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Importance and Capability of Teaching Agricultural Mechanics as Perceived by Secondary Agricultural Educators

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Abstract

Agricultural mechanics instruction is a long-standing and significant part of secondary agricultural education. Similar to the broader agricultural industry, agricultural mechanics instruction is in a constant state of dynamic change. Educators must be proactive to ensure agricultural mechanics curriculum retains its relevance within this changing environment and that educators are prepared to facilitate that change. The agricultural mechanics in-service needs of secondary agricultural educators in Iowa were examined. Researchers used descriptive measures and mean weighted discrepancy scores to determine teacher perceptions of content importance, teaching competence, and in-service training needs. The areas of highest perceived importance were welding safety, construction and shop safety, and shielded metal arc welding. Agricultural mechanics instructors rated themselves least prepared to teach computer aided design, profile leveling, and hot metal work. As shown by mean weighted discrepancy scores, areas of highest additional training need were global positioning systems, electrical safety, and computer aided design.

Keywords: agricultural mechanics; agricultural education; capability; importance; Iowa

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Agricultural mechanics courses have been a significant part of the agricultural education curriculum since its inception and are popular across the United States (Anderson, Velez, & Anderson, 2011). Numerous studies spanning several decades have underscored agricultural mechanics' place in a comprehensive secondary agriculture curriculum (Dyer & Andreasen, 1999; Kotrlik & Drueckhammer, 1987; Laird & Kahler, 1995; Reis & Kahler, 1997; Rosencrans & Martin, 1997; Saucier, Terry, & Schumacher, 2009; and Saucier, Vincent, & Anderson, 2011). Recent studies have noted the need for updated professional development initiatives in agricultural mechanics (McKim, Saucier, & Reynolds, 2010; Pate, Warnick, & Meyers, 2012; Peake, Duncan, & Rickets, 2007; and Saucier, Tummons, Terry, & Schumacher, 2010). Regarding presence of agricultural mechanics in secondary schools, McKim, Saucier, and Reynolds (2010) indicated that agricultural mechanics competencies were present in nearly 60% of the agricultural education curriculum taught in nine states studied. Specific to Iowa, Rudolphi

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and Retallick (2011) found that 89.1% of agricultural education teachers (n = 100) had taught an agricultural mechanics course. Given the popularity of these courses at the secondary level, the question must be asked; are current teachers competent in teaching these courses?

Despite this widespread acceptance of its importance, the field of secondary agricultural mechanics is not immune to modern reform pressures. Shinn (1998) studied 53 agricultural mechanics experts at universities and state departments of education. Despite seeing the strengths of agricultural mechanics, such as developing and applying hands-on skills, encouraging learning by doing, and providing a strong foundation in the physical sciences, respondents believed secondary agricultural mechanics was "'low tech' and 'old fashioned'" (p. 10) and "not state of the art" (p. 10). Additionally, there has been a push within agricultural education courses toward more science-focused content (Hubert & Leising, 2000; Laird & Kahler, 1995; National Research Council, 1988).

Stakeholders within agricultural mechanics generally agree that the industry is changing and that agricultural mechanics curriculum needs to evolve with the industry. However, the involved parties often fail to reach consensus on what the evolved curriculum should include. In a study of agriculture teachers, principals, and superintendents of secondary schools in Nebraska, Foster, Bell, and Erskine (1995) found that each of these three groups predicted less importance of agricultural mechanics in the future curriculum as compared to the current curriculum. Conversely, this same study also indicated that instructors, principals, and superintendents all believed that metals and welding, power and machinery, and robotics would be more important in the future curriculum. This discrepancy between current and future curriculum suggests that views of agricultural mechanics content appropriateness differ and are shifting. With that shift comes the need to realign both curriculum and teaching competencies (Rojewski, 2002).

This question is further complicated by issues arising from questions of who are most qualified to determine what agricultural mechanics content should be taught at the secondary level. In a model of multi-stakeholder cooperation, McCulloch, Burris, and Ulmer (2011) used information and feedback from university faculty, experts in agricultural education, and current teachers to develop and hone a list of necessary pre-service topics to be included within the agricultural education teacher preparation setting. Even though multiple stakeholders were included, it was current teachers who served as the final decision makers as to what topics remained on the final list of curricular items. Similarly, Duncan, Ricketts, Peake, and Uesseler (2006) suggested that current practitioners should be the focus of assessment efforts to determine necessary teacher education content as well as continuing education needs. Most recently, Pate, Warnick, and Meyers (2012) used experienced teachers to identify the most important competencies for welding educators to possess, and went on to suggest that future research should do the same.

