Preservice Teachers' Perceptions of Infusing Mathematics in the School-Based Agricultural Education Curricula

Nathan W. Conner
Assistant Professor
University of Nebraska-Lincoln
nconner2@unl.edu

Sarah Greer
Graduate Student
University of Tennessee
sarahjoygreer@gmail.com

Nathan Ollie
Graduate Student
University of Tennessee
nollie1@vols.utk.edu

Christopher T. Stripling
Associate Professor
University of Tennessee
cstripli@utk.edu

Carrie A. Stephens
Professor
University of Tennessee
cfritz@utk.edu

Qualitative Research
Research Priority Area: Teacher Education and School-Based Education; Teaching and Learning in Undergraduate Academic Programs

Preservice Teachers' Perceptions of Infusing Mathematics in the School-Based Agricultural Education Curricula

Mathematics knowledge is a critical component of natural and agricultural sciences, and school-based agricultural education is expected to support core academic instruction. Therefore, preservice agricultural education teachers must be prepared to teach mathematical concepts. This study explores preservice agricultural education teachers' perceptions of mathematics in the school-based agricultural education curricula. Five preservice teachers consisting of 4 females and 1 male participated in this qualitative study. Data were collected through individual semi-structured interviews that were approximately 30 minutes, and thematic analysis was used to analyze the data. Audit trails, triangulation, member checking, and thick description were used to achieve trustworthiness. Five themes emerged from the analysis: (a) mathematical importance in agriculture, (b) relevance to life, (c) mathematics skills required to teach school-based agricultural education, (d) lack of mathematics proficiency, and (e) lack of awareness of mathematics in the curricula. The participants recognized the importance of mathematics within the field of agriculture and daily life. However, the participants were unaware of specific mathematical concepts found within the school-based agricultural education curricula. Furthermore, participants did not possess an understanding of the common core mathematic standards. Findings from this study indicated preservice teachers are not prepared to teach mathematics concepts and need additional mathematics preparation as well as exposure to current mathematics standards they are expected to teach. Future research should investigate the means of meeting these needs through the teacher education program and in-service training.

Introduction

The emerging workforce must be prepared to adapt to a variety of situations with real-world, applicable knowledge gained through the integration of traditional subjects, such as mathematics (Association for Career and Technical Education, 2006). According to Shinn et al., (2003) mathematics education could help agriculturalists face challenges of the future.

> Pressures from megatrends—including increasing world population, advancing technologies, environmental degradation, increasing socio-political migration, and global terrorism—acerbate food security and safety, as well as natural resource issues. Mathematics will play an important role in discovering and applying new solutions to global challenges (Shinn et al., 2003, p. 22).

However, the Organization for Economic Cooperation and Development's (OECD) 2012 Programme for International Student Assessment (PISA) ranks the United States student performance below average in mathematics. Specifically, the United States was ranked 27th out of 34 OECD countries surveyed (OECD, 2012). The United States' low ranking in mathematics ability could be attributed to the way mathematics is taught in the United States (Steen, 2009). Common complaints regarding the instruction of mathematics in secondary schools focus around the lack of real-world connections between math and everyday life (Steen, 2009). Abstract figures and procedures leave little anchoring to the concrete connections students could form when taught within a context (Steen, 2009). Steen (2009) emphasized the importance of teaching mathematics in a contextual setting such as history or biology. Contextual settings allow the students to make meaningful connections to the real-world, thus increasing retention (Steen, 2009). Similarly, Moscovici and Newton (2006) stated the integration of traditional subjects, such as math, allows students to make deeper connections to real-world situations through the development of problem solving skills. According to OECD (2012), students in the United States "have particular weaknesses in items with higher cognitive demands, such as taking real-world situations, translating them into mathematical terms, and interpreting mathematical aspects in real-world problems" (p. 2).

