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In-Service Agricultural Mechanics Needs of Montana Mid-Career Agricultural Educators

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Abstract

Agricultural mechanics—a pillar of many secondary agricultural education programs—is a dynamic, constantly changing field, requiring educators to continually evolve their programs to maintain relevance. This study explored the in-service agricultural *mechanics needs of Montana mid-career agricultural educators. We used mean weighted discrepancy scores and descriptive measures to analyze demographics and perceived levels of importance and competency to teach agricultural mechanics content areas. The areas of highest perceived importance of teaching were welding safety, mechanical safety, and construction and shop safety. The areas that educators felt least competent to teach were differential leveling, profile leveling, and cleaning motors. Mean weight discrepancy scores revealed the greatest discrepancies between importance and competence to teach in the areas of electrical safety, computer aided design, and differential leveling. Agricultural educator associations and industry experts should collaborate with advisory groups, local businesses, and organizations such as the Chamber of Commerce to determine the relevance of low-ranking content areas and create professional development opportunities for educators in these areas.*

Keywords: agricultural mechanics; mid-career educators; in-service needs; skill competency; skill importance; relevancy

Introduction

In a rapidly changing modern world, the need for students to develop a new set of skills—often called “21st century skills”— is greater than ever. Lapek (2017) asserts that educators cannot simply focus on students’ acquisition of general knowledge; rather, students need to be taught to adapt knowledge for an ever-evolving world. As such, the education community has shifted toward higher-order skills such as communication, teamwork, problem-solving, collaboration, information literacy, and creativity (Assessment and Teaching of 21st Century Skills [ATC21S], 2012).

Agricultural education creates opportunities for students to develop 21st century skills in the form of teamwork, collaboration, and problem-solving (Dailey et al., 2001). In fact, all components of agricultural education’s three-circle model (supervised agricultural experiences [SAEs], FFA, and classroom/laboratory instruction) help students acquire skills for future careers: SAEs allow students to apply classroom learning, while engagement in the National FFA Organization builds critical thinking, teamwork, and communication skills (Swafford, 2017). Classroom and laboratory experiences allow students to develop relevant content knowledge through varied instructional methods (Shoulders & Myers, 2012). The inquiry or problem-based instruction commonly found in secondary

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agricultural education classrooms (Parr & Edwards, 2004) lends itself to developing 21st century ways of thinking (Burris & Garton, 2007). In addition to 21st century skills, agricultural education integrates high degrees of science, technology, engineering and mathematics (STEM), which is recognized as a crucial subject for an ever-advancing world and a positive contributor to 21st century skill acquisition (Stubbs & Myers, 2015; Khalil & Osman, 2017).

Agricultural mechanics laboratories are widely accepted as an integral part of agricultural education instruction (Byrd et al., 2015; Imhoff & Anderson, 2018) and provide opportunities for students to develop critical thinking, problem solving, and application skills (Shoulders & Myers, 2012; Stubbs & Myers, 2014). Like most laboratory topics, agricultural mechanics is not a static field; as technologies advance, so must agricultural mechanics instruction (Shultz et al., 2014). As such, studies identifying the perceived and real needs of agricultural educators in this area are common (McKim & Saucier, 2011; Saucier et al., 2012; Saucier, Vincent, & Anderson, 2014; Swafford & Hagler, 2018). From the immense range of skills included within agricultural mechanics instruction, a few broader areas of need may be distilled. Shultz et al. (2014) identified safety, welding, small engines, Global Positioning Systems (GPS), and computer aided design as the areas of greatest in-service need among Iowa agricultural educators. However, the dynamic nature of agricultural mechanics means the identified needs of educators in the field are not constant. For instance, Swafford and Hagler (2018) discovered the agricultural mechanics needs of beginning educators favored equipment operation and use over the safety procedures identified by Shultz et al. (2014). Therefore, to preserve program relevance, it is imperative researchers continue these studies in order to remain abreast of the current, specific in-service needs of agricultural educators.

Curriculum and program relevancy are vital at every stage of an agricultural educator's career, but Smalley and Smith (2017) found that professional development is largely focused on early-career educators, while mid-career educators lack opportunities for continuing education. However, mid-career educators are ideally poised to maintain classroom and program relevance. Early-career educators commonly exhibit a "survival" mindset, potentially foregoing the issue of relevancy, and late-career educators often reside in a state of "serenity," or comfort in their careers (National Association of Agricultural Educators [NAAE], 2015). Both survival and serenity mindsets tend to preclude continuing education and experimentation. In contrast, mid-career educators often enter a period of teaching and content experimentation in an effort to generate novelty and "spice up" their teaching (Huberman, 1989; NAAE, 2015). This period of experimentation is a vital component of the educator career cycle, presenting opportunities for development that may not exist in any other period.

