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Examining Teachers' Agricultural Mechanics Professional Development Needs: A National Study

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Abstract

Agricultural mechanics remains prominent in many school-based agricultural education (SBAE) programs. SBAE teachers need a wide range of knowledge and skills to competently teach agricultural mechanics. A lack of teacher competence can create issues within educational settings. Teacher competence can be improved through effective professional development (PD). Understanding PD needs as they relate to agricultural mechanics is crucial to help ensure teachers are as competent as realistically possible. We underpinned our study via human capital theory (HCT) as we sought to describe SBAE teachers' agricultural mechanics PD needs. Through an electronic instrument constructed using Borich's (1980) needs assessment model, we sought to collect data from 374 randomly sampled SBAE teachers from across the United States. Three hundred and sixty-four teachers received our instrument and 100 teachers responded, yielding a response rate of 27.5%. Using mean weighted discrepancy scores (MWDS), we found teachers have the greatest agricultural mechanics PD needs in: (1) American Welding Society (AWS) standards for welding procedures, (2) Use of electrical measurement units (ex. amperes, volts, Ohms, etc.), and (3) Principles of metallurgy (ex. identifying metals, proper use of metals, etc.). To help improve teachers' competence in agricultural mechanics, we recommend various approaches emphasizing agricultural mechanics knowledge and skill development be undertaken by SBAE stakeholders.

Keywords: agricultural mechanics; professional development

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Introduction

Adequately administering school-based agricultural education (SBAE) programs requires a diversity of characteristics on the part of SBAE teachers (Eck et al., 2019; Roberts & Dyer, 2004). SBAE teachers are responsible for providing high-quality, immersive learning experiences that prepare students for opportunities in the agricultural industry (Phipps et al., 2008). As such, SBAE teachers frequently use laboratories to engage students in technical agriculture subject matter (Shoulders & Myers, 2012). Used to complement classroom-based instruction, laboratory instruction has a rich history within SBAE programs (Twenter & Edwards, 2017). Examples of laboratories used in SBAE programs include greenhouses, row crop plots, and agricultural mechanics facilities (Phipps et al., 2008; Shoulders & Myers, 2012; Wells et al., 2018).

Agricultural mechanics laboratories are among the most frequently used facilities in SBAE programs (Shoulders & Myers, 2012). Agricultural mechanics laboratories support a wide range of

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teaching and learning opportunities in SBAE programs (Wells et al., 2018), such as providing space for students to plan, build, and finish agriculturally-oriented projects and allowing students to work with supervised agricultural experience (SAE) projects (Doss et al., 2019). Appropriate use of agricultural mechanics facilities in SBAE programs can generate considerable economic impacts for communities (Hanagriff et al., 2014). Agricultural mechanics laboratories provide an appropriate setting for teaching and learning in agricultural mechanics courses (Saucier et al., 2014).

Agricultural mechanics courses are traditionally taught within many SBAE programs (Burris et al., 2005; Phipps et al., 2008) and are popular choices for many students (Valdez & Johnson, 2020). Teaching agricultural mechanics courses requires that SBAE teachers have knowledge and skills in numerous topics, such as maintaining power equipment, teaching students how to properly perform welding procedures, and safely performing agricultural mechanics activities (Albritton & Roberts, 2020; Hainline & Wells, 2019). Scholars (Chumbley et al., 2018; Dyer & Andreasen, 1999; McKim & Saucier, 2011a; McKim & Saucier, 2012; Saucier et al., 2014) have indicated SBAE teachers must competently provide safe environments for effective agricultural mechanics instruction to take place. Tummons et al. (2017) noted pre-service teachers have concerns regarding their competence to safely lead agricultural mechanics instruction and minimize liability issues. Teacher competence is multi-faceted and is vital for the development of professional teachers who can create positive changes and impactful experiences for others (Malm, 2009). In the context of effective agricultural mechanics instruction, teacher competence is paramount for providing safe, informative, and effective educational opportunities for students (Albritton & Roberts, 2020; Hainline & Wells, 2019; Pate et al., 2012; Shultz et al., 2014; Swafford & Hagler, 2018).

Considering the need for teacher competence, a stark reality facing SBAE teachers is teacher liability. Teachers have many tasks, including using good judgment within their instructional practices and ensuring students in their care can interact within the learning environment safely (McDaniel, 2020). As indicated by Hainline et al. (2019), SBAE teachers face a battery of issues related to teacher liability, which can be amplified considerably when considering the structure, content, and teaching and learning processes used in agricultural mechanics courses. While presenting opportunities for hands-on, minds-on teaching and learning, laboratory-based courses such as agricultural mechanics can inadvertently present chances for injuries to students, damage to tools, equipment, and facilities, and legal issues for teachers to occur, particularly if teachers lack adequate training regarding their subject matter (Love, 2013). Scholars (Love & Roy, 2017; Schimmel & Militello, 2007) further noted the lack of adequate teacher training can create liability issues. Myers et al. (2005) identified knowledge about teacher liability as a problem for SBAE teachers, which can potentially create issues for laboratory instruction.

Teacher liability issues in laboratory-based courses have been studied for decades. Purvis et al. (1986) indicated teachers can minimize liability concerns by simply being attentive to their learning environments and ensuring students are adequately prepared to perform required tasks. Dyer and Andreasen (1999) concluded teachers often "support the concept of laboratory safety [but] many fail to fully implement safety guidelines and practices to the extent warranted by the hazards present… [thereby resulting in] increased danger to both students and teachers, and increased liability to teachers" (p. 50). Interestingly, teachers sometimes avoid laboratory activities altogether due to liability concerns (Zirkle & Barnes, 2011). Zirkle (2017) expressed teachers must be attentive to the inherent risks their teaching and learning environments bear and must competently perform their professional duties.

Love (2013) noted proactive measures (e.g., ensuring SBAE teachers are competent in their subject matter, recognizing hazards before they become accidents, etc.) can help mitigate potential liability issues. Teacher competence can be developed and improved upon through methods such as professional development (PD) and is a key factor in helping to ensure teachers can safely and adequately provide instruction in agricultural mechanics (Albritton & Roberts, 2020; Hainline & Wells, 2019; Saucier et al., 2014) while helping avoid potential legal issues (Hainline et al., 2019). Considering these ideas, closer examination of PD through the lens of improving SBAE teacher competence in agricultural mechanics is warranted.

Guskey and Huberman (1995) expressed teacher PD is important for improving educational outcomes. Darling-Hammond et al. (2017) described effective PD as "structured professional learning that results in changes to teacher knowledge and practices, and improvements in student learning outcomes" (p. 2). Darling-Hammond et al. (2017) further indicated professional learning is "a product of both externally provided and job-embedded activities that increase teachers' knowledge and help them change their instructional practice in ways that support student learning" (p. 2). Teacher PD is thus part of the professional learning process contributing to the growth of teachers and to student achievement. Harwell (2003) noted effective teacher PD is characterized by several traits, including deepening teachers' subject matter knowledge and maintaining pace with current practices both educationally and within the subject matter area. Teacher PD should intentionally be designed to improve teacher competence to help positively impact students' success (Darling-Hammond et al., 2017; Harwell, 2003). Needs assessments can be used to identify PD needs (DiBendetto et al., 2018) and "can prove to be a valuable tool to collect teacher input and determine priority area needs for teacher professional development to assist in pinpointing the content focus" (p. 64).