With that in mind, agricultural education has the potential to provide real-world contexts, which are required for students to make deeper associations with mathematics (Dailey, Conroy, & Shelly-Tolbert, 2001). According to the Food and Agricultural Organizations of the United Nations (FAO) (2009), agriculture, like any sector of the global economy, is changing quickly, and as a result, changes must occur in order to meet the demands of a growing world population. Agricultural education should focus on integrating academics, such as science and mathematics, in order to prepare students to be successful in a globalized world (ACTE, 2006). The United States Department of Education also called for career and technical education programs with "integrated academic and technical content," in their 2012 report titled *Investing in America's Future: A Blueprint for Transforming Career and Technical Education.* Furthermore, beyond these calls for change, Perkins IV required career and technical education to integrate core academic content into programs of study (Stachler, Young, & Borr, 2013), and researchers have found the integration of mathematics concepts into school-based agricultural education courses increases mathematical understanding (Parr, Edwards, & Leising, 2006; Young, Edwards, & Leising, 2009; Stone III, Alfeld, & Pearson, 2008) without lessening students' technical skill acquisition (Parr, Edwards, & Leising, 2008; Young, Edwards, & Leising, 2009).

However, despite the pressure from governmental reforms and evidence supporting mathematic integration in school-based agricultural education, our nation's preservice teachers continue to lack the mathematics content knowledge to teach the mathematics found in the agricultural education curricula (Stripling & Roberts, 2012b; Stripling, Roberts, & Stephens, 2014). This study will examine this issue by seeking to understand the preservice teachers' perceptions of the mathematics found in the school-based agricultural education curricula.

Theoretical Perspective and Framework

The theoretical perspective that served this study was constructionism. Constructionism is the theory that no meaning was ever discovered, but, as the word indicates, constructed by the environment one encounters (Crotty, 1998). Crotty simplifies his theory by stating, "before there were consciousnesses on earth capable of interpreting the world, the world held no meaning at all" (p.43). All meaning was made after there was a conscious being to construct it (Crotty, 1998). Humans must interact with their environments to construct meaning of anything (Crotty, 1998). For the context of this study, preservice agricultural educators construct their knowledge regarding mathematic concepts in agricultural education curricula based upon previous encounters, experiences and knowledge.

The theoretical framework for this study was Bandura's (1986) social cognitive theory. Bandura proposed that human behavior is influenced by (a) behavior, (b) personal factors, and (c) environment. Each factor can vary in strength and influence and interact bidirectionally and may or may not occur simultaneously (Bandura, 1986).

The interaction between personal factors and behavior highlights the idea that how a person thinks, believes, or feels can determine how they behave (Bandura, 1986). Behavior can also be shaped and restricted by personal characteristics and capabilities (Bandura, 1986). Furthermore, the environment is not a fixed entity but is shaped by personal and behavioral influences (Bandura, 1986). In addition, when the environment is influenced by specific behaviors, then a person's behavior affects the environmental climate (Bandura, 1986). Finally, behavior and environment reciprocate (Bandura, 1986). Behavior can create an environment when the environment is flexible or rigid (Bandura, 1986). Likewise, environment can influence behavior (Bandura, 1986). Therefore, for the context of this study, behavior is defined as future teaching practices, personal factors are defined as perceptions of mathematics in agricultural education, and the environment is defined by the agricultural teacher education program.

Behavior – Future Teaching Practices

Behavior, defined in this study as future teaching practices, is influenced by personal factors (as defined by perceptions of mathematics in agricultural education) as well as environment (as defined by the agricultural teacher education program). The OECD (2006) outlines that teacher roles are exceedingly variable for many reasons including the need "to keep pace with rapidly developing fields of knowledge" (p. 97), which is appropriate for this study as it highlights the integration of mathematics education into agricultural education programs.

In a large-scale investigation regarding how teachers learn to teach, the National Center for Research on Teacher Learning, found there are too many factors to implement one widespread solution (Kennedy, 1991). Future teaching methods can be influenced by (a) subject matter knowledge, (b) being taught the accommodation of diverse learners, (c) previous mentors that offered on-the-job guidance, (d) alternative certification program usage, and (e) preservice programs (Kennedy, 1991). Effective teachers are vital to the continuation of economic and social growth around the world through educating the future leaders of countries (OECD, 2006). Developing and developed countries around the world are looking for ways to improve their schools, and the most critical component is teacher development (OECD, 2006). Findings indicate that knowing how to teach (and being trained in teaching) is positively correlated with student achievement (Wenglinsky, 2002; Gustafsson, 2003; Educational Testing Service, 2000; Wayne & Youngs, 2003). In addition, personal factors such as behavior, cognition, content knowledge, character and knowledge of context and environment of their students, can largely affect the way a teacher communicates information (Shulman, 1991).

