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Mathematics Efficacy and Professional Development Needs of Wyoming Agricultural Education Teachers

J. Chris Haynes[1] and Christopher T. Stripling[2]

Abstract

School-based agricultural education programs provide contextualized learning environments for the teaching of core academic subject matter. This study sought to examine the mathematics efficacy and professional development needs of Wyoming agricultural education teachers related to teaching contextualized mathematics. Wyoming agricultural education teachers were moderately efficacious in personal mathematics teaching efficacy and mathematics teaching outcome expectancy. Professional development needs varied based upon the teachers' self-efficacy scores. With that in mind, integrating mathematics concepts from the ACT college readiness assessment was found in the top five responses of all mathematics efficacy groups reported, while modifying instruction for special needs students was found in the top five responses in 3 out of 4 of the mathematics efficacy groups. Based on the results of this study, professional development related to teaching contextualized mathematics would benefit Wyoming's school-based agricultural education teachers and students.

Keywords: STEM, mathematics, math, mathematics efficacy, professional development

The National Research Council's (2007) publication, *Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future*, outlined U.S. concern of a decline in "the scientific and technological building blocks critical to our economic leadership" (p. 3). The National Research Council revisited these issues in 2010 and reported our position had degraded. The U.S. is considered to be a laggard in K-12 instruction in the industrialized world, costing more to educate our children for the future than other countries in the Organization for Economic Cooperation and Development (OECD; National Research Council, 2010). Currently, talent in science, technology, engineering, and math (STEM) related areas has shifted from the U.S. to Asian countries and soon the U.S. will not adequately provide a competent STEM workforce to meet the future needs of the nation (Taningco, Mathew, Pachon, & Tomas Rivera Policy Institute, 2008). With an increase in the current specialists in STEM occupations situated for retirement in the near future, this is a problem of considerable consequence for the economic security of the nation (Taningco et al., 2008; Zollman, 2012).

Researchers have opined that students in the U.S. are trailing behind their global counterparts in science and math competencies (Taningco et al., 2008). The 2012 *Programme for International Student Assessment* (PISA) determined that "just over one-quarter (26%) of 15-year-olds in the U.S. do not reach the PISA baseline Level 2 of mathematics proficiency" (OECD, 2013, p. 7). Moreover, Hanushek, Peterson, and Woessmann (2011) reported a percentage of U.S. students who are surpassing their peers and exceedingly proficient in mathematics, are still found as deficient when compared to OECD countries in the PISA math

[1] J. Chris Haynes is an Assistant Professor in the Department of Secondary Education/Agricultural Education at the University of Wyoming, McWhinnie Hall 114, Dept. 3374, 1000 E. University Ave., Laramie, WY 82071, Email: jhaynes4@uwyo.edu
[2] Christopher T. Stripling is an Assistant Professor in the Department of Agricultural Leadership, Education and Communications at the University of Tennessee, 320B Morgan Hall, 2621 Morgan Circle, Knoxville, TN 37996-4511, cstripling@utk.edu

examination. Additionally, U.S. students that are found to be excelling in content areas such as mathematics are lagging behind other countries entering STEM career occupations (Taningco et al., 2008). This is considerable cause for concern, since "maintaining our productivity as a nation depends importantly on developing a highly qualified cadre of scientists, engineers, entrepreneurs, and other professionals" (Hanushek, Peterson, & Woessmann, 2011, p. 11).

The U.S. trails top nations in OECD countries in measured mathematics competencies, but improvements in U.S. student scores have been made on international assessments in mathematics performance (Hanushek, Peterson, & Woessmann, 2011; Lewis, 1997). DiMaria (2007) reported scores on the *National Assessment of Educational Progress* (NAEP) in 2003 had increased considerably from the last analysis in 2000 in both fourth and eighth grades. Following that, results from the 2004 *Long-Term Trend NAEP* assessment showed promise "as scores rose to substantially higher levels than ever before" (DiMaria, 2007, p. 23). "What really matters is the quality of the day-to-day interaction between teachers and students around a coherent curriculum" (Lewis, 1997, p. 70). As such, a firm understanding of an adapted curriculum designed to increase academic performance and meet students' instructional needs could improve math performance in the U.S. (Vigdor, 2013).