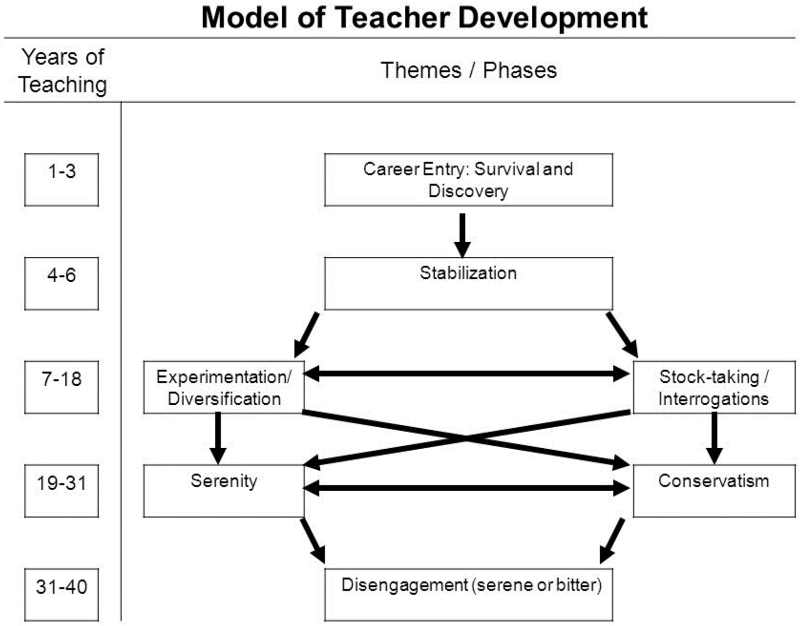
Theoretical and Conceptual Frameworks

The theoretical framework used for this study incorporates Huberman's (1989) teacher career life cycle (Figure 1) and related professional life cycle frameworks (Burke et al., 1987; NAAE, 2015; Steffy & Wolfe, 2001). We chose these frameworks to establish the potential of mid-career educators to address program relevance, particularly in agricultural mechanics, through experimentation and diversification of content and techniques. Although Huberman (1989) identified mid-career teachers as those with 7–18 years of teaching experience, we defined mid-career educators as those with 7–12 years of experience, which more closely aligns with the NAAE's (2015) definition. In this career stage, educators have "stabilized" and demonstrate confidence in teaching, which allows them to experiment with curriculum (Huberman, 1989; NAAE, 2015). Conversely, if educators do not enter the "experimentation/diversification" phase, they enter a period of "stock-taking/interrogations," which may result in a consideration or desire to leave the profession (Huberman, 1989). Due to this study's interest in identifying areas of content growth and development among participants, we only considered the experimentation/diversification phase.

Burke et al. (1987) proposed an educator career cycle framework similar to Huberman's (1989), in which mid-career educators enter periods where they are *building competency, and enthusiastic and growing*. Both periods characterize mid-career educators' tendencies to seek new strategies, attend professional development events, and enrich their classrooms (Burke et al., 1987). A related study by Richter et al. (2011) revealed mid-career educators engage in the greatest level of professional development, both individually and collaboratively, and found the uptake of professional development training to be the highest among educators in the middle of their career. Recognizing this increase in professional development engagement, a targeted approach to mid-career educator needs is necessary to maximize the effectiveness of educator development periods.

Figure 1

Huberman's (1989) Teacher Career Life Cycle



We used the Borich Needs Assessment model as a conceptual means for data collection, which Borich (1980) proposed as an improved method for collecting and analyzing data related to training needs. The model measures discrepancies in training needs between measured behaviors, skills, and competencies and the program's desired goals or outcomes (Borich, 1980). Borich outlined a five-step process for implementing educator needs assessments. First, develop a list of desired competencies using input from educators, administrators, and trainees. Once a list of competencies is developed, survey in-service educators on both the perceived importance of competencies and their attainment of those competencies. Competency attainment may be measured unilaterally or separated into three competency areas: knowledge, performance, and consequence. Upon survey completion, rank the discrepancies between importance and attainment and assign priorities. High-priority discrepancies are then reviewed and possible causes identified. Where possible, training programs should be either created or revised to address the measured discrepancies. Since mid-career teachers have a greater likelihood to engage in content experimentation and diversification (Huberman, 1989), and understanding the importance of maintaining program relevancy (Smalley & Smith, 2017), this study sought to use the Borich Needs Assessment model to explore the agricultural mechanics needs of Montana agricultural educators in an effort to develop more beneficial and relevant professional development opportunities for those educators.

Purpose and Objectives

This study gave Montana mid-career agricultural educators an opportunity to address program relevancy through an analysis of their in-service agricultural mechanics needs. This purpose aligns with the American Association for Agricultural Education's National Research Agenda Research Priority Areas Three and Five, which focus on the need for workers being prepared for the 21st century and the continued need for effective and efficient agricultural education programs, respectively (Roberts et al., 2016). The following research objectives guided this study:

1. Describe participant and program characteristics.
2. Describe the perceptions of importance that Montana mid-career secondary agricultural educators place on teaching identified agricultural mechanics content areas.
3. Describe how Montana mid-career secondary agricultural educators perceive their own competency to teach identified agricultural mechanics content areas.
4. Determine the discrepancy among Montana mid-career secondary agricultural educators' perceived importance and competency to teach identified agricultural mechanics content areas.

Methods

The selected population was all Montana agricultural educators with 7–12 years of experience ($N = 23$) who were still teaching at the time of the study. This list was developed using the 2018 Montana Agricultural Education Directory, which was compiled by the Montana Office of Public Instruction and contained contact information for all currently active Montana agricultural educators.