Personal Factors – Perceptions of Mathematics in Agricultural Education

Personal factors, defined in this study as perceptions of mathematics in agricultural education, is influenced by both behavior (as defined by future teaching practices) and environment (as defined by the agricultural teacher education program).

Few studies exist on the perceptions agricultural educators hold regarding mathematics in the curriculum. However, a preliminary qualitative study interviewed five exceptional agricultural educators in Virginia who had experience with integrating mathematics into their classrooms (Anderson & Anderson, 2012). From the interviews, four themes emerged, one being *mathematics as a component of agricultural education*, (Anderson & Anderson, 2012). This overarching theme gave way to multiple sub-themes: (a) agriculture as a real-world setting for mathematics, (b) issues regarding integration (c) agricultural education lessons integrated with mathematics (d) Career Development Events that utilize mathematics and (e) teacher's cognitive effort to emphasize mathematics (Anderson & Anderson, 2012).

Environment –Agricultural Teacher Education Program

FAO predicts a world population of over 9.1 billion people by 2050 (2009). Although this is not the fastest rate of growth seen (Federico, 2005; FAO, 2009), it is significant because it consists of new challenges such as limited land and labor resources and sprawling urbanization (FAO, 2009). In an effort to meet the needs of a changing world, The National Academies highlights the need to efficiently train faculty (2009). As the world changes, educators must change just as swiftly (The National Academies, 2009), and the environments in which educators are trained can have a large effect on a teacher's ability to teach mathematical concepts.

Environment, defined in the context of this study as the agricultural teacher education program, is influenced by both behavior (as defined by future teaching practices) and personal factors (as defined by perceptions of mathematics in agricultural education). According to Birkenholz and Simonsen (2011), distinguished agricultural education programs were successful due to the faculty members they hired, research programs, and the range of programs. Therefore, it becomes important to populate our agricultural education programs with quality educators and the ability to teach the course material being requested. However, what are the perceptions of infusing mathematics into the agricultural education curricula by preservice agricultural education teachers?

Purpose

The purpose of this study was to explore preservice agricultural education teachers' perceptions of mathematics in the school-based agricultural education curricula. The central research question guiding this study was, "What are preservice teachers' perceptions of infusing mathematics in the school-based agricultural education curricula?"

Methods

According to Creswell (2013), qualitative research provides the researcher the opportunity to holistically analyze and interpret the participants experience and thoughts to explain the participant's position on the research question being discussed. Merriam's (2002) basic interpretive approach was used for this study because it allowed the researcher to interpret "how participants make meaning of a situation or phenomenon" (p.3).

Research Participants

Participants were purposively selected based on the following criterion: participants must be a preservice agriculture teacher at Tennessee Tech University completing their final year of course work prior to student teaching. Five potential participants were identified and asked to participate in the study, because they were the only five preservice agriculture teachers in their final year of the program at Tennessee Tech University. Four females and one male voluntarily participated in the study and were labeled S1, S2, S3, S4, and S5. After graduation, all five participants planned on receiving a teaching license in Tennessee as a high school agricultural education teacher. Prior to attending college, four of the five participants were involved as a student in an agricultural education program and held prior knowledge of agricultural course offerings in Tennessee.

Data Collection and Data Analysis

To capture the conversation between the participant and the researcher, individual interviews were used as the primary data collection method (Creswell, 2013), and we also took notes during the interviews to use as data. Additionally, participants were given the opportunity to answer the same questions in writing but all five agreed to a face-to-face interview. Face-to-face interviews were conducted over a one-week time period at Tennessee Tech University. Each interview lasted approximately 30 minutes, was facilitated by the lead researchers, and was audio recorded and then transcribed. A semi-structured interview protocol was developed by the researchers.

