmeier, 1994; Protheroe, 2008).

Mathematics Self-Efficacy and Development of Mathematics Self-Efficacy

Hackett and Betz (1989) defined mathematics self-efficacy as an individual's assessment of his or her ability to successfully execute mathematical tasks or problems and subsequently perform the mathematics related content proficiently. According to Matsui, Matsui, and Ohnishi (1990) mathematics self-efficacy is the personal degree of confidence an individual possesses in his or her ability to perform mathematically. Several researchers have postulated the development of mathematics self-efficacy is consistent with Bandura's (1997) development of self-efficacy beliefs and is based on four sources of information: (a) an individual's past performance, (b) vicarious experiences through the observation of others, (c) verbal persuasion that one possesses certain capabilities, and (d) physiological states (Charalambous, Philippou, & Kyriakides, 2008; Lent, Lopez, Brown, & Gore, 1996; Siegle & McCoach, 2007). With that in mind, previously earned mathematics scores or grades, comparison of one's perceived individual mathematical abilities to another's mathematical abilities, inherent effort and motivation, attributing personal confidence to a teacher's skills, home life and parental judgment of their child's efficacy, and an emotional or physical state are all specific factors contributing to the individual development of mathematics self-efficacy (Usher, 2009). In addition, Hackett and Betz (1989) found mathematics self-efficacy is strongly correlated to mathematical performance. In a study using middle school students, Usher (2009) found strong academic performance in mathematical areas attributed to higher confidence in mathematics self-efficacy and in contrast, low performance in mathematical areas contributed to diminishing beliefs in an individual's mathematics self-efficacy. Research examining college students indicated the students enrolled in higher-level mathematics courses while in high school had significantly higher mathematics self-efficacy than those students who were enrolled in lower-level mathematics courses (Hall & Ponton, 2005). Furthermore, research has indicated people highly efficacious in mathematics typically possess lower levels of mathematics anxiety (Swars, Daane, & Giesen, 2006). Mathematics anxiety can be defined as "a state of discomfort in response to situations involving mathematical tasks that are perceived as threatening to self-esteem" (Bursal & Paznokas, 2006, p. 173). Moreover, mathematics self-efficacy is a primary contributor in deciding to enter mathematics related or non-mathematics related career options (Matsui, Matsui, & Ohnishi, 1990).

Mathematics Teacher Efficacy

Gresham (2008) purported mathematics teacher efficacy is a teacher's personal sense or belief they individually possess the skills necessary to bring about student learning in mathematics. According to Gresham (2008), teachers' self-efficacy beliefs are "often coupled with feelings of alienation and fear in mathematics settings, and anxiety about the prospect of teaching" (p. 173). Therefore, in order to sustain mathematics teacher efficacy, Gresham posited teachers must maintain a constant connection between the students' learning and their actions as a teacher. In addition, Gresham found teachers with high mathematics anxiety have low mathematics teacher efficacy and teachers with low mathematics anxiety have high mathematics teacher efficacy. Research has shown teachers with a low sense of mathematics teacher efficacy tend to attribute students' failures to factors beyond the teachers control such as poor home environment, lack of student ability, and low student motivation (Smith, 1996). Similarly, Utley, Moseley, and Bryant (2005), found a teacher's sense of mathematics teaching efficacy is influenced by the students' capacity to learn mathematics, which is partially determined by socioeconomic status and other environmental factors. Furthermore, Swars (2005) asserted a preservice teachers' past mathematics experience is highly correlated to their mathematics teaching efficacy. Negative past experiences in mathematics has shown to contribute to a low sense of mathematics teacher efficacy, whereas positive past mathematics experiences translates to a high sense of mathematics teacher efficacy in preservice teachers (Swars, 2005). To that end, it can be inferred the more positive experiences a preservice teacher has had and the more the preservice teacher has succeeded in the past, the higher their mathematics self-efficacy is and therefore, the higher their mathematics teaching efficacy will be (Swars, 2005).