Agricultural education is touted as a practical way to increase student learning in STEM areas (Jansen & Thompson, 2008; Phipps, Osborne, Dyer, & Ball, 2008), with mathematics competencies targeted as an area that can be emphasized and improved (Stripling & Roberts, 2012a, 2012b, 2013; Shinn et al., 2003). Teaching mathematics from a purely procedural stance is ineffective; students need an understanding of why math works (Oguntoyinbo, 2012). Romberg (1994) stated retention of core-educational concepts can be increased when taught through familiar contexts. As such, contextualized learning through agricultural education can be a viable learning tool for students, especially when presented in a rigorous, challenging curriculum (Baily, 1998; Nolin & Parr, 2013; United States Department of Education, 2010).

Jansen and Thompson (2008) contend preservice training in agricultural education needs to be rigorous and target interdisciplinary instruction. In 2012, the Perkins IV Act required career and technical education (CTE) teachers to emphasize and incorporate core-curricular content (i.e., science, technology, math, English, etc.) in their instruction (Stachler, Young, & Borr, 2013). Researchers have documented, that "an implementation of core academics into CTE curricula does not constitute a decrease in the degree and effectiveness of the CTE curricula itself or the students' course achievement (Stachler, Young, & Borr, 2013, p. 16), so in effect, math concepts can be emphasized in an agriculture curriculum without compromising course content (Parr, Edwards, & Leising, 2008; Young, Edwards, & Leising, 2009; Warnick & Thompson, 2007). As such, "teacher preparation and in-service education programs must be revised and expanded to develop more competent teachers" (National Research Council, 1988, pp. 6-7).

Research has asserted both preservice and in-service professional development for teachers is an important component to increasing student achievement in high stakes testing (DiMaria, 2007). Others have also identified professional development as an excellent way to enhance instruction and student success (Anderson, Barrick, & Hughes, 1992; Foster, Toma, & Troske, 2013). Moreover, a rigorous and well-planned professional development experience for both preservice and in-service CTE teachers holds potential to increase academic scores in students (Young, Edwards, & Leising, 2008, 2009; Stone, Alfeld, Pearson, Lewis, & Jensen, 2007). To that end, the importance of quality professional development opportunities for teachers cannot be underestimated, however professional development "that is content-focused, intensive, and sustainable" (Stachler, Young, & Borr, 2013, p. 14), while supporting STEM integration in CTE courses seldom exists (Birman et al., 2007). Doolittle and Camp (1999) stated knowledge is gained and shared among individuals as a result of active participation in social activities and self-reflective experiences, greatly increasing the effectiveness of professional development.

However, budgetary constraints of CTE teachers (Anderson, Barrick, & Hughes, 1992) are cause for concern in view of the increased funding required for professional development (Desimone, 2009).

Ingersoll (2003) indicated in "*Is there really a teacher shortage?"* that attrition accounts for almost half (46%) of all educators who do not complete their first five years in the classroom. Swanson and Huff (2010) proposed that an individual's self-perception of efficacy plays a large role in their personal expectations of whether they will succeed or fail; this awareness can have a positive or negative outcome on their motivation and personal goals (Tschannen-Moran, Woolfolk-Hoy, & Hoy, 1998). As educators become more entrenched in their instructional efficacy, the probability of changing their instructional beliefs becomes low (Bandura, 1997; Tschannen-Moran et al., 1998).

Research has recognized that the thought of taking mathematics courses can cause apprehension and concern for some students (Bates, Latham, & Kim, 2011), effectively lowering their self-efficacy. As mathematical self-efficacy and an individual's performance in math are correlated (Hackett & Bentz, 1989), it stands to reason a teacher's self-efficacy beliefs could motivate or potentially hinder student achievement in mathematics (Bandura, 1993). Persinger and Gliem (1987) reported agriculture teachers' mathematics ability scores were significantly related to the scores of their students. Preservice agricultural education teachers' self-efficacy beliefs related to teaching contextualized mathematics are no different, with the need for increased mathematics preparation and skills development necessary before the residency experience (Bates et al., 2011; Jansen and Thompson, 2008). Professional development for both preservice and in-service teachers should be developed to build upon and positively develop agricultural educators' self-efficacy and competency in mathematics (Stripling & Roberts, 2012a).

Theoretical Framework

This study utilizes the theoretical framework of Bandura's social cognitive theory (Bandura, 1986). Bandura (1986) stated social cognitive theory takes into consideration changes that occur cognitively in one's lifetime. Social interaction is purported to be responsible for the development of most cognitive skills as an individual develops (Bandura, 1986). Bandura asserted human behavior is predisposed by psychological factors experienced during their life, as well as their personal experiences gained, both direct and observational. Andersen and Chen (2002) proposed that interpersonal character is comprised of experiences obtained and realized through everyday interaction both at work and play. These experiences are "retained in neural codes, rather than being provided ready-made by inborn programming" (Bandura, 1986, p. 22), and can be manipulated by significant others (i.e., spouses, parents, brothers, sisters) as well as individuals outside of the family unit, such as friends, colleagues, and co-workers. Therefore, the aforementioned social interactions can have an effect on individual experiences (Andersen & Chen, 2002).