After the interviews were conducted, researchers read through the raw data three times and then individually coded the data. Thematic analysis was used because it allowed for reoccurring words and phrases to be identified (Grbich, 2007). More specifically, researchers manually color coded the data, which allowed for themes to emerge (Grbich, 2007). Grbich (2007) refers to the color coding method as the block and file approach. The codes were then categorized and titles were created for each of the themes that emerged from the data. Additionally, the findings of this study are intended to be transferable to situations and groups which are similar to the group examined in this study (Lincoln & Guba, 1985; Merriam, 2009). However, the small sample size is a limitation and care should be taken when transferring the finding to another group of preservice agricultural educators.

Trustworthiness

Attention to qualitative methodology helps a reader determine whether or not the findings are transferable to another group of individuals (Dooley, 2007). According to Lincoln and Guba (1985) the trustworthiness of qualitative research may be achieved by incorporating specific strategies into the research in order to address credibility, transferability, dependability, and confirmability.

Credibility

Credibility was achieved through triangulation, referential adequacy materials, peer debriefing, and member checking (Erlandson, Harris, Skipper, & Allen, 1993; Lincoln & Guba, 1985). Triangulation took place when the data was analyzed by multiple researchers and two data collection methods were used. Verbal member checking throughout each interview allowed the researcher to ensure participants response was captured accurately. Peer debriefing allowed the researchers to discuss the research with knowledgeable individuals in the field of qualitative research, but who were not part of the study (Erlandson, Harris, Skipper, & Allen, 1993; Lincoln & Guba, 1985).

Transferability

Transferability was addressed by providing detailed descriptions of the findings and of the participants. The participants were purposively selected based on their enrollment in an agricultural education preservice teacher program and their goal of becoming an agriculture teacher. Direct quotes and paraphrasing from the interview data were used to provide thick description.

Dependability and Confirmability

During data analysis, an audit trail was used to help ensure dependability. The audit trail allowed for methodological decisions to be recorded on paper and used as a dependability audit (Dooley, 2007). Decisions regarding why data was separated into a particular theme were also recorded in order to achieve confirmability and provide a confirmability audit.

Subjectivity Statement

There often can and will be bias in qualitative research. However, addressing those individual biases prior to research is important. The researchers involved with this project have experience teaching agricultural education and infusing mathematical concepts into the agricultural education curriculum. The researchers believe that mathematics is a natural component of agriculture. In an effort to control the biases, all researchers were involved in the questionnaire development, interviewing process, and thematic analysis.

Findings

Five themes emerged from the analysis: (a) mathematical importance in agriculture, (b) relevance to life, (c) mathematics skills required to teach school-based agricultural education, (d) lack of mathematics proficiency, and (e) lack of awareness of mathematics in the curricula.

Mathematical Importance in Agriculture

The participants recognized the importance of mathematics within the field of agriculture. Participants recognized agricultural education teachers have been teaching math, because to be able to be successful in teaching agriculture one must be able to incorporate math into the curriculum (S1; S2; S3; S5). S1 stated, “I know that in every subject there is math that has to be taught whether it’s in agriscience or in greenhouse.” Therefore, “pretty much any ag ed class you have you are going to use math in it” (S1). Furthermore, S3 stated, “but all along we have been teaching math, because to be able to be successful in agriculture you have to do math…I think that math is really important in ag and that I value the education that I received from my ag department in high school.” Additionally, S2 declared, “the only thing that I really know about it is that math is an integral part of the science that we teach.” Referring to mathematical importance in agriculture, S5 stated, “well because math is ag.”

Participants also noted mathematics to be a critical component of agriculture in the area of feed rationing. S1 stated, “you will be rationing feed and that uses mathematics.” While S3 declared “I mean when you do feed rations you have to subtract and divide and multiply and do all those.” Additionally, teaching mechanics, specifically horsepower, was mentioned by participant S1 twice. S1 stated, “horsepower and stuff like that relates to mechanics…like when you’re doing the horsepower you’re basically just multiplying and dividing and stuff like that.”