In the interest of improving professional practice and ultimately student learning outcomes, SBAE teachers should be prepared to take advantage of PD opportunities available to them. PD helps ensure SBAE teachers are competent and knowledgeable (Grieman, 2010). Phipps et al. (2008) suggested SBAE teachers should regularly engage in PD opportunities to enhance their competence and improve learning opportunities and impacts for SBAE students. As adult learners, teachers are capable of directing their own professional growth and development (Beavers, 2009). Easterly and Myers (2017) found SBAE teachers often sought PD related to their instructional foci, such as agricultural mechanics, animal science, and horticultural science. Shoulders and Myers (2014) indicated PD can help promote change within SBAE teachers themselves. While Touchstone (2015) opined relevant PD could help retain SBAE teachers within the profession, Sorensen et al. (2014) found teachers' PD needs can differ based upon experience level.

SBAE teachers' specific PD needs have been the focus of several studies in recent years. Scholars (Clemons et al., 2018; Figland et al., 2019; Smalley et al., 2019; Stair et al., 2019) have recently and consistently identified SBAE teachers have numerous PD needs across different parts of the United States. Further, each of these scholars found teachers have at least some need for agricultural mechanics PD. As agricultural mechanics is popular in many SBAE programs (Burris et al., 2005) and is usually laboratory-based, teachers must provide safe and functional teaching and learning environments for their students (Chumbley et al., 2018; Dyer & Andreasen, 1999; Saucier et al., 2014); thus, teachers should have at least some competence in agricultural mechanics (Albritton & Roberts, 2020; Hainline & Wells, 2019; Shultz et al., 2014).

Teachers face a myriad of liability issues throughout their professional careers (Hainline et al., 2019; Love, 2013; Zirkle, 2017). Because PD can help improve teacher competence (Darling-Hammond et al., 2017), which can thereby help reduce liability issues in the instructional environment (Love, 2013; Zirkle, 2017), SBAE teachers' agricultural mechanics PD needs should be examined more deeply. There are limited recent national-level data focused on identifying SBAE teachers' specific agricultural mechanics PD needs. As part of a larger effort to address agricultural mechanics instruction within SBAE programs, our study was intended to help provide these data and fill this literature gap.

Theoretical Framework

We used human capital theory (HCT) to underpin our study. HCT indicates a well-trained, capable workforce is a crucial element of a functional society (Becker, 1993; Olaniyan & Okemakinde, 2008). Conceptually, HCT explains that over time individuals acquire various characteristics including education, experience, and specialized training yielding valuable returns to individuals and society at large (Becker, 1993). Further, Becker (1993) argued "[e]ducation and training are the most important investments in human capital" (p. 17), supporting the notion of continual investment in professional growth and development. As PD is designed to improve teacher competence and add value to the educational system (Darling-Hammond et al., 2017), PD can be considered an investment in human capital. HCT has supported prior agricultural education research (e.g., Eck et al., 2019; Robinson & Baker, 2013).

Within our study, HCT helped frame the need for determining SBAE teachers' PD needs in agricultural mechanics. Prior literature indicated a need for effective PD for SBAE teachers (Thoron et al., 2016). Effective PD helps improve teacher competence (Darling-Hammond et al., 2017), which in turn helps limit liability issues (Love, 2013) present when teaching agricultural mechanics (Dyer & Andreasen, 1999; Saucier et al., 2014; Tummons et al., 2017). In addition to providing rigorous and relevant learning opportunities, SBAE teachers must also be prepared to deal with threats to life, limb, and property in the day-to-day teaching of agricultural mechanics courses (Hainline et al., 2019; Hainline & Wells, 2019), which can include but is certainly not limited to cuts, bruises, broken bones, loss of body parts, damage to tools and equipment, and theft of school property. Prepared, competent SBAE teachers are less likely to create liability issues for themselves and others (Hainline et al., 2019) and can more robustly contribute to the purposes of SBAE programs (Albritton & Roberts, 2020), which in turn help create human capital for the agricultural industry (Stripling & Ricketts, 2016).

Purpose

The purpose of our study was to describe the agricultural mechanics PD needs of SBAE teachers across the United States. Our study aligns with Research Priority 5 of the American Association for Agricultural Education (AAAE) National Research Agenda (NRA): Efficient and Effective Agricultural Education Programs (Thoron et al., 2016). In particular, our study sought to help heed the call to identify PD needs for agricultural education professionals in the context of agricultural mechanics within SBAE programs. Understanding specific agricultural mechanics PD needs can help chart the course for improving teacher competence in technical agriculture subject matter.

Methods

We used Borich's (1980) needs assessment model to help structure our study. Agricultural education scholars (e.g., Clemons et al., 2018; Shultz et al., 2014) have previously incorporated Borich's (1980) model to study SBAE teachers' PD needs. We solicited a panel of seven agricultural teacher educators to review and advise on the validity of our instrument coupled with a pilot study with SBAE teachers in Iowa to determine the reliability of the *Importance* and *Competence* scales we used. Afterward, we used our instrument to conduct a national study.

Instrumentation

The final version of our instrument included 72 items. Seven items were related to teacher demographics and contained a mixture of multiple-choice and open-ended responses. The 65 needs assessment items addressed various agricultural mechanics topics (e.g., *Procedures for laying out projects*, *Use of computer numerical control (CNC) systems*, etc.). We used the list of agricultural mechanics knowledge and skills needed by SBAE teachers ascertained by Hainline and Wells (2019) to help establish the needs assessment items used in our study. A coupled set of five-point scales were included for each needs assessment item. For each item, respondents were asked to indicate the importance (1 = *Not important* [*NI*], 2 = *Of little importance* [*LI*], 3 = *Somewhat important* [*SI*], 4 = *Important* [*I*], 5 = *Very important* [*VI*]) to teach each agricultural mechanics topic within SBAE programs and to then assess their perceived competence (1 = *Not competent* [*NC*], 2 = *Little competence* [*LC*], 3 = *Somewhat competent* [*SC*], 4 = *Competent* [*C*], 5 = *Very competent* [*VC*]) to teach each agricultural mechanics topic.

Validity and Reliability

During the Fall 2019 semester, we consulted a panel of seven agricultural teacher educators at seven universities across the United States to critique and assess the validity of our instrument. Each panel member was intentionally selected to bring diverse, unique perspectives and experiences related to agricultural mechanics. Panel member one was a professor at a land-grant university and had prior experience researching agricultural mechanics in the context of teacher preparation. Panel member two was an assistant professor at a land-grant university and taught agricultural mechanics courses at his university. Panel member three was an associate professor at a land-grant university and taught both an agricultural mechanics course and a teaching methods in agricultural education laboratories course there.

Panel member four was a professor at a land-grant university. He taught agricultural mechanics courses at the secondary level and has chaired committees for graduate students who focused their research around agricultural mechanics-related topics. Panel member five was a professor at a land-grant university. He taught agricultural mechanics courses at his university and has previously researched agricultural mechanics in SBAE settings. Panel member six was an assistant professor at a regional university. He taught agricultural mechanics courses at the secondary level, taught an agricultural mechanics course for pre-service teachers, and has studied the agricultural mechanics knowledge and skill needs of SBAE teachers. Panel member seven was an associate professor at a land-grant university. He previously taught agricultural mechanics at the secondary and university levels and taught a methods of teaching in agricultural education laboratories course at his institution.