Bandura (1997) stated "social cognitive theory encompasses a large set of factors that operate as regulators and motivators of established cognitive, social, and behavioral skills" (p. 35). Bandura's (1986) model of triadic reciprocality suggests that "behavior, cognitive and other personal factors, and environmental events all operate as interacting determinants of each other" (p. 18). However, the strengths of the influences of the determinants may differ (Bandura, 1986). Stripling and Roberts (2013) operationalized the use of the triadic reciprocality in *Investigating the Effects of a Math-Enhanced Agricultural Teaching Methods Course,* as follows, "behavior is the teaching of contextualized mathematics, external environment is the teacher education program, and personal factors are self-efficacy and mathematics ability" (p. 138). For purposes of this study, the model has been amended such that the external environment reflects professional development instead of the teacher education program (Figure 1).

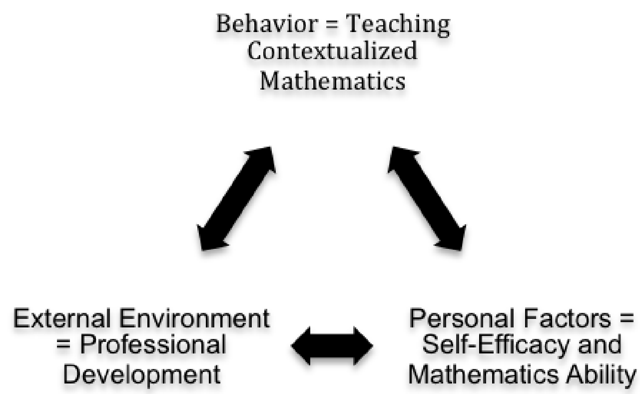

Figure 1. Triadic reciprocality model. Adapted from Bandura (1986).

Behavior – Teaching Contextualized Mathematics

Teaching contextualized mathematics through agricultural education has been part of the call for increased academic rigor and content through CTE (National Commission on Excellence in Education, 1983). Taylor and Mulhall (1997) established that instruction of contextualized mathematics through agriculture provides relevance for learning, while potentially strengthening connections between school and community learning environments (Cawelti, 1999; Taylor & Mulhall, 1997).

To that end, a semester-length study focusing on effects of a mathematics-enhanced curriculum by Parr, Edwards, and Leising (2006) found an agricultural power and technology (APT) course did "significantly affect ($p < .05$) student performance on a mathematics placement test used to determine a student's need for mathematics remediation at the postsecondary level" (p. 89). Recommendations espoused the need for further implementation of this research over longer periods of time (Parr, Edwards, & Leising, 2006). As such, a year-long study by Young, Edwards, and Leising (2008) sought to determine if a contextualized mathematics-enhanced curriculum in an APT course would have an effect on student knowledge of mathematical concepts. Students receiving the experimental curriculum when compared to students receiving a traditional course realized practical significance in scores over the control group (Young, Edwards, & Leising, 2008). Additionally, Young, Edward, and Leising (2009) desired to know if a mathematics-enhanced curriculum in an APT course would have an effect on student technical aptitude of the content. Research including 32 high school APT courses was conducted to test the hypothesis, and the Oklahoma Department of CTE online agricultural mechanics competency exam was utilized. Young et al., (2009) determined "that within this population, a math-enhanced APT curriculum and aligned instructional approach did not significantly diminish ($p < .05$) students' attainment of technical skills in APT" (p. 123).

Personal Factors

Self-efficacy. According to Bandura (1994), self-efficacy is "people's beliefs about their capabilities to produce designated levels of performance that exercise influence over events that affect their lives" (p. 1). Self-efficacy, particularly teacher self-efficacy, can have an impact upon student achievement (Tschannen-Moran & Hoy, 2001). According to Woolfolk (2007), teacher self-efficacy is "a teacher's belief that he or she can reach even difficult students to help them learn" (p. 334). Teacher self-efficacy "appears to be one of the few personal characteristics of teachers correlated with student achievement" (p. 334). Teacher self-efficacy has been directly related to "the extent to which teachers believe they can affect student learning" (Dembo &

Gibson, 1985, p. 1). This effect on student learning can have a positive or negative outcome upon the content knowledge and academic success of the student (Tschannen-Moran & Hoy, 2001), and is a pronounced contributor to teacher effectiveness (Friedman & Kass, 2002).