For this descriptive study, we used a previously developed paper-based questionnaire adapted for online delivery via Qualtrics to summarize characteristics and opinions to accurately describe a norm (Ary et al., 2006). The previously developed questionnaire (Shultz et al., 2014) consisted of three sections. Section one described 54 agricultural mechanics content areas in five unique domains: mechanical skills, structures/construction, electrification, power and machinery, and soil and water. Participants in our modified online survey used a summated rating scale to rate the perceived importance of teaching each of the 54 identified content areas. Participants then used a similar scale to rate their competencies to teach the same content areas. The structure of section one was based on the methods outlined by Borich's (1980) described needs assessment. Sections two and three solicited participant demographics and program and school characteristics. Our survey modified these two sections of the original questionnaire by removing or modifying demographic or characteristic questions irrelevant for our population. This included narrowing the range of possible years teaching, and number of teachers, as well as adding a question about participant age, and expanding the highest degree earned to include doctoral degrees. Schultz et al. (2014) reported content validity for the original survey using a panel of experts specializing in agricultural mechanics and education. Shultz et al. (2014) pilot tested the instrument and reported acceptable (Gliem & Gliem, 2003) post hoc reliability coefficients for importance ($\alpha = 0.97$) and competency ($\alpha = 0.98$).

We used a modified version of Dillman et al.'s (2009) tailored design method for data collection, which consisted of three points of contact over an approximate three-week period. We sent a pre-notice email to the target population and distributed another email containing a link to the web survey three days later. One week after the survey was distributed, we sent a follow-up reminder email to participants. Ultimately, contact methods yielded a 78.3% ($n = 18$) response rate. Although research suggests non-response error would be minimal because our data collection methods produced a response rate above the recommended 75% for consideration (Ary et al., 1996), we followed the suggestions of Miller and Smith (1983) by comparing respondents' personal and program demographic data to data from the 2018 Montana Agricultural Education Directory. After appropriate follow-up procedures, we found no significant differences between respondents and non-respondents.

To assess potential discrepancies revealed by the Borich Needs Assessment, we analyzed the data using McKim and Saucier's (2011) Excel-based platform to calculate mean weight discrepancy scores (MWDS) for each of the 54 identified content areas. The MWDS is calculated by multiplying the discrepancy score (Importance Rating minus Competency Rating) by the mean Importance Rating and dividing by the number of observations (Saucier. McKim, et al., 2014). Reported scores for importance and competency in each area were entered into spreadsheets that automatically calculated discrepancy scores, weighted discrepancy scores, and MWDS for each item (McKim & Saucier, 2011). Content areas were ranked from largest to smallest MWDS, and areas with larger MWDS were identified as having a higher need for in-service training than those with smaller MWDS (Borich, 1980; Garton & Chung, 1997; McKim & Saucier, 2011).

Results

Our first research objective was to describe participant demographics and program characteristics. All participants (*n* = 18; 100.0%) were employed in a single educator program and the majority (*n* = 16; 88.9%) were teaching in rural school districts. The majority were males (*n* = 12; 66.7%) with a bachelor's degree as their highest degree obtained (*n* = 12; 66.7%). All but one participant (*n* = 17; 99.4%) had 7–10 years of teaching experience. Table 1 summarizes participant demographics and program characteristics.

Table 1

Summary of Participant Demographics and Program Characteristics (n = 18)

Category	*f*	%
Gender		
Male	12	66.7
Female	6	33.3
Highest level of education		
Bachelor's degree	12	66.7
Master's degree	5	27.8
Doctoral degree	1	5.6
Years of teaching experience		
7 years	9	50.0
8 years	2	11.1
9 years	3	16.7
10 years	3	16.7
11 years	1	5.6
12 years	0	0.0
Age		
27–32	9	50.0
33–38	4	22.2
39–44	1	5.6
45+	4	22.2
Grade levels taught		
7th grade	10	55.6
8th grade	11	61.1
9th – 12th grade	18	100.0
Campus location designation		
Rural (population < 5,000)	16	88.9
Small urban (population 5,000–20,000)	2	11.1
Urban (population > 20,000)	0	0.0
Number of agricultural science teachers in department		
1 teacher	18	100.0

Our second research objective was to determine participants' perceived importance of teaching identified agricultural mechanics content areas. Each level of importance was assigned a weight (5 = very important, 4 = important, 3 = moderately important, 2 = slightly important, and 1 = not important). All participants (*n* =18; 100.0%) identified four content areas as exclusively important or very important to teach: welding safety, mechanical safety, construction and shop safety, and arc welding. Half (*n* = 9; 50.0%) identified oxy-propylene cutting and tractor overhaul as slightly or not important to teach. We calculated the weighted frequency mean of participants' perceived importance of teaching for each of the content areas. These weighted scores were summed and divided by the number of respondents to determine the weighted mean. Table 2 reports frequencies of responses and weighted means.