The importance of fertilization and calculations was also mentioned. S1 stated, “you have to use it for the fertilizers and stuff like that.” Additionally, S4 added “certainly like with plant science you would learn how to do fertilizer calculations and with animal science you deal with ratios dealing with genetics such as the Punnett square and with agricultural engineering aspect you could deal with how many square acres of fertilizer you need or how to calibrate a machine to work efficiently. Furthermore, participants agreed educators must distribute the math teaching throughout the curriculum (S4; S5). Participant S5 stated, "you kind of space it [math] out throughout the year in different scenarios where it applies." Participant S4 stated, "you don't want to talk about land measuring or how to draft or cutting at the same time…those don't really apply so you don't want to do all the math at once, you kind of want to space it out" (S4).

Relevance to Life

The participants recognized the relevance of mathematics in daily life. Two things were found in the participants' beliefs about the mathematics: (a) the need to understand math to get through everyday life and (b) the need to demonstrate math concepts to be successful. Referring to the need to understand math to get through everyday life, participant S1 stated, "you can't get through life without knowing it [math]" and "you see it being done in real-world experiences that you are going to be using later on." Additionally, S4 stated, "math is a subject that you take with you no matter what you plan on majoring in or doing with your life. It's constant use." Furthermore, in agriculture, you have the opportunity to apply math to real-world situations (S1; S2; S4).

Pertaining to the need to know math be successful, participants S1 and S4 believed it was impossible to get through life without understanding math. Participants also believed math had some sort of relevance to life (S1; S3; S4; S5). While participants S2 and S3 stated, "you cannot run a successful farming operation if you do not know how to do math." Additionally, participants related math to being successful agriculturists.

> I mean if you have a crop and you have to go put fertilizer on it. You have to know how to read the bags and after you read the bags, you have to know the math of if it has 50/30/20, you have to know then that there is .05 nitrogen in it, and you have to calculate that out to see how many actual pounds of that fertilizer you need to put on it (S1).

While S2 stated, "because you could simply lose a crop if you do not know how to apply fertilizer correctly." Additionally, participants gave examples of what should be taught in regard to relevance to life. S4 stated, "I think that a teacher should use more worldly examples so students know exactly why they are learning this material and why they need it" (S4). Furthermore, participant S3 stated,

> we should teach how to do graphs and how to read graphs in your algebra class, because it really helps. Because in agriculture, no matter what the discipline, is there is different graphs that you have to be able to read whether it's a bar graph or a line graph, so that helps.

Mathematics Skills Required to Teach School-Based Agricultural Education

Five factors related to mathematics skills required to teach school-based agricultural education: (a) basic math, (b) algebra, (c) geometry, (d) critically thinking, and (e) statistics (S1; S2; S3; S4; S5). Participants noted knowing basic math was required. "You need to know adding, subtracting which hopefully by high school they even know multiplication and division" (S1). Also, S4 felt, "you would need to know your basic math skills." S1 stated, "it's basic and you just need to know the basic stuff". S2 indicated "they[students] are going to have to know the system of where you usually go and you do the parenthesis and then you divide and multiply and then you add and subtract."

S1 stated, "I would say more algebra, definitely geometry." While S3 also stated "I think you need a firm foundation on algebra, but also geometry and even some form of statistics." Additionally, S5 stated "going to need a little bit of algebra but probably not as much as you would the geometry type stuff." Also, participant S3 stated,

> I mean measuring that's algebra and even geometry, but like in your mechanic's class you use math a lot because of like in making the rafters you have to know the geometry and the area and all this physics stuff too, how much weight it can hold and geometry, pre-algebra, and algebra that would help."

Furthermore, S5 stated, "I think like basic algebra, basic geometry like you don't want to not have any understanding about those, because when you get in like you do a lot of angles in ag you do a lot of measurements." Participant S5 went as far to say "I think geometry is the most important."

Participants S4 and S5 felt students need to know how to use math to think critically and solve problems in agriculture. Agricultural education is not just knowing how to use equations, it requires students to break information a part and solve real problems using math (S4; S5). S5 stated, "I think you need to take more critical thinking math." While S3 and S4 mentioned some form of "statistics."

Lack of Mathematics Proficiency

Some participants displayed a lack of mathematics proficiency. S1 stated, "I've never taken a pre-cal class, so I don't know what all goes on in pre-cal." As indicated by S4,

> I have problems with math. I am very weak in math. I am one of those people that rely on a calculator to do math, and it is going to be very difficult to teach students math and expect them not to use one. So, I have to reteach myself in order to expect the same out of them."