Knobloch and Whittington (2003), sought to determine how the first ten-weeks of the school year influenced teacher self-efficacy in agricultural education. They discovered first year teachers experienced a drop in self-efficacy throughout their initial 10 weeks of the academic year, with no change occurring between both residency period preservice teachers, and in-service teachers in their second and third year (Knobloch & Whittington, 2003). Group analysis indicated the largest inconsistency in teacher self-efficacy occurring between the preservice and first year in-service teachers. Preservice teachers experienced the highest level of efficacy, while first year teachers experienced the lowest. Bandura (1994) postulated that in order to build self-efficacy, mastery experience was essential for success, as “successes build a robust belief in one’s efficacy” (Bandura, 2004, p. 3).

Self-efficacy studies conducted with both preservice and in-service agricultural educators regarding instruction of contextualized mathematics (Jansen & Thompson, 2008; Miller & Gliem, 1994, 1996; Persinger & Gliem, 1987; Stripling & Roberts, 2012a, 2012b, 2013; Swan, Moore, & Echevarria, 2008) has revealed varying levels of self-efficacy. Since the Michigan State University Center for Research in Mathematics and Science Education (2010) has stated that students of teachers lacking in mathematical ability are found to be deficient themselves in mathematical concepts, improvement of professional development designed to bolster skills of both preservice and in-service teachers in contextualized mathematics is important to the mathematical competencies and success of our students (Sullivan, 1999).

Mathematics ability. Deficiencies exist in the content knowledge of the nations’ teachers in mathematics (Liu, Rosenstein, Swan, & Khalil, 2008; Oguntoyinbo, 2012; Stewart, 2002). Moreover, a substantial amount of research (Adams, 1998; Ball & Wilson, 1990; Even, 1990; Miller & Gliem, 1996; Wilburne & Long, 2010) as well as Stripling and Roberts (2012a, 2012b, 2013, in press) indicates this problem exists amid both core content and agricultural education preservice teachers similarly, contributing to student academic deficiencies (Sullivan, 1999). Stewart (2002) stated that although improvement has been made across all grade levels, this success is credited principally to elementary level achievement, as mathematics scores on the secondary level have declined. Haycock (as cited in Stewart, 2002) stated “you don’t have to look at the research very long to see that falling short in one area relates to failure in others” (p. 14). Moreover, Haycock (as cited in Stewart, 2002) went on to say

> the short supply of mathematically proficient teachers hampers our efforts to dramatically raise student achievement, which in turn, produces fewer college students interested in entering math fields, leading to a smaller supply of math majors, especially math majors who want to become teachers. It’s a dangerous downward spiral. (p. 14)

Stripling and Roberts (2012b) stated a mathematics examination used to evaluate competency levels of the nation’s preservice teachers uncovered an average score of 38.5% on the assessment, supporting the assumptions of Liu et al. (2008) that institutions of higher education are not providing a sufficient number of knowledgeable educators with a mathematics background adequate to teach mathematics. More specifically, Stripling, Roberts and Stephens (2014) found the nation’s preservice teachers were not proficient in 10 of 13 nationally cross-referenced agricultural mathematics standards and called for research to investigate why and to find the most appropriate strategies for increasing relevant mathematics subject matter knowledge.

External Environment – Professional Development

An absence of sustained professional development opportunities for both preservice and in-service teachers has been documented as contributing to deficient student learning (Darling-Hammond, 1996). New educational objectives increasingly incorporated in agricultural education, especially in science and mathematics, have emphasized a need for extensive, high quality professional development in this area, designed to contribute to the success of both the teacher and the academic success of the student (Jansen & Thompson, 2008).

Wilson and Flowers (2002) sought to describe and compare teacher self-efficacy of those participating in either a zero, five, or seven day professional development treatment "in teaching agricultural biotechnology skills, controversial issues, and content" (p. 132). This quasi-experimental study found no statistically significant differences in self-efficacy between those attending the five or seven day training. Conversely, a statistically significant difference existed between those participating in professional development and those not receiving the treatment (Wilson & Flowers, 2002). To that end, there was a statistically significant increase in self-efficacy related to instruction of the curriculum and associated agricultural biotechnology skills. Wilson and Flowers recommended training for teachers should exist in agricultural biotechnology curriculum integration and the rigorous application of hands-on laboratory experiences. Similarly, Young (2006) purported a direct relationship exists between high quality professional development and the academic success of students. With an increase in teacher support seen as necessary to successful integration and emphasis of core academic content in agricultural education (Ulmer et al., 2013; Wilson & Curry, 2011), the significance of this research cannot be underestimated.