Table 2

Most Important Agricultural Mechanics Areas to Teach (n=18)

		NI	SI	MI	I	VI		
Rk	Skill	*f*(%)	*f*(%)	*f*(%)	*f*(%)	*f*(%)	M	SD
1	Welding Safety	0(0.0)	0(0.0)	0(0.0)	0(0.0)	18(100.0)	5.00	0.00
2	Mechanical Safety	0(0.0)	0(0.0)	0(0.0)	2(11.1)	16(88.9)	4.89	0.32
3	Construction and Shop Safety	0(0.0)	0(0.0)	0(0.0)	3(16.7)	15(83.3)	4.83	0.38
4	Arc Welding	0(0.0)	0(0.0)	0(0.0)	5(27.8)	13(72.2)	4.72	0.46
5	MIG Welding	0(0.0)	1(5.6)	0(0.0)	4(22.2)	13(72.2)	4.61	0.78
6	Electrical Safety	0(0.0)	0(0.0)	2(11.1)	3(16.7)	13(72.2)	4.61	0.70
7	Plasma Cutting	0(0.0)	0(0.0)	1(5.6)	6(33.3)	11(61.1)	4.56	0.62
8	Tractor Safety	0(0.0)	1(5.6)	0(0.0)	7(38.9)	10(55.6)	4.44	0.78
9	Power and Machinery Safety	0(0.0)	0(0.0)	3(16.7)	5(27.8)	10(55.6)	4.39	0.78
10	Construction Skills	0(0.0)	0(0.0)	2(11.1)	8(44.4)	8(44.4)	4.33	0.69
11	Woodworking Power Tools	0(0.0)	1(5.6)	2(11.1)	7(38.9)	8(44.4)	4.22	0.88
12	Selection of Materials	0(0.0)	0(0.0)	4(22.2)	6(33.3)	8(44.4)	4.22	0.81
13	Bill of Materials	0(0.0)	1(5.6)	2(11.1)	8(44.4)	7(38.9)	4.17	0.86
14	Wiring Skills	0(0.0)	0(0.0)	4(22.2)	8(44.4)	6(33.3)	4.11	0.76
15	Small Engine Safety	0(0.0)	2(11.1)	2(11.1)	6(33.3)	8(44.4)	4.11	1.02
16	Oxy-acet. Cutting	0(0.0)	1(5.6)	3(16.7)	8(44.4)	6(33.3)	4.06	0.87
17	Plumbing	0(0.0)	2(11.1)	2(11.1)	10(55.6)	4(22.2)	3.89	0.90
18	Metallurgy and Metal Work	0(0.0)	1(5.6)	6(33.3)	7(38.9)	4(22.2)	3.78	0.88
19	Drawing and Sketching	0(0.0)	0(0.0)	6(33.3)	10(55.6)	2(11.1)	3.78	0.65
20	Global Positioning Systems (GPS)	0(0.0)	0(0.0)	7(38.9)	8(44.4)	3(16.7)	3.78	0.73
21	Electrical Controls	0(0.0)	1(5.6)	6(33.3)	8(44.4)	3(16.7)	3.72	0.83
22	Electrician Tools	0(0.0)	1(5.6)	6(33.3)	8(44.4)	3(16.7)	3.72	0.83
23	Service Machinery	0(0.0)	4(22.2)	2(11.1)	7(38.9)	5(27.8)	3.72	1.13
24	Computer Aided Design (CNC)	0(0.0)	1(5.6)	7(38.9)	7(38.9)	3(16.7)	3.67	0.84
25	Concrete	0(0.0)	1(5.6)	6(33.3)	9(50.0)	2(11.1)	3.67	0.77