In addition, S1 discussed being in a small animal care and not being taught mathematical concepts.

> I know when I was in small animal care we never talked really that much about how it was math and stuff. So, I guess the ag ed teachers need to just speak up more about the fact that they are doing math and relate it back because most of the time they don't know.

Furthermore, S5 commented, "I do feel like some of them [agriculture teachers] just skip over it [teaching mathematics]. Overall, participants discussed several areas of where they lacked mathematical proficiency because mathematics was not taught or emphasized in their agricultural education curriculum.

Lack of Awareness of Mathematics in the Curricula

Some participants did not possess an understanding of the common core mathematic standards. Participant S1 stated, "I don't know of any specific standard" and participant S5 stated "I couldn't tell you." Correspondingly, participant S5 stated, "as far as specific concepts go, don't really know any specific concepts." Statements like these were a common theme for all participants throughout the interview (S1; S2; S3; S4; S5).

"Honestly I do not know very much about the Tennessee mathematics standards" (S4). Additionally, participant S3 stated, "I honestly have not looked at just the regular Tennessee Mathematic standards, because we have been so focused on what core is in Tennessee. But, I do know that a lot of the Tennessee standards do match with the agriculture standards." Both participants were unfamiliar with Tennessee standards.

Conclusions and Discussion

Five themes emerged from the analysis: (a) mathematical importance in agriculture, (b) relevance to life, (c) mathematics skills required to teach school-based agricultural education, (d) lack of mathematics proficiency, and (e) lack of awareness of mathematics in the curricula. Participants recognized the importance of mathematics within the field of agriculture, with a majority of participants indicating that to be successful in agriculture you must incorporate mathematics into agricultural education classes. This concept aligns with the Association of Career and Technical Education (2006) assertion that agricultural education must stay true to its interdisciplinary nature, which allows for mathematics integration. In addition, participants stated agricultural education teachers taught some form of math in their agriculture courses, which supports Parr et al. (2008) confirmation of the value of teaching mathematics through and agricultural context. Furthermore, Dailey (2001) postulated that agricultural education has the potential to provide the concrete contexts required for students to make deeper associations with mathematics and the natural sciences, which appear to be lacking in the traditional mathematics classroom.

The participants recognized the relevance of mathematics in daily life. Two things were found in the participants' beliefs about the mathematics and how it is relevant to life: (a) the need to understand math to get through everyday life and (b) the need to demonstrate math concepts to be successful. Participants' recognizing the relevance of mathematics to daily life directly corresponds to Bandura's (1986) social cognitive theory, which proposed that learning is a lifelong developmental process influenced by (a) behavior, (b) personal factors, and (c) environment. Additionally, participants believed that the ability to perform mathematical calculations is a skill that students retain and can use throughout their life. According to Bandura (1986), behavior can be shaped and restricted by the personal characteristics and capabilities. However, according to Steen (2009) common complaints regarding the instruction of math in secondary schools center around the lack of real-world connections made between the math and everyday life, which indicates people do not recognize the relevance of mathematics when it is in an abstract form. Steen (2009) emphasized the importance of teaching mathematics in a contextual setting such as history or biology. As noted by participants in this study, agriculture provides a real-world context that may be used to bring mathematics concepts to life. Agricultural settings allow students to deeply explore the context in which the challenge or issue is embedded and allows the student to understand how mathematics can be used to solve the challenge or issue. Developing contextually-based mathematics courses would not only align with Parr et al's (2006) recommendation, but it would also help high school students to graduate with the capability to solve real-world problems (OECD, 2012). Similarly, the focus on mathematics in an agricultural classroom aligns with Moscovici and Newton's (2006) assertion that the integration of traditional subjects allows students to make deeper connections to the real-world.