We contacted each panel member via e-mail and provided them with a copy of the instrument and a panel of experts form. The panel of experts form contained detailed instructions about the instrument. We requested each panel member assess the instrument for content validity and face validity. We instructed each panel member to complete the panel of experts form and return it to us via e-mail along with detailed feedback about the instrument and how to improve it prior to use. Panel members indicated our instrument would be suitable for our study if their recommendations were undertaken. We subsequently made adjustments to the instrument based on their feedback (e.g., reworded items as suggested, discarded unnecessary items, combined similar items together, etc.), which yielded the final 72-item instrument. Our instrument was thus content valid, face valid, and ready to proceed to the pilot study stage.

Pilot Study

We conducted a pilot study to assess the reliability of the *Importance* and *Competence* scales used within the 65-item needs assessment portion of our instrument. We conducted our pilot study during the Fall 2019 semester as a census study with all 287 SBAE teachers in Iowa. Per the recommendations of Dillman et al. (2014), we used multiple contacts and incentives (i.e., five $20.00 gift cards drawn at random) to solicit participants for our pilot study. Five e-mail contacts sent via Qualtrics were used: (1) a pre-notice about the study sent on Tuesday, November 19, 2019, (2) an initial invitation to participate in the study sent on Tuesday, November 26, 2019, (3) the first reminder sent on Tuesday, December 3, 2019, (4) the second reminder sent on Tuesday, December 10, 2019, and (5), the third and final reminder sent on Tuesday, December 17, 2019. E-mails to two teachers bounced, reducing the total number of potential respondents to 285. Pilot study data collection ceased on Tuesday, December 24, 2019.

Seventy SBAE teachers responded to our pilot study instrument, yielding a response rate of 24.4%. We used Cronbach's alpha coefficients to assess the reliability of the *Importance* and *Competence* scales within the 65-item needs assessment portion of our instrument. A post-hoc reliability assessment yielded Cronbach's alpha coefficients for the *Importance* (α = .97) and *Competence* (α = .98) scales, which were deemed to be acceptable levels of reliability in accordance with the interpretations provided by George and Mallery (2003). After our pilot study concluded and we deemed the scales used in our instrument reliable, we conducted our formal study during the Spring 2020 semester.

Sample

The target population for our formal study was comprised of all SBAE teachers in the United States in the 2019-2020 academic year. According to Nina Crutchfield, the South Central Local Program Success Specialist at the National FFA Organization, there were 13,471 SBAE teachers in the United States during the 2019-2020 academic year (personal communication, March 24, 2020). Provided by the National FFA Organization at our request, we used a probabilistic sample of 374 SBAE teachers from across the United States. The sample size was calculated based on Dillman et al.'s (2014) probability sampling calculator (acceptable amount of sampling error = ±5% of the true population; Z statistic associated with confidence level = 1.96, 95% level), which follows Krejcie and Morgan's (1970) formula.

Data Collection

During our formal study, we used Qualtrics to send five e-mail contacts to SBAE teachers. E-mails to 10 teachers bounced (failure rate = 2.6%), reducing the total number of potential respondents to 364. Per the recommendations of Dillman et al. (2014), multiple contacts and incentives (i.e., 10 $20.00 gift cards drawn at random) were used to help elicit responses. The five e-mail contacts included: (1) a pre-notice about the study sent on Wednesday, April 22, 2020, (2) an initial invitation to participate in the study sent on Monday, April 27, 2020, (3) the first reminder sent on Monday, May 4, 2020, (4) the second reminder sent on Monday, May 11, 2020, and (5), the third and final reminder sent on Monday, May 18, 2020. Data collection ceased on Wednesday, May 27, 2020.

One hundred SBAE teachers responded to our instrument during the formal study, yielding a response rate of 27.5%. Recent national studies (Sherman & Sorensen, 2020; Sorensen et al., 2017) have had similar response rates (26.8% and 30.08%, respectively). After the conclusion of the formal study, we elected to reassess the reliability of the *Importance* and *Competence* scales within the 65-item needs assessment portion of our instrument and used Cronbach's alpha coefficients to do so. A post-hoc reliability assessment yielded Cronbach's alpha coefficients for the *Importance* (α = .99) and *Competence* (α = .99) scales, which we once again deemed to be acceptable levels of reliability in accordance with the interpretations provided by George and Mallery (2003).

Data Analysis

We used the IBM® Statistical Package for the Social Sciences (SPSS©) Version 25 software to analyze our data. To address nonresponse error, we compared early respondents to late respondents in accordance with the recommendations of Lindner et al. (2001). Teachers who responded before the first reminder email sent on Monday, May 4, 2020 ($n = 50$) were considered early respondents while teachers who responded on or after Monday, May 4, 2020 ($n = 50$) were considered late respondents. We used an independent samples t-test to compare responses on all *Competence* scale items. No statistically significant differences ($t(98) = -1.41$, $p = .16$) between the groups were identified.

We used descriptive statistics (i.e., frequencies and percentages) to analyze data regarding demographic characteristics of the SBAE teachers. We used descriptive statistics (i.e., frequencies, modes, medians, means, and standard deviations) to analyze the SBAE teachers' perceived importance to teach and perceived competence to teach each agricultural mechanics topic. We set real limits (RL; 1 [RL = 0 – 1.49], 2 [RL = 1.50 – 2.49], 3 [RL = 2.50 – 3.49], 4 [RL = 3.50 – 4.49], 5 [RL = 4.50 – 5.00]) to aid the interpretation of measures of central tendency derived from the scale items.

We operationalized SBAE teachers' perceived PD needs by calculating mean weighted discrepancy scores (MWDS) for the 65 needs assessment items. We used the Excel-based MWDS Calculator (McKim & Saucier, 2011b) to calculate discrepancy scores (DS), weighted discrepancy scores (WDS), and MWDS for our study. The Excel-based MWDS calculator served to expedite the analysis of MWDS and mitigated user error (McKim & Saucier, 2011b). We placed the 65 needs assessment items in descending order based on their MWDS to rank teachers' perceived PD needs. Similar to prior needs assessment studies (Blickenstaff et al., 2015; Harder & Wingenbach, 2008), we interpreted needs assessment items with positive MWDS as areas in which PD was needed. Conversely, we interpreted items with a negative MWDS as signifying no need for PD associated with these items. Moreover, we considered the items with greater MWDS to represent areas with higher priority for PD (Sorensen et al., 2014; Ward, 2018).

Results

The typical respondent had taught agricultural mechanics coursework in an SBAE program during any of the last three years ($f = 67$; 67%), had previously worked in the agricultural industry prior to their current agricultural education teaching position ($f = 66$; 66%), had taught agricultural education for an average of 10.40 ($SD = 9.81$) academic years, and obtained agricultural education teacher certification via an undergraduate-level teacher preparation program ($f = 61$; 61%; see Table 1).