Preservice Agricultural Education Teachers

Research on preservice agricultural education teachers' mathematics efficacy and mathematics teacher efficacy is limited. Four studies (Stripling & Roberts, 2012a, 2013a, 2013b, 2013c) were found in the agricultural education literature related to mathematics efficacy and mathematics teaching efficacy. Stripling and Roberts (2012a, 2013a, 2013b) found preservice teachers at the University of Florida were efficacious in personal mathematics efficacy and moderately efficacious in mathematics teaching efficacy. Furthermore, Stripling and Roberts (2013a, 2013b) found the incorporation of mathematics teaching and integration strategies based on the Math-in-CTE model (Stone, Alfeld, Pearson, Lewis, & Jensen, 2006) into an agricultural education teaching methods course did not significantly affect mathematics efficacy or mathematics teaching efficacy. As a result, they suggested further inquiry was needed to improve and understand the development of mathematics teaching efficacy.

The other study identified, Stripling and Roberts (2013c), explored relationships between mathematics teaching efficacy and personal mathematics teaching efficacy and background characteristics of preservice agricultural education teachers. They found the following: (a) males possessed slightly higher mathematics teaching efficacy, (b) males and females possessed similar personal mathematics efficacy, (c) personal mathematics efficacy increased in regard to completing higher levels of mathematics in high school, but not when completing higher levels in college, (d) higher levels of mathematics in high school and college had little effect on mathematics teaching efficacy, (e) preservice teachers with higher grades in their last mathematics course had higher mathematics teaching efficacy and personal mathematics efficacy, (f) preservice teachers who completed a mathematics course more recently had lower mathematics teaching efficacy and personal mathematics efficacy, (g) preservice teachers 24 or older had lower mathematics teaching efficacy and personal mathematics efficacy than those 20–23 years old, and (h) preservice teachers with higher GPAs had higher personal mathematics efficacy and mathematics teaching efficacy. Based on the limitation of their study, Stripling and Roberts (2013c) concluded further research was needed to build the empirical knowledge based in this emerging area before research-based recommendations for practice can be made.

Methods

Target Population and Sample

The target population for this study was Tennessee preservice agricultural education teachers. The sampling frame utilized for this study was senior undergraduate students majoring in school-based agricultural education at the University of Tennessee. The entire sampling frame consented to participate in this study and signed the informed consent approved by the University of Tennessee's IRB. This convenience sample consisted of 10 preservice agricultural education teachers, six females and four males. The average age of the preservice teachers were 23.1 years old, with a range of 21 to 30. Their self-reported mean college grade point average was 2.66 on a 4-point scale. The number of college level mathematics courses completed by the participants ranged from two to three. Nine preservice teachers described themselves as white and one as other. A limitation of this study was that data were only collected from one group of preservice teachers and caution should be used in generalizing the results.

Dooley (2007) warns that credibility may be lost if "time, money, location, and availability" (p. 36) are the only reasons for using a convenience sample. Furthermore, Gall, Gall, and Borg (2007) stated a convenience sample is appropriate as long as the reasons for using the selected sample are described by the researcher. Therefore, the sample utilized in this study was selected based upon Stripling and Roberts (2012a, 2013a, & 2013b) studies, which discovered preservice agricultural education teachers displayed a disconnect between mathematics efficacy and mathematics ability. To further validate the use of the sample, participants were given the *Mathematics Ability Test* (Stripling & Roberts, 2012b) and the Mathematics Enhancement Teaching Efficacy Instrument (Jansen, 2007) to determine if the sample exhibited a disconnect between mathematics efficacy and mathematics ability before proceeding with the study. On the mathematics efficacy instrument, the participants were confident in their mathematics ability (personal mathematics efficacy: M = 3.06, SD = 0.52; 4-point scale), moderately efficacious in their ability to teach mathematics (mathematics teaching efficacy: M = 3.28, SD = 0.63; 5-point scale), and perceived themselves as having the ability to influence student learning (personal teaching efficacy: M = 7.21, SD = 0.80; 9-point scale). Furthermore, the participants averaged 26.5% on the mathematics ability instrument, which indicated the preservice teachers were not proficient in solving agricultural mathematics problems. This disconnect between mathematics efficacy and mathematics ability is consistent with prior research (Stripling & Roberts, 2012a, 2012b, 2013a, 2013b) and supports the use of the sample.