Purpose and Objectives

The purpose of this study was to examine the mathematics efficacy and professional development needs of Wyoming agricultural education teachers related to teaching contextualized mathematics. The following objectives framed this study:

1. Describe the personal mathematics teaching efficacy of Wyoming agricultural education teachers.
2. Describe the mathematics teaching outcome expectancy of Wyoming agricultural education teachers.
3. Determine the professional development needs of Wyoming agricultural education teachers related to teaching contextualized mathematics.
4. Describe the differences, if any exist, in professional development needs related to teaching contextualized mathematics based upon personal mathematics teaching efficacy and mathematics teaching outcome expectancy.

Methods

The research design for this descriptive study was a one-shot case study (Campbell & Stanley, 1963), which was conceptualized as a slice in time (Oliver & Hinkle, 1982). The target population was all school-based agricultural education teachers (N = 53) in Wyoming. Contact information for all 53 Wyoming agricultural education teachers was provided by the Wyoming FFA State Advisor. Data were collected during the fall 2013 semester using the Qualtrics online survey platform. Dillman, Smyth, and Christian's (2009) web survey implementation procedures guided the multiple contacts made with the agricultural education teachers. Dillman et al. stated little research exists on the optimal combination of contacts and suggested additional contacts are not needed when responses per contact stalls. Thus, six emails were sent to the entire target population: (a) pre-notice, (b) email with a link to the survey, (c) three reminder emails with a link to the survey, and a (d) final email with a link to the survey announcing the end of the study. Data were collected from 33 (62.3%) agricultural education teachers. Data from two agricultural education teachers were excluded from the study due to missing data. Thus, the exclusion of two teachers resulted in a sample size of 31 or 58% of the target population. Since a 100% response rate was not achieved, to examine the external validity of the results to the target population, we compared early to late respondents (Ary, Jacobs, Sorensen, & Walker, 2014) on all items and compared respondents to the target population for the only known demographic variable – gender. Chi-square tests or Fisher's exact tests were utilized for nominal data and MANOVA was used for interval data. We would like to note, the small sample size, a product of a small target population, limits statistical power when comparing early to late respondents. Therefore, early respondents were considered the first 16 to respond, and late respondents the final 15 to respond.

The sample was representative of the target population regarding gender. One significant difference was found when comparing early and late respondents; respondents differed in how often they taught mathematics concepts in their agricultural education classes (p = .05). Late respondents were more likely to report teaching mathematics *every day* or *several times a month*, and early respondents were more likely to report teaching mathematics *several times a week*. Thus, the implications of the differences were mixed, and we believe there is no practical significance. Furthermore, significant differences were not found for the following variables when comparing early and late respondents: (a) gender, (b) age, (c) ethnicity, (d) years of teaching experience, (e) like or dislike of mathematics, (f) grade level taught, (g) highest degree obtained, (h) highest level of mathematics successfully completed in high school, and (i) highest level of mathematics successfully completed in college. Based on these findings, the sample appears unbiased and representative of the target population; therefore, we believe the results of this study are generalizable to the target population.

The *Mathematics Teaching Efficacy Beliefs Instrument* (MTEBI; Enochs, Smith, & Huinker, 2000) and a researcher-developed questionnaire were used to collect data. The MTEBI (Enochs et al., 2000) is comprised of two scales that measure the constructs personal mathematics teaching efficacy (PMTE) and mathematics teaching outcome expectancy (MTOE). Based on Enochs, Smith, and Huinker (2000), PMTE is defined as self-belief in one's ability to teach mathematics, and MTOE is defined as one's ability to bring about a desired learning outcome as a result of mathematics instruction. The PMTE scale consists of 13 items, and the MTOE scale consists of 8 items. All items use a 5-point rating scale (1 = *strongly disagree* to 5 = *strongly agree*). The following item was modified by removing the word elementary: "I understand mathematics concepts well enough to be effective in teaching elementary mathematics" (Enochs et al., 2000, p. 201). Enochs et al. reported confirmatory factor analysis indicated the two constructs were independent. Additionally, Enochs et al. stated reliability analysis produced Cronbach's alpha coefficients of .88 for PMTE and .75 for MTOE. Construct scores were calculated by computing a summated mean of corresponding items after reverse coding items 3, 6, 8, 15, 17, 18, 19, and 21. Post-hoc reliabilities for PMTE and MTOE were .87 and .72, respectively. These measures of internal-consistency are acceptable give the nature of the constructs and present reliabilities on comparable measures (Ary et al., 2014).