Table 1
SBAE Teacher Demographics

Item	*f*	%
Including this academic year, have you taught agricultural mechanics coursework in an agricultural education program during any of the past three academic years? (*n* = 100)		
Yes	67	67.0
No	33	33.0
Prior to your current agricultural education teaching position, did you previously work in the agricultural industry? (*n* = 100)		
Yes	66	66.0
No	34	34.0
Including this academic year, how many years have you have been teaching agricultural education? (*n* = 97)		
1-5	41	42.3
6-10	21	21.6
11-15	12	12.4
16-20	9	9.3
21-25	4	4.1
26-30	3	3.1
31-35	5	5.2
36-40	2	2.1
Which of the following best describes how you obtained your agricultural education teacher certification? (*n* = 100)		
Undergraduate-level teacher preparation program	61	61.0
Began teaching agricultural education after working in industry	15	15.0
Graduate-level teacher preparation program	13	13.0
Began teaching agricultural education after teaching another content area	7	7.0
Alternative teacher certification (post-baccalaureate)	4	4.0

We reported responses to the 65 needs assessment items within the *Importance* scale in Table 2. The responses with the highest modes for each item are bolded. Sixteen items had a mode of five (*VI*), 45 items had a mode of four (*I*), three items had a mode of three (*SI*), and one item, *Procedures for hot metalworking cutting*, had a mode of three (*SI*) and four (*I*). The item with the highest percentage of *very important* responses was *Use of personal protective equipment (PPE)* (*VI*: 94.1%, *f* = 80, *Md* = 5). Moreover, items such as *Safety procedures for agricultural mechanics activities* (*VI*: 92.9%, *f* = 79, *Md* = 5), *Use of measuring tools (ex. tape measure, framing square, etc.)* (*VI*: 86.8%, *f* = 79, *Md* = 5), *Use of laboratory safety equipment (ex. fire extinguishers, eye wash stations, etc.)* (*VI*: 85.9%, *f* = 73, *Md* = 5), *Use of hand tools (ex. screwdriver, hammer, etc.)* (*VI*: 73.6%, *f* = 67, *Md* = 5), and *Use of handheld power tools (ex. cordless drill, jig saw, etc.)* (*VI*: 73.3%, *f* = 66, *Md* = 5) were perceived to be *very important* by a majority of SBAE teachers in our study.

Table 2
SBAE Teachers' Perceived Importance to Teach Agricultural Mechanics

		%						
Item	*n*	*NI*	*LI*	*SI*	*I*	*VI*	*Mdn*	*Md*
Use of personal protective equipment (PPE)	85	1.2	0.0	1.2	3.5	**94.1**	5	5

Table 2
SBAE Teachers' Perceived Importance to Teach Agricultural Mechanics, Continued…

Safety procedures for agricultural mechanics activities	85	1.2	0.0	1.2	4.7	**92.9**	5	5
Use of measuring tools (ex. tape measure, framing square, etc.)	91	2.2	0.0	1.1	9.9	**86.8**	5	5
Use of laboratory safety equipment (ex. fire extinguishers, eye wash stations, etc.)	85	1.2	0.0	1.2	11.8	**85.9**	5	5
Use of hand tools (ex. screwdriver, hammer, etc.)	91	2.2	1.1	4.4	18.7	**73.6**	5	5
Use of handheld power tools (ex. cordless drill, jig saw, etc.)	90	2.2	0.0	4.4	20.0	**73.3**	5	5
Use of fasteners (ex. screws, nails, glue, etc.)	89	2.2	1.1	12.4	33.7	**50.6**	5	5
Principles of electrical theory (ex. conductors, insulators, alternating current [AC], direct current [DC], etc.)	90	1.1	0.0	8.9	40.0	**50.0**	5	5
Procedures for wiring outlets	90	1.1	0.0	10.0	38.9	**50.0**	5	5
Use of stationary power equipment (ex. band saw, table saw, etc.)	94	3.2	0.0	11.7	37.2	**47.9**	4	5
Procedures for GMAW (MIG welding)	90	1.1	1.1	13.3	36.7	**47.8**	4	5
Use of electrical systems tools (ex. digital multi-meter, wire strippers, etc.)	90	1.1	0.0	10.0	43.3	**45.6**	4	5
Procedures for wiring single-pole switch circuits	90	1.1	0.0	10.0	43.3	**45.6**	4	5
Use of electrical measurement units (ex. amperes, volts, Ohms, etc.)	90	1.1	0.0	12.2	41.1	**45.6**	4	5
Procedures for troubleshooting small engines	90	1.1	0.0	13.3	42.2	**43.3**	4	5
Procedures for SMAW (Arc welding)	90	1.1	1.1	14.4	41.1	**42.2**	4	5
Procedures for laying out projects	83	3.6	1.2	4.8	**56.6**	33.7	4	4
Procedures for using PVC pipe	91	2.2	3.3	11.0	**54.9**	28.6	4	4
Drawing project plans to scale	83	3.6	2.4	19.3	**54.2**	20.5	4	4
Procedures for building wood projects	92	3.2	1.1	7.6	**48.9**	39.1	4	4
Procedures for agricultural equipment operation	90	1.1	0.0	12.2	**48.9**	37.7	4	4
Procedures for oxy-fuel cutting	90	1.1	1.1	15.6	**47.8**	34.4	4	4
Procedures for cold metalworking cutting	90	1.1	4.4	32.2	**47.8**	14.4	4	4
Estimating materials for projects	82	3.7	0.0	3.7	**47.6**	45.1	4	4
Procedures for plasma arc cutting	89	1.1	2.2	13.5	**47.2**	36.0	4	4
Procedures for building metal projects (ex. trailers, barbecue pits, etc.)	89	1.1	1.1	18.0	**47.2**	32.6	4	4
Procedures for cold metalworking shaping	90	1.1	6.7	32.2	**46.7**	13.3	4	4
Procedures for structural welding	89	1.1	3.4	19.1	**46.1**	30.3	4	4
Use of marking tools (ex. chalk line, paint marker, etc.)	91	2.2	2.2	10.0	**45.1**	40.7	4	4
Principles of four-stroke engine operational theory	91	1.1	0.0	18.7	**45.1**	35.2	4	4
Creating a bill of materials for projects	82	3.7	0.0	8.5	**45.1**	42.7	4	4
Interpreting project blueprints	82	3.7	2.4	14.6	**45.1**	34.1	4	4
Principles of welding theory (ex. joint types, positions, etc.)	90	1.1	2.2	11.1	**44.4**	41.1	4	4

Table 2
SBAE Teachers' Perceived Importance to Teach Agricultural Mechanics, Continued…