Research Design, Data Collection, and Analysis

In order to understand the disconnect between mathematics ability and efficacy, a qualitative paradigm was selected for this study. This research approach allowed the researchers to interpret and understand the phenomenon based on the participants' view of reality or truth (Denzin & Lincoln, 1994). The specific research design used in this study was the basic or generic methodological approach (Ary, Jacobs, Sorensen, & Walker, 2014; Dooley, 2007; Merriam, 1998), which seeking to interpret experiences by determining how events, processes, and activities are perceived by the participants (Ary, et al., 2014). According to Merriam (1998), the generic approach provides flexibility and is used commonly in qualitative research. This approach also allowed the participants to provide data rich in description, which can then be used in the forming of patterns or themes (Merriam, 1998).

Data were collected through a focus group, and this interview method was utilized because it allowed the facilitation of questions to a group of individuals (Ary et al., 2014). The focus group was approximately 90 minutes in length. The focus group was audio-recorded and transcribed verbatim. The individual participants were assigned a student number (S1, S2, etc.) to protect their identities. The researcher (associate professor) not associated with supervision or course instruction of the preservice teachers during their senior year facilitated the focus group, and the following researcher-developed semi-structured interview guide was used by the facilitator to guide the focus group:

1. Why do you believe you have the ability to solve and/or complete mathematical problems (or tasks)?
2. Explain what you know about secondary mathematics in the agricultural education curriculum.
3. How do you compare to other agricultural education majors as it relates to teaching mathematics?
4. How do you compare to other agricultural education majors as it relates to understanding mathematics?
5. How do you compare to other agricultural education majors as it relates to solving mathematics?
6. How have you developed yourself in the area of mathematics?
7. What have you accomplished or studied that leads you to believe you are prepared to teach mathematical concepts to agricultural education students effectively?

Data were analyzed using a thematic analysis method. The method allowed the researchers to reduce the data and "focus on repeated words of phrases… or evidence of answers to the research question/s which have been devised" (Grbich, 2007, p. 32). Grbich (2007) noted researchers should allow the data to "speak for themselves initially before any predesigned themes are imposed" (p. 32); thus, the researchers allowed the data to speak by bracketing their prior knowledge of the research literature. Additionally, we used the block and file approach to conduct the thematic analysis (Grbich, 2007). Each researcher chunked the data into smaller portions by color-coding segments of data in an initial effort to categorize the data into themes. After the data were color-coded the researchers compared their coding and came to a consensus of the emergent themes. Data were then reexamined collectively in order to develop titles for each emergent theme and appropriate data were included as evidence of the emergent theme.

Rigor and trustworthiness were established by addressing credibility, dependability, confirmability and transferability (Ary et al., 2014). Investigator triangulation of data analyses, using member checks during the focus group, and reflexivity were used to ensure credibility of the researchers' observations, interpretations, and conclusions (Ary et al., 2014). Dependability and confirmability were established by creating audit trails to document analysis decisions and themes were consistent across multiple researchers (Ary et al., 2014). Additionally, reflexivity also aided in enhancing confirmability (Ary et al., 2014). To enhance transferability literature comparisons were made and a detailed description of the participants was provided (Ary et al., 2014).

Findings

Data analysis revealed five themes that help explain the disconnect between mathematics ability and mathematics efficacy. Common themes that help in explaining the preservice teachers' mathematics self-efficacy included: (a) review of mathematics, (b) misconceptions, (c) prior success, (d) use of guest lectures/students, and (e) the importance of pedagogical knowledge.

Review of Mathematics

Participants expressed it had been a long time since they last took a mathematics course. As indicated by the participants, many had not taken a mathematics course since their freshman year in college stating "a lot of this stuff has been three years since I took my last math test or my last math class" (S1), "It's been a few years" (S8), and "it's been a really long time for me" (S10). In addition, a non-traditional age student stated she had not seen mathematics problems "in 20 years" (S8).