The researcher-developed questionnaire consisted of 33 items. Twenty items asked teachers to provide their perceived levels of knowledge and relevance on competencies related to teaching contextualized mathematics or math embedded in the Wyoming agricultural education career pathways. Knowledge and relevance items were measured using a 5-point rating scale (1 = *low knowledge* or *relevance* and 5 = *high knowledge* or *relevance*). Post-hoc reliability was assessed for the aforementioned items using Cronhach's alpha (α = .96). The remaining 13 items consisted of 10 demographic questions and three survey questions related to professional development delivery preferences, like or dislike for mathematics, and how often the participants taught mathematics concepts. Face and content validity was established by an expert panel consisting of three agricultural education faculty and two high school agricultural education teachers. Based on the recommendations of the expert panel, one item was revised for clarity.

Data were analyzed using IBM SPSS version 20. Descriptive statistics (i.e., frequencies, percentages, and means) were used to describe the demographic and mathematics efficacy data. Additionally, based on Enochs et al. (2000), low, moderate, and high self-efficacy was defined as

1.00 to 2.33, 2.34 to 3.67, and 3.68 to 5, respectively. To describe the professional development needs, mean weighted discrepancy scores (MWDS; Borich, 1980) were used.

Findings

Objective 1: Describe the Personal Mathematics Teaching Efficacy of Wyoming Agricultural Education Teachers

The summated mean for PMTE was 3.56 (*SD* = 0.48) with a range of 2.46 to 4.38 on a 5-point scale. Sixteen of the agricultural education teachers (51.6%) possessed moderate PMTE, and 15 (48.4%) possessed high PMTE. None of the agricultural education teachers possessed low personal mathematics teaching efficacy (Table 1).

Objective 2: Describe the Mathematics Teaching Outcome Expectancy of Wyoming Agricultural Education Teachers

The summated mean for MTOE was 3.49 (*SD* = 0.49) with a range of 2.50 to 4.45 on a 5-point scale. Nineteen (61.3%) of the agricultural education teachers possessed moderate MTOE, and 12 (38.7%) possessed high MTOE. None of the agricultural education teachers possessed low mathematics teaching outcome expectancy (Table 1).

Table 1

Mathematics Efficacy Scores

			Low		*Moderate*		*High*	
Scale	*M*	*SD*	*f*	%	*f*	%	*f*	%
Personal Mathematics Teaching Efficacy	3.56	0.48	0	0.0	16	51.6	15	48.4
Mathematics Teaching Outcome Expectancy	3.49	0.49	0	0.0	19	61.3	12	38.7

Note. 1.00 to 2.33 = *low efficacy*, 2.34 to 3.67 = *moderate efficacy*, 3.68 to 5 = *high efficacy*.

Objective 3: Determine the Professional Development Needs of Wyoming Agricultural Education Teachers Related to Teaching Contextualized Mathematics

The top five rated professional development items were (a) *integrating math content from the ACT into agricultural instruction* (*MWDS* = 1.94), (b) *modifying math instruction for special needs students* (*MWDS* = 1.77), (c) *locating and selecting reference materials related to math instruction* (*MWDS* = 1.32), (d) *teaching math concepts embedded in the plant science pathway* (*MWDS* = 1.29), and (e) *teaching math concepts embedded in the natural resource management pathway* (*MWDS* = 1.10). The professional development items MWDS ranged from –0.86 to 1.94. A complete list of professional development items and MWDS are found in Table 2.