Procedures for reassembling small engines	90	1.1	0.0	21.1	**44.4**	33.3	4	4
Procedures for disassembling small engines	90	1.1	0.0	22.2	**44.4**	32.2	4	4
American Welding Society (AWS) standards for welding procedures	90	1.1	1.1	21.1	**44.4**	32.2	4	4
Procedures for GTAW (TIG welding)	90	1.1	3.3	24.4	**44.4**	26.7	4	4
Procedures for using PEX pipe	90	3.3	4.4	27.8	**44.4**	20.0	4	4
Procedures for using legal land descriptions	87	3.4	5.7	26.4	**43.7**	20.7	4	4
Procedures for building masonry projects	92	2.2	8.7	26.1	**43.5**	19.6	4	4
Principles of metallurgy (ex. identifying metals, proper use of metals, etc.)	90	1.1	1.1	20.0	**43.3**	34.4	4	4
Procedures for cold metalworking bending	90	1.1	5.6	33.3	**43.3**	16.7	4	4
Principles of two-stroke engine operational theory	91	1.1	2.2	17.6	**42.9**	36.3	4	4
Procedures for painting projects	89	3.4	5.6	19.1	**41.6**	30.3	4	4
Procedures for FCAW (Flux-core arc welding)	89	2.2	4.5	36.0	**40.5**	16.9	4	4
Procedures for using copper pipe	91	3.3	6.6	34.1	**40.0**	16.5	4	4
Procedures for wiring double-pole switch circuits	90	1.1	2.2	26.7	**40.0**	30.0	4	4
Procedures for wiring trailer electrical systems	90	1.1	3.3	25.6	**40.0**	30.0	4	4
Procedures for oxy-fuel brazing	89	2.2	4.5	36.0	**39.3**	18.0	4	4
Procedures for building fence projects	92	2.2	2.2	30.4	**39.1**	26.1	4	4
Use of handheld pneumatic (air) tools (ex. impact wrench, paint spray gun, etc.)	94	3.2	1.1	28.7	**38.3**	28.7	4	4
Procedures for wiring three-way switch circuits	90	1.1	1.1	28.9	**37.8**	31.1	4	4
Procedures for wiring four-way switch circuits	90	1.1	4.4	34.4	**37.8**	22.2	4	4
Principles of vehicle powertrain operational theory	91	1.1	4.4	30.0	**37.4**	27.5	4	4
Use of hydraulic equipment (ex. shears, iron worker, etc.)	94	3.2	5.3	29.8	**37.2**	24.5	4	4
Use of computer numerical control (CNC) systems	94	3.2	9.6	28.7	**37.2**	21.3	4	4
Procedures for using unmanned aerial vehicles in land surveying	87	3.5	8.0	34.5	**36.8**	17.2	4	4
Procedures for oxy-fuel welding	90	2.2	5.6	33.3	**36.7**	22.2	4	4
Principles of diesel engine operational theory	91	1.1	1.1	28.6	**36.3**	33.0	4	4
Procedures for conducting land surveys	87	2.3	10.3	34.5	**35.6**	17.2	4	4
Use of precision tools (ex. micrometer, dial caliper, etc.)	91	3.3	1.1	26.4	**35.2**	34.1	4	4
Procedures for hot metalworking shaping	90	1.1	6.7	**40.0**	36.7	15.6	4	3
Procedures for hot metalworking bending	90	1.1	6.7	**38.9**	37.8	15.6	4	3
Procedures for hot metalworking cutting	90	1.1	6.7	**37.8**	**37.8**	16.7	4	3 / 4
Procedures for using land surveying equipment	87	3.0	11.5	**36.8**	32.2	17.2	3	3

Note. Importance scale: 1 = *Not important* (*NI*), 2 = *Of little importance* (*LI*), 3 = *Somewhat important* (*SI*), 4 = *Important* (*I*), 5 = *Very important* (*VI*); *Mdn* = Median; *Md* = Mode.

The four items with the lowest modes were *Procedures for hot metalworking shaping* (*SI*: 40.0%, f = 36, *Md* = 3), *Procedures for hot metalworking bending* (*SI*: 38.9%, f = 35, *Md* = 3), *Procedures for hot metalworking cutting* (*SI* / *I*: 37.8%, *f* = 34, *Md* = 3 / 4), and *Procedures for using land surveying equipment* (*SI*: 36.8%, *f* = 32, *Md* = 3).

We reported responses to the 65 needs assessment items within the *Competence* scale in Table 3. The responses with the highest modes for each item are bolded. Nine items had a mode of five (*VC*), 25 items had a mode of four (*C*), 16 items had a mode of three (*SC*), two items had a mode of two (*LC*), and 12 had a mode of one (*NC*). One item, *Use of computer numerical control (CNC) systems*, had two modes (i.e., *SC*: 28.7%, *f* = 27, *Md* = 3; *LC*: 28.7%, *f* = 27, *Md* = 2).

The item with the highest percentage of *very competent* responses was *Use of personal protective equipment (PPE)* (*VC*: 62.4%, *f* = 53, *Md* = 5). A majority of SBAE teachers also perceived themselves to be very competent with *Use of hand tools (ex. screwdriver, hammer, etc.)* (*VC*: 56.0%, *f* = 51, *Md* = 5), *Use of measuring tools (ex. tape measure, framing square, etc.)* (*VC*: 53.8%, *f* = 49, *Md* = 5), and *Use of laboratory safety equipment (ex. fire extinguishers, eye wash stations, etc.)* (*VC*: 51.8%, *f* = 44, *Md* = 5).

Table 3
SBAE Teachers' Perceived Competence to Teach Agricultural Mechanics

		%						
Item	*n*	*NC*	*LC*	*SC*	*C*	*VC*	*Mdn*	*Md*
Use of personal protective equipment (PPE)	85	0.0	0.0	10.6	27.1	**62.4**	5	5
Use of hand tools (ex. screwdriver, hammer, etc.)	91	0.0	1.1	8.8	34.1	**56.0**	5	5
Use of measuring tools (ex. tape measure, framing square, etc.)	91	0.0	2.2	6.6	37.4	**53.8**	5	5
Use of laboratory safety equipment (ex. fire extinguishers, eye wash stations, etc.)	85	0.0	0.0	11.8	36.5	**51.8**	5	5
Use of handheld power tools (ex. cordless drill, jig saw, etc.)	90	0.0	2.2	14.4	34.4	**48.9**	4	5
Safety procedures for agricultural mechanics activities	85	0.0	2.4	16.5	35.3	**45.9**	4	5
Procedures for SMAW (Arc welding)	90	13.3	12.2	16.7	27.8	**30.0**	4	5
Procedures for oxy-fuel cutting	90	17.8	14.4	11.1	27.8	**28.9**	4	5
Procedures for GMAW (MIG welding)	90	17.8	11.1	16.7	25.6	**28.9**	4	5
Use of fasteners (ex. screws, nails, glue, etc.)	89	1.1	1.1	19.1	**46.1**	32.6	4	4
Procedures for painting projects	89	1.1	9.0	14.6	**44.9**	30.3	4	4
Use of marking tools (ex. chalk line, paint marker, etc.)	91	0.0	4.4	11.0	**42.9**	41.8	4	4
Estimating materials for projects	82	2.4	6.1	22.0	**42.7**	26.8	4	4
Creating a bill of materials for projects	82	2.4	3.7	23.2	**41.5**	29.3	4	4
Procedures for laying out projects	83	2.4	7.2	33.7	**39.8**	16.9	4	4
Use of stationary power equipment (ex. band saw, table saw, etc.)	94	3.2	10.6	13.8	**38.3**	34.0	4	4
Procedures for building wood projects	92	1.1	5.4	21.7	**38.0**	33.7	4	4
Procedures for wiring single-pole switch circuits	90	17.8	13.3	16.7	**35.6**	16.7	4	4
Use of handheld pneumatic (air) tools (ex. impact wrench, paint spray gun, etc.)	94	6.4	15.0	18.1	**35.1**	25.5	4	4
Drawing project plans to scale	83	2.4	14.5	31.3	**34.9**	16.9	4	4
Use of electrical systems tools (ex. digital multi-meter, wire strippers, etc.)	90	18.9	13.3	20.0	**34.4**	13.3	3	4
Procedures for building fence projects	92	4.3	11.0	22.8	**32.6**	29.3	4	4