Furthermore, participants agreed they would be able to teach mathematics with content "refreshers" (S5; S8) and "practice" (S5; S10). Similarly, S6 stated, "in order to teach it, you have to be exposed to do it repetitively." Participants S1 and S5 also expressed similar beliefs. Furthermore, participants S6 and S10 agreed "someone behind the scenes" to "show" them mathematics content would assist them in teaching mathematics. However, S6 believed "self-teaching" would suffice too. Other participants stated using methods such as "tutoring or reading a book" (S8) and "glancing at book examples" (S4; S9) as ways to "train yourself to teach math" (S9). Additionally, S8 declared, "If I'm going to teach it, I'm going to study material."

Misconceptions

Two misconceptions were found in the participants' beliefs about the mathematics present in the school-based agricultural education curricula: (a) the need for procedural mathematics knowledge as opposed to conceptual mathematics knowledge and (b) the type of mathematics found in school-based curricula. Referring to procedural and conceptual mathematics knowledge, participant S5 admitted, "basic everyday math I am fine, but if you give me a math problem, I am not going to be able to do it." Additionally, the general consensus among the participants was that there are "a lot of formulas" (S1; S5; S6) in mathematics and "I can teach it because it is just numbers I am plugging in a formula" (S6); therefore, "you don't have to know the math, you just plug it into the calculator" (S1; S5; S6). Furthermore, participant S8 explained "we can tell [students] to plug it in a calculator and they will get it that way." In agreement, participant S6 said in regards to addressing students, "you put this in this, and you get this." Overall, participants agreed some students need formulas and some already know them; however it is all in how the teacher presents the steps that determines a student's success (S1; S2; S3; S5; S6; S8; S9).

Pertaining to the type of mathematics found in school-based curricula, participants S5, S6, and S9 all stated some of the concepts on the *Mathematics Ability Test* (Stripling & Roberts, 2012b) were foreign to them because they never learned them in high school. "There was a lot of stuff on that test I didn't learn in high school, I hadn't seen any of it" stated participant S9. Similarly participants S5 and S6 declared "I had not seen some of those concepts" (S6) and "I am struggling now because I didn't learn it in high school" (S5). Several of the participants associated high school math with only algebra and geometry (S6; S7; S10).

Prior Success

Two factors related to prior success emerged that contributed to the participants' mathematics self-efficacy: (a) good teachers and (b) mathematical success in high school. Participants attributed their prior success to their high school teachers stating, "my teacher in high school was great" (S3; S7) and "I had good math teachers" (S3; S4; S7).

Participants also noted having general mathematical success in high school. Participant S8 attributed success to good grades and exclaimed, "I have always aced all of my stuff through high school. I was in honors, and I was good at math." Participants S1, S7, and S9 added "I was really, really good in math in high school" (S7), "Math was always my best subject growing up in high school" (S1), and "I always did very well in high school" (S9).

Use of Guest Lecturers and Students

Participants identified two forms of assistance that they could use when teaching contextualized mathematics in their future careers as agricultural education teachers: (a) guest lecturers and (b) students. Several students agreed that guest lecturers were an option stating "you can have someone teach other than you" (S2), "I would bring in a professional" (S4), and "I would call in a teacher for that portion" (S8). Participant S8 later added, "If it is math, I would have someone else do it." Moreover, participant S9 said "I would get someone to come in and say 'here is an expert who can teach you because he knows it better than I do" and participant S1 agreed. However, participant S2 disagreed with participant S9's statement saying, "It's a bad idea to tell a student you don't know how to do something." As a follow up to participant S2, participant S6 added, "we have all had college professors that are supposed to be intelligent that bring other people in."

Additionally there were some participants who felt getting a student to teach them or the class was acceptable. In accordance with participant S7's statement about helping other people with mathematics, participant S3 added,

> I can teach some of it in a classroom just because those students, like you guys said, they are good at it. There are students that are going to be in my classroom that are going to know how to do it, it can be a group effort, and they can teach me and I can teach them. That's the way I see it.

Furthermore, S1 provided a contextualized example about welding to illustrate the use of students to aid in teaching stating,

> that's where you have a kid in there and you know that they are going to be good at welding, then that kid can teach you. That happened to someone I know, he learned welding from his student and he had that student teach the other kids.