These studies underscore the need for secondary teachers' voices to be heard when determining both teacher preparation topics and ongoing professional development needs. The importance of teacher input in curricular development is supported in research from across the country, and is highlighted in states such as Iowa, where teachers have a direct role in deciding what is taught in each class. Iowa is a *local control* state, meaning that curricular choices are left up to the local district (Iowa Department of Education, 2011). With this local control comes a benefit to assessing the in-service needs of the state's secondary instructors, as they are most likely to directly impact curricular development outcomes.

Theoretical Framework

Bandura's theory of self-efficacy was used to guide this work. Self-efficacy, as defined by Bandura (1977) is a belief in one's capability to execute the actions necessary to achieve a certain level of performance. Bandura also stated "the stronger the perceived self-efficacy, the more active the efforts" (p. 194). Self-efficacy determines if an individual will initiate coping behaviors, how much effort an individual will put into an activity, and how long an individual will persist when faced with difficulties. Individuals with high self-efficacy tend to work harder, persist longer, participate more readily, and have fewer emotional reactions than those with lower self-efficacy. Self-efficacy is gained through mastery experiences, physiological and emotional arousal, vicarious experience, and social persuasion (Bandura, 1997). Predetermined beliefs of teachers often influence how they teach content in both the classroom and laboratory (Knobloch, 2008). These beliefs are formed from a variety of sources, among them, comfort level with the content, (Knobloch & Ball, 2003) and perceived value of the content (Lawrenz, 1985). Bandura's theory of self-efficacy was chosen because this study sought to describe both comfort level and perceived value of selected agricultural mechanics content.

Problem Statement

Literature has established the importance of sustaining agricultural mechanics instruction at both the secondary (Anderson, Velez, & Anderson, 2011; Kotrlik & Drueckhammer, 1987; Laird & Kahler, 1995; Reis & Kahler, 1997; Rosencrans & Martin, 1997; Saucier, Terry, & Schumacher, 2009; and Saucier, Vincent, & Anderson, 2011) and teacher preparation (Burris, Robinson, Terry, 2005; Hubert & Leising, 2000; McCulloch, Burris, & Ulmer, 2011) levels. The question remains however; what should constitute a modern agricultural mechanics curriculum? Just as importantly; what changes must be made in teacher preparation and professional development to ensure our teaching workforce remains highly qualified and capable of preparing the next generation of career and technical education students? The study of this question aligns with the American Association for Agricultural Education's National Research Agenda Research Priority Area 3: Sufficient Scientific and Professional Workforce That Addresses the Challenges of the 21st Century (Doerfert, 2011). This research purpose also aligns with the National Career and Technical Education Research Agenda Research Problem Area (RPA) 5: Program Relevance and Effectiveness, specifically relating to research activity (RA) 5.1.3: Professional Development of Teachers; with secondary implications in (RA) 1.2.2: CTE Teacher Education (Lambeth, Elliot, & Joerger, 2008).

Purpose & Objectives

The purpose of this study was to describe secondary agricultural educators' perceptions of the importance of, and their capability to teach selected agricultural mechanics skills in a formal secondary education setting. The following objectives were identified to fulfill the purpose of this study.

1. Describe the demographic characteristics of participating agricultural educators.
2. Describe the importance of selected agricultural mechanics content areas as perceived by secondary agricultural educators.
3. Describe the perceived capability of secondary agricultural educators to teach agricultural mechanics content areas.
4. Determine the discrepancy between the importance of agricultural mechanics content areas and the capability to teach agricultural mechanics content areas as perceived by secondary agricultural educators.

Methods and Procedures

This descriptive study used survey research methods to summarize characteristics, attitudes, and opinions to accurately describe a norm (Ary, Jacobs, Razavieh, & Sorensen, 2006). A researcher-modified, paper based questionnaire was used to address the objectives of the study. The instrument contained three sections. Section one included 54 skills related to agricultural mechanics. Skills were separated into five domains, including: Mechanic Skills, Structures/Construction, Electrification, Power and Machinery, and Soil and Water. Respondents were asked to use a five-point summated rating scale to rate their perceptions of the importance of teaching each skill in secondary agricultural education, as well as their competency to teach each skill. Section two consisted of 15 demographic questions relating to the teacher, and section three included nine questions about program and school characteristics. Content validity was reviewed by a team of five university faculty members with expertise in the fields of agricultural mechanics and agricultural education. Following the recommendations of Dillman, Smyth, and Christian (2009), the initial electronic version of the instrument was pretested through a pilot study with a group of 12 agriculture teachers in a nearby state. Suggestions from this pilot study led researchers to adopt a paper-based, rather than electronic, instrument. Post-hoc reliability was estimated following the suggestions of Gliem and Gliem (2003) and resulted in reliability coefficients for importance ($\alpha = 0.97$) and competency ($\alpha = 0.98$).