Table 3
SBAE Teachers' Perceived Competence to Teach Agricultural Mechanics, Continued…

Principles of welding theory (ex. joint types, positions, etc.)	90	16.7	13.3	20.0	**32.2**	17.8	4	4
Procedures for wiring outlets	90	17.8	14.4	17.8	**32.2**	17.8	4	4
Procedures for agricultural equipment operation	90	16.7	7.8	26.7	**32.2**	16.7	3	4
Procedures for using PVC pipe	91	5.5	7.7	24.2	**31.9**	30.8	4	4
Principles of electrical theory (ex. conductors, insulators, alternating current [AC], direct current [DC], etc.)	90	14.4	15.6	23.3	**31.1**	15.6	3	4
Principles of two-stroke engine operational theory	91	18.7	13.2	23.1	**30.0**	15.4	3	4
Procedures for troubleshooting small engines	90	24.4	10.0	21.1	**30.0**	14.4	3	4
Principles of four-stroke engine operational theory	91	20.0	12.1	23.1	**28.6**	16.5	3	4
Procedures for plasma arc cutting	89	22.5	13.5	13.5	**28.1**	22.5	4	4
Procedures for building metal projects (ex. trailers, barbecue pits, etc.)	89	23.6	16.9	15.7	**25.8**	18.0	3	4
Procedures for disassembling small engines	90	18.9	16.7	21.1	**25.6**	17.8	3	4
Procedures for reassembling small engines	90	21.1	14.4	21.1	**25.6**	17.8	3	4
Interpreting project blueprints	82	2.4	13.4	**42.7**	29.3	12.2	3	3
Use of precision tools (ex. micrometer, dial caliper, etc.)	91	6.6	7.7	**36.3**	29.7	19.8	3	3
Use of hydraulic equipment (ex. shears, iron worker, etc.)	94	12.8	21.4	**36.2**	19.2	12.8	3	3
Procedures for building masonry projects	92	10.9	20.7	**35.9**	22.8	9.8	3	3
Procedures for using copper pipe	91	15.4	18.7	**33.0**	18.7	14.3	3	3
Procedures for wiring double-pole switch circuits	90	23.3	13.3	**32.2**	18.9	12.2	3	3
Procedures for conducting land surveys	87	19.5	25.3	**32.2**	17.2	5.7	3	3
Procedures for using PEX pipe	90	15.6	23.3	**30.0**	21.1	10.0	3	3
Procedures for using land surveying equipment	87	21.8	25.3	**29.9**	17.2	5.7	3	3
Procedures for wiring three-way switch circuits	90	23.3	15.6	**28.9**	20.0	12.2	3	3
Principles of metallurgy (ex. identifying metals, proper use of metals, etc.)	90	21.1	20.0	**28.9**	21.1	8.9	3	3
Use of electrical measurement units (ex. amperes, volts, Ohms, etc.)	90	14.4	18.9	**27.8**	26.7	12.2	3	3
American Welding Society (AWS) standards for welding procedures	90	25.6	17.8	**27.8**	21.1	7.8	3	3
Procedures for wiring four-way switch circuits	90	25.6	18.9	**27.8**	20.0	7.8	3	3
Procedures for oxy-fuel brazing	89	22.5	21.3	**25.8**	14.6	15.7	3	3
Procedures for using legal land descriptions	87	21.8	19.5	**23.0**	21.8	13.8	3	3
Procedures for GTAW (TIG welding)	90	17.8	**35.6**	22.2	17.8	6.7	2	2
Use of computer numerical control (CNC) systems	94	26.6	**28.7**	**28.7**	12.8	3.2	2	2 / 3
Principles of vehicle powertrain operational theory	91	22.0	**28.6**	25.3	16.5	7.7	2	2
Procedures for hot metalworking cutting	90	**32.2**	22.2	14.4	22.2	8.9	2	1
Procedures for hot metalworking bending	90	**32.2**	20.0	17.8	21.1	8.9	2	1
Procedures for hot metalworking shaping	90	**32.2**	24.4	14.4	22.2	6.7	2	1

Table 3
SBAE Teachers' Perceived Competence to Teach Agricultural Mechanics, Continued…

Procedures for using unmanned aerial vehicles in land surveying	87	**32.2**	27.6	29.9	8.0	2.3	2	1
Procedures for cold metalworking shaping	90	**31.1**	25.6	17.8	18.9	6.7	2	1
Procedures for cold metalworking bending	90	**31.1**	23.3	18.9	21.1	5.6	2	1
Procedures for cold metalworking cutting	90	**28.9**	23.3	20.0	18.9	8.9	2	1
Procedures for structural welding	89	**29.2**	13.5	25.8	20.2	11.2	3	1
Procedures for wiring trailer electrical systems	90	**26.7**	17.8	18.9	22.2	14.4	3	1
Procedures for FCAW (Flux-core arc welding)	89	**25.8**	21.3	20.2	22.5	10.1	3	1
Principles of diesel engine operational theory	91	**25.3**	**25.3**	17.6	23.1	8.8	2	1
Procedures for oxy-fuel welding	90	**24.4**	20.0	17.8	22.2	15.6	3	1

Note. Competence scale: 1 = *Not competent* (*NC*), 2 = *Little competence* (*LC*), 3 = *Somewhat competent* (*SC*), 4 = *Competent* (*C*), 5 = *Very competent* (*VC*); *Mdn* = Median; *Md* = Mode.

Twelve needs assessment items had a mode of one (*NC*). Greater than 30% of the SBAE teachers who responded to our instrument reported being *not competent* on six of the 12 items. The four items with the highest percentages of *not competent* (*Md* = 1) responses were *Procedures for hot metalworking cutting* (*NC*: 32.2%, *f* = 29), *Procedures for hot metalworking bending* (*NC*: 32.2%, *f* = 29), *Procedures for hot metalworking shaping* (*NC*: 32.2%, *f* = 29), and *Procedures for using unmanned aerial vehicles in land surveying* (*NC*: 32.2%, *f* = 28).

We reported agricultural mechanics PD needs by MWDS in Table 4. The five highest PD needs for SBAE teachers were: (1) *American Welding Society (AWS) standards for welding procedures* (MWDS = 5.59), (2) *Use of electrical measurement units (ex. amperes, volts, Ohms, etc.)* (MWDS = 5.45), (3) *Principles of metallurgy (ex. identifying metals, proper use of metals, etc.)* (MWDS = 5.41), (4) *Procedures for troubleshooting small engines* (MWDS = 5.40), and (5) *Principles of diesel engine operational theory* (MWDS = 5.35).