Importance of Pedagogical Knowledge

All participants unanimously agreed that pedagogical knowledge is more important that content knowledge. Participant S6 stated, "I feel like my ability to teach [is more important] because I can learn the content, but I have got to be able to teach regardless." Correspondingly, participant S8 declared "I think instead of just adding a math class, I think you should add a [math] class that is about effective teaching methods…. that'd be a math class people would want to take." Following this statement, all participants agreed.

Conclusions and Implications

Data analysis revealed five themes that help explain the disconnect between mathematics ability and mathematics efficacy: (a) review of mathematics, (b) misconceptions, (c) prior success, (d) use of guest lecturers/students, and (e) the importance of pedagogical knowledge. First, participants indicated it had been a long time since they last took a mathematics course, with a majority of participants not having a mathematics course since their freshman year in college. This timeframe is similar to Stripling and Roberts (2013c). However, the participants felt with a refresher course, practice, or by re-teaching themselves, they would be prepared to teach mathematics found in the school-based agriculture education curricula. This perception from participants aligns closely with Hackett and Betz (1989) who postulated that one's own ability to successfully execute mathematics is based on one's own assessment of oneself. In addition, participants' assessment of mathematics knowledge is directly linked to Bandura's (1986) social cognitive theory which highlights the reciprocal relationship within the context of personal, social, and environmental determinants. Therefore, based on this study, preservice teachers personally believe with some mathematics refresher courses, they could teach mathematics. In addition, this personal degree of confidence is directly related to one's mathematics self-efficacy (Matsui, Matsui, & Ohnishi, 1990) and their personal belief they can teach mathematics if exposed to it repetitively (Gresham, 2008). Thus, their belief in their ability to learn mathematics concepts in the future contributes to their high sense of mathematics efficacy.

Prior success also contributed to a high sense of mathematics efficacy. To that end, the preservice teachers drew upon prior experiences with good mathematics teachers and their personal success with mathematics in high school. According to Bandura (1997), self-efficacy is influenced by vicarious experiences and enactive mastery experiences. Observing good teachers is a vicarious experience, and personal success with mathematics in high school is an enactive mastery experience. Bandura (1997) also stated that "enactive mastery experiences are the most influential source of efficacy information" (p. 80), thus to the preservice teachers, their personal success in mathematics in high school is evidence of future success. Correspondingly, Swars (2005) stated, positive past mathematics experiences translates to a high sense of mathematics teacher efficacy in preservice teachers. Other researchers have also found mathematical performance influences mathematics efficacy (Hackett & Bentz, 1989; Stripling & Roberts, 2013c; Usher, 2009), and observing a modeler of effective teaching improves teaching efficacy (Ebmeier, 1994; Protheroe, 2008).

Furthermore, participants revealed misconceptions in their knowledge of the school-based agricultural education curricula and the need for procedural mathematics knowledge as opposed to conceptual mathematics knowledge. Participants believed algebra and geometry were the only mathematical subject areas needed to teach school-based agricultural education. This is not consistent with the cross-referenced mathematics standards found in the National Agriculture, Food and Natural Resources Career Cluster Content Standards (National Council for Agricultural Education, 2009). According to Crotty (1998), constructivism supports the notion that multiple truths or realities exist, thus experiences produce different meanings for different people. Therefore, participants' realties were a misconception of the mathematics present in the school-based agricultural education curricula. Similarly, participants believed the mathematics found in the school-based curricula required a procedural knowledge of mathematics. Possessing conceptual understandings of mathematics were not perceived as important to teaching mathematics. These misconceptions are troubling and may negatively impact their future teaching of contextualized mathematics and the mathematics achievement of their future secondary school student. Underscoring this concern, is the fact current educational reform efforts and mathematics standards focus on fewer topics and emphasize "conceptual understanding, procedurals skills and fluency, and application with equal intensity" (Common Core State Standards Initiative, 2014, Key Shifts in Mathematics, para. 6).