Table 2

Professional Development Mean Weighted Discrepancy Scores

	Knowledge		Relevance		
Item	*M*	*SD*	*M*	*SD*	*MWDS*
Integrating math content from the ACT into agricultural instruction	2.64	0.95	3.24	1.05	1.94
Modifying math instruction for special needs students	2.60	0.87	3.16	0.90	1.77
Locating and selecting reference materials related to math instruction	2.74	1.18	3.17	1.03	1.32
Teaching math concepts embedded in the plant science pathway	3.35	1.11	3.70	1.15	1.29
Teaching math concepts embedded in the natural resource management pathway	3.48	1.04	3.78	1.00	1.10
Designing curricula that utilize agriculture as a context for teaching math concepts	3.20	1.32	3.48	0.92	0.97
Utilizing the common core math standards in agricultural instruction	3.04	1.02	3.32	0.69	0.93
Motivating students to learn math concepts embedded in the agriculture and natural resources cluster	3.48	0.96	3.72	0.98	0.89
Developing lesson plans that utilize agriculture as a context for teaching math concepts	3.36	1.08	3.56	0.87	0.71
Teaching math concepts in laboratory settings (ex. Land lab, greenhouse, garden, ag mechanics lab, etc.)	3.83	0.94	3.96	1.07	0.48
Teaching math concepts using instructional technology	3.08	0.86	3.16	0.99	0.25
Teaching math concepts embedded in the agriculture business pathway	3.89	0.97	3.91	1.04	0.16
Teaching math concepts embedded in the animal science pathway	3.78	1.00	3.83	1.11	0.15
Collaborating with math teachers	2.84	1.21	2.88	1.20	0.13
Collaborating with other agriculture teachers related to math instruction	3.04	1.14	3.04	1.21	0.00
Teaching math concepts embedded in the agricultural mechanics pathway	3.39	1.12	3.39	1.37	0.00
Teaching personal financial management	4.00	0.90	4.00	0.90	0.00
Teaching SAE financial record-keeping	4.09	1.04	4.04	1.02	-0.18
Teaching math concepts embedded in career development events	3.87	1.01	3.83	1.11	-0.38
Utilizing agriculture as a context for teaching math concepts	3.84	0.90	3.60	0.82	-0.86

Objective 4: Describe the Differences, If Any Exist, in Professional Development Needs Related to Teaching Contextualized Mathematics Based Upon Personal Mathematics Teaching Efficacy and Mathematics Teaching Outcome Expectancy.

Similarities and differences were present in mathematics professional development needs based upon Wyoming agricultural education teachers' PMTE and MTOE. The top five rated professional development items for each group (high/moderate PMTE and high/moderate MTOE) are presented in Table 3. One item was rated in the top five of all groups – *Integrating math content from the ACT into agricultural instruction*. One item was found in the top five of every group except moderate PMTE – *Modifying math instruction for special needs students*. Three items were only found in the moderate groups – (a) *utilizing the common core math standards in agricultural instruction*, (b) l*ocating and selecting reference materials related to math instruction*, and (c) *developing lesson plans that utilize agriculture as a context for teaching math concepts*. *Designing curricula that utilize agriculture as a context for teaching math concepts* was only found in the moderate PMTE group. In regard to high efficacy, two items were found only in the high groups – (a) *Teaching math concepts embedded in the plant science pathway* and (b) *teaching math concepts embedded in the natural resource management pathway*. Lastly, one item was only found in the high PMTE group (*motivating students to learn math concepts embedded in the agriculture and natural resources cluster*), and one item in the high MTOE group (*collaborating with math teachers*).

Table 3

Difference in Professional Development Needs Based Upon Mathematics Efficacy

Group	Item	*MWDS*
Moderate PMTE	Utilizing the common core math standards in agricultural instruction	2.55
	Integrating math content from the ACT into agricultural instruction	2.49
	Locating and selecting reference materials related to math instruction	2.44
	Developing lesson plans that utilize agriculture as a context for teaching math concepts	1.92
	Designing curricula that utilize agriculture as a context for teaching math concepts	1.87
High PMTE	Teaching math concepts embedded in the plant science pathway	1.85
	Modifying math instruction for special needs students	1.84
	Integrating math content from the ACT into agricultural instruction	1.35
	Teaching math concepts embedded in the natural resource management pathway	0.69
	Motivating students to learn math concepts embedded in the agriculture and natural resources cluster	0.31
Moderate MTOE	Locating and selecting reference materials related to math instruction	1.48
	Utilizing the common core math standards in agricultural instruction	1.33
	Integrating math content from the ACT into agricultural instruction	1.30
	Modifying math instruction for special needs students	1.26
	Developing lesson plans that utilize agriculture as a context for teaching math concepts	1.19
High MTOE	Integrating math content from the ACT into agricultural instruction	2.92
	Modifying math instruction for special needs students	2.53
	Teaching math concepts embedded in the natural resource management pathway	2.52
	Teaching math concepts embedded in the plant science pathway	1.64
	Collaborating with math teachers	1.28