Table 4
SBAE Teachers' Agricultural Mechanics Professional Development Needs by MWDS

				Importance		Competence	
Item	*n*	Rank	*MWDS*	*M*	*SD*	*M*	*SD*
American Welding Society (AWS) standards for welding procedures	90	1	5.59	4.06	0.83	2.68	1.28
Use of electrical measurement units (ex. amperes, volts, Ohms, etc.)	90	2	5.45	4.30	0.77	3.03	1.24
Principles of metallurgy (ex. identifying metals, proper use of metals, etc.)	90	3	5.41	4.09	0.83	2.77	1.25
Procedures for troubleshooting small engines	90	4	5.40	4.27	0.78	3.00	1.41
Principles of diesel engine operational theory	91	5	5.35	3.99	0.88	2.65	1.32
Use of electrical systems tools (ex. digital multi-meter, wire strippers, etc.)	90	6	5.28	4.32	0.75	3.10	1.33
Principles of electrical theory (ex. conductors, insulators, alternating current [AC], direct current [DC], etc.)	90	7	5.25	4.38	0.74	3.18	1.29
Procedures for structural welding	89	8	5.23	4.01	0.86	2.71	1.38
Procedures for wiring outlets	90	9	5.19	4.37	0.76	3.18	1.37
Procedures for GTAW (TIG welding)	90	10	5.19	3.92	0.86	2.60	1.17
Principles of vehicle powertrain operational theory	91	11	4.87	3.86	0.91	2.59	1.22

Table 4
SBAE Teachers' Agricultural Mechanics Professional Development Needs by MWDS, Continued…

Procedures for wiring single-pole switch circuits	90	12	4.85	4.32	0.75	3.20	1.36
Procedures for using unmanned aerial vehicles in land surveying	87	13	4.83	3.56	0.98	2.21	1.06
Use of computer numerical control (CNC) systems	94	14	4.61	3.64	1.02	2.37	1.11
Procedures for building metal projects (ex. trailers, barbecue pits, etc.)	89	15	4.55	4.09	0.81	2.98	1.45
Procedures for wiring three-way switch circuits	90	16	4.54	3.97	0.87	2.82	1.33
Procedures for wiring trailer electrical systems	90	17	4.51	3.94	0.89	2.80	1.42
Procedures for cold metalworking bending	90	18	4.51	3.69	0.86	2.47	1.28
Procedures for wiring double-pole switch circuits	90	19	4.44	3.96	0.87	2.83	1.32
Procedures for cold metalworking shaping	90	20	4.37	3.64	0.84	2.44	1.29
Principles of welding theory (ex. joint types, positions, etc.)	90	21	4.27	4.22	0.82	3.21	1.34
Principles of four-stroke engine operational theory	91	22	4.27	4.13	0.79	3.10	1.37
Procedures for reassembling small engines	90	23	4.27	4.09	0.80	3.04	1.41
Procedures for cold metalworking cutting	90	24	4.23	3.70	0.81	2.56	1.32
Principles of two-stroke engine operational theory	91	25	4.16	4.11	0.85	3.10	1.34
Procedures for plasma arc cutting	89	26	4.15	4.15	0.82	3.15	1.49
Procedures for agricultural equipment operation	90	27	4.13	4.22	0.75	3.24	1.30
Procedures for wiring four-way switch circuits	90	28	4.13	3.76	0.89	2.66	1.27
Procedures for disassembling small engines	90	29	4.07	4.07	0.80	3.07	1.38
Procedures for hot metalworking shaping	90	30	4.03	3.59	0.87	2.47	1.33
Procedures for GMAW (MIG welding)	90	31	3.96	4.29	0.82	3.37	1.46
Procedures for hot metalworking cutting	90	32	3.94	3.62	0.88	2.53	1.38
Procedures for hot metalworking bending	90	33	3.80	3.60	0.87	2.54	1.37
Procedures for FCAW (Flux-core arc welding)	89	34	3.49	3.65	0.89	2.70	1.34
Procedures for using PEX pipe	90	35	3.24	3.73	0.95	2.87	1.21
Procedures for conducting land surveys	87	36	3.23	3.55	0.97	2.64	1.15
Procedures for oxy-fuel welding	90	37	3.22	3.71	0.95	2.84	1.42
Procedures for oxy-fuel cutting	90	38	3.21	4.13	0.80	3.36	1.48
Procedures for using legal land descriptions	87	39	3.21	3.72	0.97	2.86	1.36
Procedures for using land surveying equipment	87	40	3.18	3.51	0.99	2.60	1.18
Procedures for oxy-fuel brazing	89	41	3.17	3.66	0.90	2.80	1.37
Safety procedures for agricultural mechanics activities	85	42	3.10	4.88	0.52	4.25	0.82
Procedures for SMAW (Arc welding)	90	43	3.10	4.22	0.82	3.49	1.38
Use of hydraulic equipment (ex. shears, iron worker, etc.)	94	44	2.79	3.74	0.99	3.00	1.19
Interpreting project blueprints	82	45	2.76	4.04	0.96	3.35	0.95
Procedures for building masonry projects	92	46	2.57	3.70	0.96	3.00	1.13
Procedures for laying out projects	83	47	2.25	4.16	0.86	3.61	0.93
Procedures for using copper pipe	91	48	2.21	3.59	0.95	2.98	1.26
Use of laboratory safety equipment (ex. fire extinguishers, eye wash stations, etc.)	85	49	1.98	4.81	0.56	4.40	0.69
Estimating materials for projects	82	50	1.94	4.30	0.86	3.85	0.97

Table 4
SBAE Teachers' Agricultural Mechanics Professional Development Needs by MWDS, Continued…

Use of precision tools (ex. micrometer, dial caliper, etc.)	91	51	1.87	3.96	0.98	3.48	1.10
Use of personal protective equipment (PPE)	85	52	1.84	4.90	0.51	4.52	0.68
Use of measuring tools (ex. tape measure, framing square, etc.)	91	53	1.74	4.79	0.68	4.43	0.72
Use of stationary power equipment (ex. band saw, table saw, etc.)	94	54	1.59	4.27	0.91	3.89	1.09
Use of handheld power tools (ex. cordless drill, jig saw, etc.)	90	55	1.49	4.62	0.77	4.30	0.80
Drawing project plans to scale	83	56	1.39	3.86	0.90	3.49	1.02
Creating a bill of materials for projects	82	57	1.34	4.23	0.89	3.91	0.95
Procedures for using PVC pipe	91	58	1.20	4.04	0.86	3.75	1.14
Use of handheld pneumatic (air) tools (ex. impact wrench, paint spray gun, etc.)	94	59	1.16	3.88	0.95	3.59	1.20
Use of fasteners (ex. screws, nails, glue, etc.)	89	60	0.92	4.29	0.89	4.08	0.81
Procedures for building wood projects	92	61	0.91	4.20	0.88	3.98	0.94
Use of hand tools (ex. screwdriver, hammer, etc.)	91	62	0.71	4.60	0.81	4.45	0.70
Procedures for building fence projects	92	63	0.50	3.85	0.91	3.72	1.13
Use of marking tools (ex. chalk line, paint marker, etc.)	91	64	-0.09	4.20	0.87	4.22	0.81
Procedures for painting projects	89	65	-0.18	3.90	1.01	3.94	0.96

Note. Importance Scale: 1 [RL = 0 – 1.49] = *Not important* (*NI*), 2 [RL = 1.50 – 2.49] = *Of little importance* (*LI*), 3 [RL = 2.50 – 3.49] = *Somewhat important* (*SI*), 4 [RL = 3.50 – 4.49] = *Important* (*I*), 5 [RL = 4.50 – 5.00] = *Very important* (*VI*); Competence Scale: 1 [RL = 0 – 1.49] = *Not competent* (*NC*), 2 [RL = 1.50 – 2.49] = *Little competence* (*LC*), 3 [RL = 2.50 – 3.49] = *Somewhat competent* (*SC*), 4 [RL = 3.50 – 4.49] = *Competent* (*C*), 5 [RL = 4.50 – 5.00] = *Very competent* (*VC*); *MWDS* = Mean weighted discrepancy score; *M* = Mean; *SD* = Standard deviation.