Five factors related to teaching mathematics in school-based agricultural education were identified: (a) basic math, (b) algebra, (c) geometry, (d) critically thinking, and (e) statistics. However, according to PISA (2012), the United States ranks below average in mathematics on a worldwide scale. In addition, the United States ranked 27th out of the 34 countries surveyed (OECD, 2012). Being able to use basic math, algebra, geometry, critical thinking, and statistics is critical; however, it is not enough. According to Steen (2009), American's failure in mathematics could be attributed to the way it is taught. Therefore, how can we expect school-based agricultural education teachers to be proficient in math, if the education system which produced the teachers has failed them? In agreement with Parr et al. (2008), school-based agricultural education courses need to be designed to specifically teach mathematics through the context of agriculture, which would provide the opportunity for real-world connections and increased retention (Steen, 2009)

However, some participants were unaware of specific mathematical concepts found within the school-based agricultural education curricula. This is a directly linked to the following tenets of Bandura's social cognitive theory (1986); behavior, (defined in this study as future teaching practices), and is influenced by personal factors (as defined by perceptions of mathematics in agricultural education) as well as environment (as defined by the agricultural teacher education program). Explicit connections between mathematics and agriculture should be incorporated into the agricultural teacher preparation program.

To that end, Kennedy (1991) posited that there are too many factors involved in teacher preparation to implement one widespread fix. Different teaching methods and approaches should be taught in teacher preparation programs and based on state standards, in order to limit the lack of awareness of specific mathematical concepts found within the school-based agricultural education curricula. Kennedy (1991) also found the teaching methods teachers choose to use may be influenced by their understanding of the content, professional mentors, and the method in which they were certified to teach.

Furthermore, participants did not possess an understanding of the common core mathematic standards or the Tennessee mathematic standards. Findings from this study indicated preservice SBAEs are not prepared to teach mathematics concepts and need additional mathematics preparation as well as exposure to current mathematics standards they are expected to teach. This particular theme supports personal factors, which is defined in this study as perceptions of mathematics in agricultural education, is influenced by both behavior (as defined by future teaching practices) and environment (as defined the agricultural teacher education program). The assertion that preservice teachers are not prepared to teach mathematics concepts aligns with the findings from Stripling and Roberts (2012a, 2012b, 2013a, 2013b).

Recommendations

Participants recognized the importance of mathematics within the field of agriculture, but are not prepared to integrate mathematics into the high school classroom. Therefore, preservice agricultural teachers should consider enrolling in a university level applied mathematics course contextualized within agriculture. An applied mathematics course should help to prepare preservice agricultural teachers to teach mathematics in the SBAE classroom. Additionally, the creation of mathematics courses contextualized in agriculture for SBAE should be, developed and empirically tested across the United States. Further research should be conducted to evaluate both preservice and in-service agriculture teachers' mathematic abilities and their ability to effectively teach contextualized mathematics. Additionally, baseline data should be collected to determine how agriculture teachers across the United States are currently teaching mathematics.

References

Anderson, R. & Anderson, S. (2012). Emerging themes in integrating mathematics into agricultural education: A qualitative study of star teachers in Virginia. *Journal of Career and Technical Education, 27(*2), pp. 8-19. doi: 10.21061/jcte.v27i2.556

Association for Career and Technical Education. (2006). *Reinventing the American high school for the 21st century.* Alexandria, VA.

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

Birkenholz, R., & Simonsen, J. (2011). Characteristics of Distinguished Programs of Agricultural Education. *Journal of Agricultural Education*, *52*(3), 16-26. doi:10.5032/jae.2011.03016

Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process*. London, UK: SAGE Publications.

Creswell, J. W. (2013). *Qualitative inquiry and research design: Choosing among five traditions* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Dailey, A. L., Conroy, C. A., and Shelley-Tolbert, C. A. (2001). Using agricultural education as the context to teach life skills. *Journal of Agricultural Education, 42*(1), 11-20. doi: 10.5032/jae.2001.01011

Dooley, K. E. (2007). Viewing Agricultural Education Research through a Qualitative Lens. *Journal of Agricultural Education*, *48*(4), 32-42. doi: 10.5032/jae.2007.04032

Educational Testing Service. (2000). *How teaching matters: Bringing the classroom back to discussions of teacher quality.* Princeton, NJ: H.Wenglinsky.

Erlandson, D. A., Harris, E. L., Skipper, B. L., & Allen, S. D. (1993). *Doing naturalistic inquiry: A guide to methods.* Newbury Park, CA: Sage Publications.

Federico, G. (2005). *Feeding the world: An economic history of agriculture, 1800-2000.* Princeton, NJ: Princeton University Press.