Table 2

Most Important Agricultural Mechanics Areas to Teach (n=18), Continued…

26	Fasteners	0(0.0)	2(11.1)	6(33.3)	7(38.9)	3(16.7)	3.61	0.92
27	Small Engine Services - 4 cycle	0(0.0)	2(11.1)	5(27.8)	9(50.0)	2(11.1)	3.61	0.85
28	Tool Conditioning	0(0.0)	4(22.2)	4(22.2)	6(33.3)	4(22.2)	3.56	1.10
29	Woodworking Hand Tools	0(0.0)	4(22.2)	4(22.2)	6(33.3)	4(22.2)	3.56	1.10
30	Legal Land Descriptions	1(5.6)	3(16.7)	3(16.7)	7(38.9)	4(22.2)	3.56	1.20
31	TIG Welding	0(0.0)	4(22.2)	4(22.2)	8(44.4)	2(11.1)	3.44	0.98
32	Soldering	0(0.0)	4(22.2)	5(27.8)	7(38.9)	2(11.1)	3.39	0.98
33	Tractor Maintenance	1(5.6)	4(22.2)	5(27.8)	3(16.7)	5(27.8)	3.39	1.29
34	Use of Survey Equipment	0(0.0)	4(22.2)	5(27.8)	7(38.9)	2(11.1)	3.39	0.98
35	Tractor Operation	0(0.0)	6(33.3)	3(16.7)	6(33.3)	3(16.7)	3.33	1.14
36	Hot Metal Work	0(0.0)	3(16.7)	9(50.0)	4(22.2)	2(11.1)	3.28	0.89
37	Pipe Cut. and Thread	1(5.6)	4(22.2)	5(27.8)	5(27.8)	3(16.7)	3.28	1.18
38	Machinery Operation	0(0.0)	6(33.3)	4(22.2)	5(27.8)	3(16.7)	3.28	1.13
39	Tractor Service	0(0.0)	8(44.4)	2(11.1)	4(22.2)	4(22.2)	3.22	1.26
40	Cold Metal Work	0(0.0)	5(27.8)	6(33.3)	6(33.3)	1(5.6)	3.17	0.92
41	Fencing	1(5.6)	4(22.2)	6(33.3)	5(27.8)	2(11.1)	3.17	1.10
42	Machinery Selection	1(5.6)	5(27.8)	4(22.2)	6(33.3)	2(11.1)	3.17	1.15
43	Differential Leveling	1(5.6)	3(16.7)	7(38.9)	6(33.3)	1(5.6)	3.17	0.99
44	Small Engine Overhaul	1(5.6)	4(22.2)	7(38.9)	4(22.2)	2(11.1)	3.11	1.08
45	Tractor Driving	0(0.0)	7(38.9)	6(33.3)	1(5.6)	4(22.2)	3.11	1.18
46	Profile Leveling	1(5.6)	3(16.7)	9(50.0)	3(16.7)	2(11.1)	3.11	1.02
47	Types of Electric Motors	1(5.6)	4(22.2)	8(44.4)	5(27.8)	0(0.0)	2.94	0.87
48	Oxy-acet. Welding	1(5.6)	8(44.4)	4(22.2)	3(16.7)	2(11.1)	2.83	1.15
49	Oxy-acet. Brazing	1(5.6)	8(44.4)	4(22.2)	5(27.8)	0(0.0)	2.72	0.96
50	Small Engine Services - 2 cycle	0(0.0)	9(50.0)	5(27.8)	4(22.2)	0(0.0)	2.72	0.83
51	Tractor Selection	3(16.7)	6(33.3)	3(16.7)	5(27.8)	1(5.6)	2.72	1.23
52	Cleaning Motors	1(5.6)	6(33.3)	10(55.6)	1(5.6)	0(0.0)	2.61	0.70
53	Oxy-propylene Cutting	6(33.3)	3(16.7)	4(22.2)	3(16.7)	2(11.1)	2.56	1.42
54	Tractor Overhaul	4(22.2)	5(27.8)	6(33.3)	2(11.1)	1(5.6)	2.50	1.15

Note: Rk = Rank. NI = Not Important. SI = Somewhat Important. MI = Moderately Important. I= Important. VI = Very Important. M = Weighted Frequency Mean

Our third objective was to identify participants' perceived competence to teach each of the 54 identified agricultural mechanics content areas. Each level of competence was assigned a rank (5 = very competent, 4 = competent, 3 = moderately competent, 2 = slightly competent, and 1 = not competent). All participants (*n* = 18; 100.0%) reported feeling at least moderately competent to teach four content areas: welding safety, MIG welding, mechanical safety, and arc welding. Half (*n* = 9; 50.0%) indicated slight or no competence to teach six content areas: Computer aided design, types of electric motors, tractor overhaul, differential leveling, profile leveling, and cleaning motors. We calculated weighted frequency means for perceived competency to teach for all 54 identified content areas. Weighted scores were summed and divided by number of respondents to determine the weighted mean. Table 3 details participants' frequencies and weighted means.

Table 3

Agricultural Mechanics Areas of Highest Perceived Competence to Teach (n=18)

		NC	SC	MC	C	VC		
Rk	Skill	*f*(%)	*f*(%)	*f*(%)	*f*(%)	*f*(%)	M	SD
1	Welding Safety	0(0.0)	0(0.0)	1(5.6)	4(22.2)	13(72.2)	4.67	0.59
2	MIG Welding	0(0.0)	0(0.0)	1(5.6)	7(38.9)	10(55.6)	4.50	0.62
3	Mechanical Safety	0(0.0)	0(0.0)	1(5.6)	7(38.9)	10(55.6)	4.50	0.62
4	Arc Welding	0(0.0)	0(0.0)	2(11.1)	6(33.3)	10(55.6)	4.44	0.70
5	Oxy-acet. Welding	0(0.0)	1(5.6)	1(5.6)	6(33.3)	10(55.6)	4.39	0.85
6	Plasma Cutting	0(0.0)	0(0.0)	3(16.7)	5(27.8)	10(55.6)	4.39	0.78
7	Woodworking Power Tools	0(0.0)	1(5.6)	2(11.1)	4(22.2)	11(61.1)	4.39	0.92
8	Construction and Shop Safety	0(0.0)	0(0.0)	4(22.2)	4(22.2)	10(55.6)	4.33	0.84
9	Power and Machinery Safety	0(0.0)	0(0.0)	2(11.1)	9(50.0)	7(38.9)	4.28	0.67
10	Oxy-acet. Cutting	0(0.0)	0(0.0)	2(11.1)	10(55.6)	6(33.3)	4.22	0.65
11	Woodworking Hand Tools	0(0.0)	2(11.1)	2(11.1)	4(22.2)	10(55.6)	4.22	1.06
12	Tractor Safety	0(0.0)	1(5.6)	1(5.6)	11(61.1)	5(27.8)	4.11	0.76
13	Fencing	0(0.0)	2(11.1)	3(16.7)	5(27.8)	8(44.4)	4.06	1.06
14	Bill of Materials	0(0.0)	3(16.7)	3(16.7)	3(16.7)	9(50.0)	4.00	1.19
15	Legal Land Descriptions	1(5.6)	2(11.1)	2(11.1)	4(22.2)	9(50.0)	4.00	1.28
16	Fasteners	0(0.0)	0(0.0)	7(38.9)	6(33.3)	5(27.8)	3.89	0.83
17	Electrical Safety	0(0.0)	2(11.1)	4(22.2)	6(33.3)	6(33.3)	3.89	1.02
18	Small Engine Safety	2(11.1)	1(5.6)	1(5.6)	7(38.9)	7(38.9)	3.89	1.32
19	Tractor Driving	1(5.6)	1(5.6)	2(11.1)	9(50.0)	5(27.8)	3.89	1.08
20	Selection of Materials	0(0.0)	2(11.1)	3(16.7)	9(50.0)	4(22.2)	3.83	0.92
21	Construction Skills	0(0.0)	1(5.6)	7(38.9)	4(22.2)	6(33.3)	3.83	0.99
22	Wiring Skills	0(0.0)	1(5.6)	6(33.3)	6(33.3)	5(27.8)	3.83	0.92