The five lowest PD needs for SBAE teachers were: (1) *Procedures for painting projects* (MWDS = -0.18), (2) *Use of marking tools (ex. chalk line, paint marker, etc.)* (MWDS = -0.09), (3) *Procedures for building fence projects* (MWDS = 0.50), (4) *Use of hand tools (ex. screwdriver, hammer, etc.)* (MWDS = 0.71), and (5) *Procedures for building wood projects* (MWDS = 0.91). The two items with negative MWDS (i.e., *Procedures for painting projects* [MWDS = -0.18] and *Use of marking tools (ex. chalk line, paint marker, etc.)* [MWDS = -0.09]) can be interpreted as items teachers have no PD needs for.

Conclusions, Discussion, Limitations, and Recommendations

The purpose of our study was to describe the agricultural mechanics PD needs of SBAE teachers across the United States. Our findings indicate SBAE teachers across the United States have the greatest agricultural mechanics PD needs in the metal fabrication (i.e., *American Welding Society (AWS) standards for welding procedures*, *Principles of metallurgy (ex. identifying metals, proper use of metals, etc.)*, *Procedures for structural welding*, and *Procedures for GTAW (TIG welding)*) and agricultural power technology (i.e., *Use of electrical measurement units (ex. amperes, volts, Ohms, etc.)*, *Procedures for troubleshooting small engines*, *Principles of diesel engine operational theory*, *Use of electrical systems tools (ex. digital multi-meter, wire strippers, etc.)*, *Principles of electrical theory (ex. conductors, insulators, alternating current [AC], direct current [DC], etc.)*, and *Procedures for wiring outlets*) subject matter within agricultural mechanics. Our findings are consistent with Shultz et al. (2014), who likewise identified metal fabrication- and agricultural power technology-related items are among the greatest agricultural mechanics PD needs for SBAE teachers.

Identifying specific agricultural mechanics PD needs provides opportunities to continue developing human capital in the scope of SBAE. Human capital is important to the progression of society (Becker, 1993; Olaniyan & Okemakinde, 2008) and is likewise a priority in educational settings. In the context of agricultural mechanics within SBAE programs, our study addressed Thoron et al.'s (2016) call to identify PD needs for agricultural education professionals. Determining PD needs is useful and can help create professional change for SBAE teachers (DiBenedetto et al., 2018). Engagement in PD activities helps ensure teachers are competent and prepared (Grieman, 2010). Focused, relevant PD may be practical for retaining SBAE teachers by providing them with necessary training to carry out their professional responsibilities (Touchstone, 2015). While prior studies (Clemons et al., 2018; Figland et al., 2019; Smalley et al., 2019; Stair et al., 2019) have found teachers desire PD in agricultural mechanics, our study further defined specific PD needs across the United States. Our study should be considered as a reference point when planning agricultural mechanics PD for teachers across the United States in the coming years.

Regarding teachers' perceived importance to teach agricultural mechanics, none of the 65 items within our instrument were rated as *not important* or *of little importance* by a majority of the respondents, indicating all these items are still at least *somewhat important* to teach in SBAE programs. However, this likely depends on factors such as local program capacities, surrounding industry opportunities, and student interests. Perhaps more interesting was teachers' perceived competence to teach the 65 agricultural mechanics topics. Throughout the list of 65 topics, a majority of respondents to each item rated their competence as *not competent*, *little competence*, or *somewhat competent* in 41 topics. Was this a product of aspects such as teachers' prior agricultural mechanics course experiences or what they teach within their programs? As a limitation to our study, we did not ask respondents about the specific agricultural mechanics topics taught within their courses or their prior agricultural mechanics course experiences. We elected to forego asking such questions to reduce the length of our instrument and help ease respondent fatigue, which can negatively impacted data collection efforts (Dillman et al., 2014). However, future studies should consider exploring these demographics variables.

While our response rate was only 27.5%, we found nonresponse error was not a limitation of our study and can thus generalize our findings to the entire population of SBAE teachers across the United States in accordance with Lindner et al. (2001). As such, our findings can be used to help provide direction for addressing agricultural mechanics PD needs of all SBAE teachers. It is worth noting future studies should address how demographic variables such as teacher career phase and teacher certification route impact agricultural mechanics PD needs. While beyond the scope of our study, improving understanding of how teacher demographics affect PD needs would yield useful information for SBAE stakeholders who design and implement agricultural mechanics PD. Intentionally-designed PD targeting teacher needs can help improve teacher competence and ultimately lead to improved student achievement (Darling-Hammond et al., 2017; Harwell, 2003).

Considering the MWDS rankings of the items in Table 4, we were left with a few observations and thoughts for us as agricultural teacher educators to ponder. Per these rankings, we noticed SBAE teachers have limited PD needs for many of what could arguably be classified as fundamental items critical to effectively teaching agricultural mechanics courses (e.g., *Creating a bill of materials for projects*, *Use of handheld power tools (ex. cordless drill, jig saw, etc., Use of personal protective equipment (PPE)*, etc.) versus more technical, complex items, such as *Procedures for GTAW (TIG welding)* and *Use of computer numerical control (CNC) systems*. There are several practical explanations for this phenomenon, such as: (1) these teachers have already received numerous experiences related to these fundamental items such as through secondary- and university-level agricultural mechanics courses, which have likely increased their own competence with these fundamental items, (2) teachers may focus more greatly upon these fundamental items during the courses they teach and thus allow them to practice developing their competence with these items, and (3) teachers may not be emphasizing more technical, complex items within the courses they teach, thus inhibiting their own competence development processes.

We must acknowledge that if SBAE teachers are not teaching more technical, complex items, this may be reflective of factors such as perceived lack of competence and lack of adequate tools and equipment, which are often beyond the control of agricultural teacher educators. Agricultural teacher educators must set the example for SBAE teachers to follow by ensuring we are providing relevant and adequate experiences related to agricultural mechanics whenever possible within our own courses. This can be accomplished in several ways, including early field experiences and embedding agricultural mechanics-related experiences within broader agricultural teacher education courses. We must be willing to alter our own practices to accommodate the changing needs of our own stakeholders. Doing so will help to more effectively address SBAE teachers' long-term needs.

Specific recommendations for agricultural teacher education faculty and stakeholders include: (1) continuous refinement of both university-level agricultural mechanics courses and PD opportunities that better anticipate and reflect teachers' needs, (2) partnering with industry representatives to provide PD opportunities for teachers, (3) aligning university-level agricultural mechanics courses with identified needs to better prepare teachers to impact students' career and learning opportunities, and (4) further exploring teachers' agricultural mechanics PD regularly in the future to ensure relevant, timely data are used to drive decision-making processes related to agricultural mechanics in SBAE. Agricultural mechanics activities within SBAE programs have economic impacts beyond the program level (Hanagriff et al., 2014) and are popular with students enrolled in SBAE courses (Valdez & Johnson, 2020). Thus, teachers should be adequately prepared to engage in this technical agriculture subject matter.

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