Participants also believed using an expert in the field, such as a guest lecturer or an experienced student, was an acceptable means of assistance in teaching contextualized mathematics. This belief supports the notion that vicarious experiences are a source of self-efficacy information (Bandura, 1997). Data suggested the participants developed this belief by observing college professors and/or school-based teachers using guest lecturers or experienced students as a teaching method. This conclusion is consistent with Holt-Reynolds (1992) and Kagan (1992) who reported observations of educators affected preservice teachers' understanding of teaching. We found it interesting that using guest lecturers and students was the preservice teachers answer for not possessing the necessary mathematics content knowledge for teaching the mathematics found in the agricultural education curricula, especially in light of the last theme.

The final theme indicated participants were in agreement that pedagogical knowledge was more important than content knowledge. At first glance, this seems to be consistent with Ross, Cousins, and Gadalla (1996) who reported teachers with high efficacy set higher standards for themselves and do not focus on content coverage. However, as noted above, the preservice teachers indicated using guest lecturers or students was an acceptable means of teaching contextualized mathematics. We believe the preservice teachers have a distorted view of effective mathematics teaching, and this should be of concern for teacher educators at the University of Tennessee given a majority of the preservice teachers agreed this is how they would teach mathematics concepts.

To that end, we believe the themes that emerged highlight how inadequately prepared the student teachers were in regard to teaching contextualized mathematics and completing mathematical tasks. The participants relied on future reviews of mathematics, past success, and the idea that they could use guest lecturers or students to teach mathematics concepts to form their high sense of mathematics efficacy. In addition, the school-based curricula and knowledge misconceptions also contributed to their high sense of self-efficacy. Bandura (1997) postulated factors that influence efficacy beliefs can be of unequal strength. The results of this study suggest past success in mathematics and vicarious experiences related to mathematics influence mathematics efficacy beliefs more than current mathematics proficiency.

Recommendations

Based on the findings of this study the following recommendations are given:

- Research is warranted to determine if preservice teachers are effective at teaching contextualized mathematics concepts in their secondary school classes after graduation. This recommendation is based on the preservice teachers' belief that they only need a refresher course, practice, or time to re-teach themselves mathematical concepts and skills. To that end, are preservice teachers participating in refreshers, practicing mathematics concepts, and/or re-teaching themselves? If so, how effective is this preparation and what effect does it have on secondary school students' mathematics achievement?
- The preservice teachers did not possess an accurate knowledge of current cross-referenced mathematics standards, which contributed to the disconnect between mathematics ability and efficacy. We recommend the agricultural teacher education program at the University of Tennessee incorporate current cross-referenced mathematics standards into the preservice curriculum. Other agricultural teacher education programs should also examine their curriculum to see if the curriculum promotes an accurate view of the mathematics found naturally in the school-based curricula. Future research should build upon the work of Stripling and Roberts (2013a, 2013b) and seek to determine the most effective means of incorporating cross-referenced mathematics standards into agricultural education programs and examine the impacts on preservice teachers' mathematics content knowledge and their future students' academic achievement.
- The preservice teacher education programs at the University of Tennessee should discuss/provide instruction on the different types of knowledge needed for teaching contextualized mathematics to aid in the development of an accurate view of the types of knowledge needed for teaching contextualized mathematics with their preservice teachers. The National Research Council's (2000) publication, *How People Learn: Brain, Mind, Experience, and School*, and Stripling and Barrick's (2013) article, *Examining the Professional, Technical, and General Knowledge Competencies Needed by Beginning School-Based Agricultural Education Teachers*, are examples of two publications that can be used to spur and guide discussion. Additionally, other teacher education programs may also

find it beneficial to expand upon current efforts or discussions of the different types of knowledge needed by preservice teachers.

- In addition to the types of knowledge and consistent with the participants, the researchers suggest the teacher education program at the University of Tennessee provide instruction on effectively teaching contextualized mathematics beyond current offerings or integration. This should aid the preservice teachers in developing a broader set of pedagogical tools and lessen their reliance on guest lectures and students for teaching contextualized mathematics. Future research should be conducted to determine the most effective means of incorporating effective methods of teaching contextualized mathematics. Stripling and Roberts (2013a, 2013b) may aid researchers interested in this line of inquiry, since they investigated the use of the Stone et al.'s (2006) seven elements of a math-enhanced lesson in an agricultural teaching methods course.
- This study should be replicated in other populations of preservice agricultural education teachers.

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