Table 3

Agricultural Mechanics Areas of Highest Perceived Competence to Teach (n=18), Continued…

23	Soldering	0(0.0)	3(16.7)	4(22.2)	5(27.8)	6(33.3)	3.78	1.11
24	Pipe Cut. and Thread	1(5.6)	2(11.1)	3(16.7)	7(38.9)	5(27.8)	3.72	1.18
25	Plumbing	1(5.6)	2(11.1)	4(22.2)	5(27.8)	6(33.3)	3.72	1.23
26	Electrician Tools	0(0.0)	2(11.1)	5(27.8)	8(44.4)	3(16.7)	3.67	0.91
27	Tractor Operation	2(11.1)	1(5.6)	3(16.7)	7(38.9)	5(27.8)	3.67	1.28
28	Small Engine Services - 4 cycle	2(11.1)	2(11.1)	4(22.2)	4(22.2)	6(33.3)	3.56	1.38
29	Machinery Operation	2(11.1)	1(5.6)	4(22.2)	7(38.9)	4(22.2)	3.56	1.25
30	Metallurgy and Metal Work	1(5.6)	2(11.1)	7(38.9)	3(16.7)	5(27.8)	3.50	1.20
31	Drawing and Sketching	0(0.0)	5(27.8)	3(16.7)	7(38.9)	3(16.7)	3.44	1.10
32	Cold Metal Work	1(5.6)	3(16.7)	6(33.3)	4(22.2)	4(22.2)	3.39	1.20
33	Oxy-acet. Brazing	0(0.0)	5(27.8)	4(22.2)	6(33.3)	3(16.7)	3.39	1.09
34	Tool Conditioning	0(0.0)	5(27.8)	5(27.8)	5(27.8)	3(16.7)	3.33	1.08
35	Small Engine Services - 2 cycle	2(11.1)	4(22.2)	2(11.1)	6(33.3)	4(22.2)	3.33	1.37
36	Service Machinery	2(11.1)	3(16.7)	3(16.7)	8(44.4)	2(11.1)	3.28	1.23
37	Concrete	1(5.6)	4(22.2)	6(33.3)	4(22.2)	3(16.7)	3.22	1.17
38	Tractor Maintenance	3(16.7)	1(5.6)	5(27.8)	7(38.9)	2(11.1)	3.22	1.26
39	Machinery Selection	0(0.0)	7(38.9)	2(11.1)	7(38.9)	2(11.1)	3.22	1.11
40	Hot Metal Work	1(5.6)	5(27.8)	5(27.8)	4(22.2)	3(16.7)	3.17	1.20
41	Small Engine Overhaul	4(22.2)	3(16.7)	2(11.1)	4(22.2)	5(27.8)	3.17	1.58
42	Global Positioning Systems (GPS)	0(0.0)	6(33.3)	6(33.3)	3(16.7)	3(16.7)	3.17	1.10
43	Electrical Controls	1(5.6)	4(22.2)	7(38.9)	5(27.8)	1(5.6)	3.06	1.00
44	Oxy-propylene Cutting	3(16.7)	5(27.8)	2(11.1)	5(27.8)	3(16.7)	3.00	1.41
45	Tractor Selection	2(11.1)	5(27.8)	4(22.2)	5(27.8)	2(11.1)	3.00	1.24
46	Tractor Service	4(22.2)	2(11.1)	5(27.8)	5(27.8)	2(11.1)	2.94	1.35
47	Use of Survey Equipment	2(11.1)	5(27.8)	6(33.3)	4(22.2)	1(5.6)	2.83	1.10
48	TIG Welding	5(27.8)	3(16.7)	3(16.7)	5(27.8)	2(11.1)	2.78	1.44
49	Computer Aided Design (CNC)	4(22.2)	5(27.8)	2(11.1)	5(27.8)	2(11.1)	2.78	1.40
50	Types of Electric Motors	2(11.1)	10(55.6)	4(22.2)	2(11.1)	0(0.0)	2.33	0.84