Food and Agricultural Organizations of the United Nations (2009). *How to feed the world in 2050.* Rome: Commodity Policy and Projections Service.

Gustafsson, J-E. (2003), "What Do We Know About Effects of School Resources on Educational Results?", *Swedish Economic Policy Review*, 10, pp. 77-110.

Grbich, C., (2007). *Qualitative data analysis: An introduction.* Thousand Oaks, CA: Sage.

Kennedy, M. M. (1991). Some surprising findings on how teachers learn to teach. *Educational Leadership, (49)*3, 14-17.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry.* Newbury Park, CA: SAGE Publications.

Merriam, S. B. (2002). Introduction to qualitative research. *Qualitative research in practice: Examples for discussion and analysis*, 3-17.

Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation.* San Francisco, CA: Jossey-Bass.

Moscovici, H. and Newton, D. L. (2006). On my mind: Math and science: A natural connection? *National Council of Teachers of Mathematics*, *42*(8), 356-358.

Organization for Economic Cooperation and Development. (2006). T*eachers matter: Attracting, developing and retaining effective teachers.* OECD Publishing. http://dx.doi.org/10.1787/9789264018044-2-en

Organization for Economic Cooperation and Development. (2012). [Review of data for United States]. *Programme for international student assessment results from PISA 2012.* Retrieved from http://www.oecd.org/pisa/keyfindings/PISA-2012-results-US.pdf.

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

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

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

Shulman, L. (1991). Ways of seeing, ways of knowing, ways of teaching, ways of learning about teaching. *Journal of Curriculum Studies, 23* (5), pp. 393-395.

Stachler, W. M., Young, R. B., & Borr, M. (2013). Sustainability of professional development to enhance student achievement: A shift in the professional development paradigm. *Journal of Agricultural Education, 54*(4), 13–30. doi: 10.5032/jae.2013.04013

Steen, L.A., (2009). How mathematics counts. In Marge Scherer (Eds.) *Challenging the whole child: Reflections on best practices in learning, teaching and leadership* (63-74). Alexandria, VA: Association for Supervision and Curriculum Development.

Stone III, J.R., Alfeld, C., & Pearson, D. (2008). Rigor and relevance: Enhancing high school students' math skills through career and technical education. *American Educational Research Journal, (45)*3, 767-795.

Stripling, C. T., & Roberts, T. G. (2012a). Florida preservice agricultural education teachers' mathematics ability and efficacy. *Journal of Agricultural Education*, *53*(1), 109-122. doi:10.5032/jae.2012.01109

Stripling, C. T., & Roberts, T.G. (2012b). Preservice agricultural education teachers' mathematics ability. *Journal of Agricultural Education, 53*(3), 28-41. doi: 10.5032/jae.2012.03028

Stripling, C. T., & Roberts, T. G. (2013a). Effects of mathematics integration in a teaching methods course on self-efficacy of preservice agricultural education teachers. *Journal of Agricultural Education, 54*(2), 114-129. doi: 10.5032/jae.2013.02114

Stripling, C. T., & Roberts, T. G. (2013b). Investigating the effects of a math-enhanced agricultural teaching methods course. *Journal of Agricultural Education, 54*(1), 124-138. doi: 10.5032/jae.2013.01124

Stripling, C. T., Roberts, T. G., & Stephens, C. A. (2014). Mathematical strengths and weaknesses of preservice agricultural education teachers. *Journal of Agricultural Education, 55*(1), 24-37. doi: 10.5032/jae.2014.010124

National Research Council. (2009). *Transforming agricultural education for a changing world.* Washington D.C.: The National Academies Press.

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

United States Department of Education. (2012). *Investing in America's future: A blueprint for transforming career and technical education.* Washington, DC: Author.

Wayne, A. J. & Youngs, P. (2003). Teacher characteristics and student achievement gains: A review. *Review of Educational Research*, *73*(1), pp. 89-122.

Wenglinsky, H. (2002). How schools matter: The link between teacher classroom practices and student academic performance. *Education Policy Analysis Archives*, *10*(12). Retrieved 1/11/2016 from http://epaa.asu.edu/epaa/v10n12/