Conclusions and Recommendations

A majority of Wyoming agricultural education teachers were moderately efficacious in personal mathematics teaching efficacy, which is not consistent with Jansen and Thompson (2008) and Swan, Moore, and Echevarria (2008). These studies reported agricultural education teachers were very efficacious or completely confident in their ability to teach mathematics concepts. However, 48.4% of the agricultural education teachers in this study were highly efficacious. This suggests there are approximately an equal number of agricultural education teachers in Wyoming with high or moderate personal mathematics teaching efficacy. According to Bandura (1997), self-efficacy influences behavior. Thus, theoretically, being highly efficacious in PMTE should positively impact the teaching of contextualized mathematics in Wyoming's school-based agricultural education programs; on the other hand, being moderately efficacious may negatively impact the teaching of contextualized mathematics, potentially contributing to attrition rates as posited by Ingersoll (2003). Future research should be conducted to determine why approximately an equal number of teachers are moderately or highly efficacious in PMTE, and determine if moderate self-efficacy negatively impacts the teaching of contextualized mathematics. Insight into the development of PMTE would aid in the planning of professional development for agricultural education teachers, in turn, leading to increased student achievement and success as postulated by DiMaria (2007), Anderson, Barrick, and Hughes (1992), and Foster, Toma, and Troske (2013). Additionally, this information would be valuable to teacher educators in modifying/designing teacher education curricula and experiences, helping to deter low self-efficacy levels of first year in-service teachers as found by Knobloch and Whittington (2003).

In regard to mathematics teaching outcome expectancy, a majority of the agricultural education teachers were moderately efficacious in MTOE. We were unable to find any literature that examined the MTOE of agricultural education teachers, and thus we were unable to compare our finding with prior research. As a result, research is warranted to investigate the MTOE of both preservice and in-service agricultural education teachers. Research should also be conducted to understand the development of MTOE and determine why Wyoming agricultural education teachers are moderately efficacious in MTOE. This research is vital since self-efficacy influences behavior (Bandura, 1997). Theoretically, being moderately efficacious in MTOE may negatively impact the teaching of contextualized mathematics found in the Wyoming agricultural education curricula. The aforementioned research will also aid the planning of professional development for agricultural education teachers and can be used to guide experiences offered in agricultural teacher education programs.

To that end, the professional development needs varied based upon the teachers' PMTE and MTOE. Integrating mathematics concepts from the ACT was found in the top five of all the mathematics efficacy groups. Modifying instruction for special needs students was found in the top five of 3 out of 4 mathematics efficacy groups. We recommend professional development related to the mathematics concepts from the ACT and modifying instruction for special needs students are offered in Wyoming. Congruently, research is needed to evaluate this professional development and determine the most effective design and format. Additionally, based upon the results of this study, teachers with moderate efficacy would benefit from professional development related to common core mathematics, locating and selecting mathematics reference material, and designing lesson plans that utilize agriculture as a context for teaching mathematics found naturally in the Wyoming secondary curricula. Teachers with high efficacy would benefit from professional development on teaching specific mathematics concepts found in the natural resource management and plant science pathways, collaborating with math teachers, and motivating students to learn mathematics found in the agriculture and natural resources curricula. These findings suggest teachers with moderate efficacy are more concerned with procedural elements or task (e.g., locating reference material, developing lesson plans) of teaching contextualized mathematics, and high efficacy teachers are more concerned with improving pedagogical content knowledge and collaborating with math teachers. Future research should seek to determine if other populations of agricultural education teachers possess similar beliefs and professional development should be tailored accordingly. To that end, Bandura (1997) purported the external environment influences behavior. Thus, in the context of this study, professional development in the aforementioned areas should positively influence the teaching of contextualized mathematics in Wyoming. Future research should seek to quantify the effect of professional development on PMTE and MTOE. Research related to the teaching of contextualized mathematics, mathematics efficacy, and mathematics professional development may prove to be invaluable in developing school-based agricultural education teachers and preservice agricultural education teachers that are prepared to teach the mathematics concepts found naturally in the agricultural curricula, developing students' competence in STEM, and closing the gap on international assessments in mathematics.

In summary, research is needed to investigate the development of mathematics self-efficacy in agricultural education teachers. To that end, the mathematics self-efficacy of Wyoming agricultural education teachers can be improved. Since professional development needs varied based on mathematics self-efficacy, professional development in Wyoming should be tailored to maximize the effect of professional development on the agricultural education teachers' mathematics competence and student achievement.

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