Table 3

Agricultural Mechanics Areas of Highest Perceived Competence to Teach (n=18), Continued…

51	Tractor Overhaul	9(50.0)	2(11.1)	2(11.1)	3(16.7)	2(11.1)	2.28	1.53
52	Differential Leveling	6(33.3)	5(27.8)	4(22.2)	2(11.1)	1(5.6)	2.28	1.23
53	Profile Leveling	6(33.3)	6(33.3)	3(16.7)	2(11.1)	1(5.6)	2.22	1.22
54	Cleaning Motors	5(27.8)	9(50.0)	3(16.7)	1(5.6)	0(0.0)	2.00	0.84

Note: Rk = Rank. NC = Not Competent. SC = Somewhat Competent. MC = Moderately Competent. C = Competent. VC = Very Competent. M = Weighted Frequency Mean.

Our fourth research objective was to measure the discrepancy between participants' perceived importance of teaching and perceived competency to teach the identified agricultural mechanics content areas. A MWDS was calculated for each of the 54 content areas. The five highest MWDS were calculated for the content areas of electrical safety (MWDS = 3.33), computer aided design (MWDS = 3.26), differential leveling (MWDS = 2.81), profile leveling (MWDS = 2.77), and electrical controls (MWDS = 2.48). Oxy-acetylene welding (MWDS = -4.41), fencing (MWDS = -2.81), tractor driving (MWDS = -2.42), woodworking hand tools (MWDS = -2.37), and oxy-acetylene brazing (MWDS = -1.81) had the lowest calculated MWDS. Table 4 reports the MWDS for each content area.

Table 4

Educator Competencies Ranked by MWDS

Rank	Content Area	MWDS	Importance Rank	Competency Rank
1	Electrical Safety	3.33	6	17
2	Computer Aided Design	3.26	24	49
3	Differential Leveling	2.81	43	52
4	Profile Leveling	2.77	46	53
5	Electrical Controls	2.48	21	43
6	Construction and Shop Safety	2.42	3	8
7	Global Positioning Systems (GPS)	2.31	20	42
8	TIG Welding	2.30	31	48
9	Construction Skills	2.17	10	21
10	Mechanical Safety	1.90	2	3
11	Use of Survey Equipment	1.88	34	47
12	Types of Electric Motors	1.80	47	50
13	Welding Safety	1.67	1	1
14	Service Machinery	1.65	23	36
15	Selection of Materials	1.64	12	20
16	Concrete	1.63	25	37
17	Cleaning Motors	1.60	52	54
18	Tractor Safety	1.48	8	12
19	Arc Welding	1.31	4	4
20	Drawing and Sketching	1.26	19	31

Table 4

Educator Competencies Ranked by MWDS, Continued…

21	Wiring Skills	1.14	14	22
22	Metallurgy and Metal Work	1.05	18	30
23	Small Engine Safety	0.91	15	18
24	Tractor Service	0.90	39	46
25	Tool Conditioning	0.79	28	34
26	Plasma Cutting	0.76	7	6
27	Bill of Materials	0.69	13	14
28	Plumbing	0.65	17	25
29	Tractor Maintenance	0.56	33	38
30	Tractor Overhaul	0.56	54	51
31	MIG Welding	0.51	5	2
32	Power and Machinery Safety	0.49	9	9
33	Hot Metal Work	0.36	36	40
34	Electrician Tools	0.21	22	26
35	Small Engine Services - 4 cycle	0.20	27	28
36	Small Engine Overhaul	-0.17	44	41
37	Machinery Selection	-0.18	42	39
38	Oxy-acet. Cutting	-0.68	16	10
39	Cold Metal Work	-0.70	40	32
40	Woodworking Power Tools	-0.70	11	7
41	Tractor Selection	-0.76	51	45
42	Machinery Operation	-0.91	38	29
43	Fasteners	-1.00	26	16
44	Tractor Operation	-1.11	35	27
45	Oxy-propylene Cutting	-1.14	53	44
46	Soldering	-1.32	32	23
47	Pipe Cut. and Thread	-1.46	37	24
48	Legal Land Descriptions	-1.58	30	15
49	Small Engine Services - 2 cycle	-1.66	50	35
50	Oxy-acet. Brazing	-1.81	49	33
51	Woodworking Hand Tools	-2.37	29	11
52	Tractor Driving	-2.42	45	19
53	Fencing	-2.81	41	13
54	Oxy-acet. Welding	-4.41	48	5

Conclusion and Recommendations

This study addressed the agricultural mechanics in-service needs of mid-career agricultural educators. Objective one sought to determine participant and program characteristics. The majority of

Montana mid-career agricultural educators are males under the age of 38, who are employed in a rural, single-educator program. These educators primarily hold a bachelor's degree and have 7–10 years of experience. For Montana, this demographic breakdown was expected given the relative homogeneity of our educator population. Given the small sample size and single state consideration, direct application of findings and discussion to other situations is not recommended until further examination of particular mid-career educator populations are conducted.

Objective two explored participants' perceptions of the importance of teaching various agricultural mechanics content areas. Results revealed similarities with agricultural educators studied by Shultz et al. (2014), Swafford and Hagler (2018), and Saucier et al. (2012) particularly with regard to the importance of, and emphasis on, teaching agricultural mechanics safety. What is not clear is whether the identified importance of teaching safety involves direct instruction on safety in each content area or is the result of developing and teaching a culture of safety in the agricultural mechanics laboratory. If it is based on a culture of safety, determining how educators accomplish this could help other educators cultivate that same culture.

Montana is a local control state, meaning there is no state curriculum, and educators determine what is taught. Within this system, what an educator considers important is often what will be taught. This study found that educators identified metals- and welding-related content areas as relatively important to teach. Given the local control system, it is vital to understand why these content areas are deemed important to teach. In this case, are metals-based content areas important to teach because of high industry demand or because of individual educators' preferences and strengths? We recommend agricultural educator associations work with industry experts to determine important content areas to ensure continued program relevance. Additionally, educators should consider the needed career-skills in their community to best prepare their students for local jobs. Collaboration between local industry, agricultural educators, and advisory committees to complete a community needs assessment could help guarantee appropriate content focus and program relevance. Lastly, emphasizing both the potential and realized ways these content areas help to develop 21st century skills such as teamwork, problem-solving, or creativity (Shoulders & Myers, 2012) could provide further justification for their importance and relevance in agricultural education programs.

Objective three sought to determine educators' perceived competence to teach identified agricultural mechanics content areas. Once again, safety and metals-based content areas were highest on the list. This would seem to follow logically given the results from Objective two and the state's local control status. The more importance an educator places on a content area, the more likely they are to teach and develop that skill. Perhaps more importantly for this group, however, are the content areas at the bottom of the list. Our results here echo those of a previous study, which indicated low levels of competence to teach content areas such as TIG welding, cleaning motors, and computer aided design (Shultz et al., 2014). These deficiencies indicate opportunities for growth among mid-career educators, who often engage in what Burke et al. (1987) identified as "competency building."

Additionally, if competency among mid-career educators is low in these areas, it can be reasonably inferred that competency is likely also low among beginning educators because nearly all Montana agricultural educators go through the same teacher preparation program. Therefore, we recommend several actions be taken. First, agricultural educator associations and industry professionals specializing in each of the five domains identified should collaborate with business owners, community leaders, and local educators to determine the relevance of low-ranking content areas. With content area relevance determined, agricultural educators and advisory committees should then evaluate current program focuses and identify necessary adjustments. Second, professional development opportunities for educators should be created in any low-ranking, relevant areas in order to support continued program relevancy across the state. Lastly, post-secondary agricultural education programs should consider these findings, as well as community needs results, when planning curriculum for pre-service agricultural educators to ensure their teacher-preparation programs remain up-to-date and produce prepared educators for their state and situation.

Objective four identified discrepancies between perceived importance of teaching and perceived competence to teach various agricultural mechanics skill areas. Once again, safety skills were found near the top of the list. Electrical safety, in particular, revealed a prominent discrepancy between perceived importance and competence, which was echoed in a previous study (Shultz et al. 2014). Results from this study also revealed discrepancies in more advanced and emerging agricultural mechanics technologies, such as computer aided design and GPS. As the integration of science, technology, engineering, and mathematics (STEM) into agricultural education becomes a more important aspect of curriculum development (Saucier et al., 2012), educator associations and educator preparation programs should focus on developing methods for closing the content gap between perceived importance and competence of STEM related content areas such as computer aided design. This recommendation is supported by the work of Stubbs and Myers (2015) who found strong support connecting agricultural mechanics with STEM, and Khalil and Osman (2017) who demonstrate a focus on STEM and STEM related subjects can help improve students' 21^{st} century skill acquisition. Additionally, as Huberman (1989) described, educators in the mid-career experience range commonly seek new strategies and look for ways to experiment with instruction compared to their colleagues in the early- or late-career stages (NAAE, 2015) Since mid-career educators are also more inclined to attend professional development (Burke et al., 1987; Huberman, 1989; Richter et al., 2011; NAAE, 2015), we recommend that professional development opportunities directed primarily towards this group and focused on advanced agricultural mechanics skill areas along with STEM content integration be created to reduce identified discrepancies and provide the diversification desired by educators as well as the competency necessary to help students obtain key 21^{st} century skills.

Further recommendations include topics to consider for researchers, practicing teachers, and teacher educators. First, we recommend studies be completed to explore educators' perceptions of importance further, particularly in areas with large discrepancy scores. Understanding the reasoning behind low importance rankings of these content areas could provide insight into how well professional development efforts would be received by educators. Second, we recommend that additional studies describe the correlations between demographics and the confidence in teaching mechanical skills. Third, we recommend that research be conducted to evaluate student knowledge of agricultural mechanics skills related to teacher confidence in teaching those skills. Knowing the importance of the 21^{st} century skill development and the role of agricultural laboratory settings in this development, continued research and exploration of this topic and type should be a priority of Montana and other states as a means of better preparing agricultural educators and students for the coming changes and advancements in agriculture and the agricultural workforce.

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