Data were collected through a census conducted during the 2011 Iowa agricultural education teachers' conference. This population was purposively targeted because of their likelihood to be involved in additional professional development activities. Researchers distributed a questionnaire to each secondary instructor ($N = 130$) in attendance and asked that it be completed by the end of the conference. Each participant was offered a power tool institute safety curriculum as an incentive for completing and returning the questionnaire. These efforts yielded a sample of 103 usable instruments for a 79.2% response rate. No further effort was made to obtain data from non-respondents. As a result, non-response error was addressed following the suggestions of Miller and Smith (1983) by comparing respondents' personal and program demographic data to data from the Iowa Department of Education (2010). A Pearson's χ^2 analysis yielded no significant differences *($p > .05$)* for gender, age, highest degrees held, years of teaching experience, or size of school community between respondents and the general population of agriculture teachers in Iowa. However, due to the purposively selected sample, data from this study should be interpreted with care and not extrapolated beyond the target population. Data were coded and analyzed using JMP Pro Version 9.0.0.

Researchers used the Borich (1980) needs assessment model to quantify teacher's perceived ability to teach and the teachers' perception of the necessity to teach concepts within agricultural mechanics. A Mean Weighted Discrepancy Score (MWDS) was calculated for each construct by finding the mathematical difference between each teacher's perception of the appropriateness for each construct and his or her perceived ability to teach each construct. This difference was multiplied by the mean of the appropriateness rating for each construct. The values for all participants were summed, and then divided by the total number of responses for that construct. Competencies were then ranked from largest to smallest MWDS. Constructs with a higher MWDS were in higher need for in-service training compared to those constructs with a lower MWDS (Garton & Chung, 1997).

Results

The first research objective sought to describe the demographic characteristics of participating teachers. The vast majority of teachers were employed by rural school districts with single-teacher departments. Also worthy of note, the majority of respondents reported 10 or fewer years of teaching experience. Table 1 contains a summary of respondent characteristics.

Table 1

Summary of Respondents' Demographic Characteristics

	f	%
Gender		
Male	69	67.0
Female	34	33.0
Highest Level of Education		
Bachelor's Degree	64	62.1
Master's Degree	39	37.9
Years of Teaching Experience		
0-5	32	31.1
6-10	22	21.4
11-15	11	10.7
16-20	7	6.8
21-25	5	4.8
26-30	10	9.7
More than 30	16	15.5
Campus Location Designation		
Rural (population less than 5,000)	80	79.2
Small Urban (population between 5,000 and 20,000)	19	18.8
Urban (population greater than 20,000)	2	2.0
Number of Agricultural Science Teachers in Department		
1 Teacher	91	90.0
2 Teachers	7	7.0
3 Teachers	3	3.0

Describing the importance of selected agricultural mechanics content areas as perceived by secondary agricultural educators was the goal of research objective two. Six skills were described as Very Important by a majority of respondents. These skills included Welding Safety, Construction Site and Shop Safety, SMAW Welding, Mechanical Safety, and Electrical Safety. No skills had a majority of respondents rating the items as Not Important. Weighted frequency means were calculated for 54 independent agricultural mechanics topics with respect to perceived importance of teaching at the secondary level. For each respondent, a response of Very Important received a weighted score of five, important received four, Moderately Important received three, Slightly Important received two, and Not Important received one. Weighted scores for each skill were summed and divided by the number of respondents for that item to calculate a weighted frequency mean. Frequencies and percentages of respondents are displayed in Table 2.

Table 2

Agricultural Mechanics Areas of Highest Perceived Importance

		NI	SI	MI	I	VI	
Rk	Skill	*f*(%)	*f*(%)	*f*(%)	*f*(%)	*f*(%)	*M*
1	Welding Safety	2(2.02)	2(2.02)	2(2.02)	11(11.11)	82(82.83)	4.71
2	Construction and Shop Safety	0(0.00)	2(2.13)	12(12.77)	21(22.34)	59(62.77)	4.46
3	SMAW Welding	2(2.04)	3(3.06)	7(7.14)	35(35.71)	51(52.04)	4.33
4	Small Engine Safety	2(2.22)	1(1.11)	9(10.00)	33(36.67)	45(50.00)	4.31
5	GMAW Welding	2(2.11)	3(3.16)	9(9.47)	31(32.63)	50(52.63)	4.31
6	Mechanical Safety	3(3.30)	5(5.49)	9(9.89)	22(24.18)	52(57.14)	4.26
7	Wood Working Power Tools	2(2.08)	2(2.08)	13(13.54)	33(34.38)	46(47.92)	4.24
8	Global Positioning Systems (GPS)	2(2.22)	1(1.11)	13(14.44)	32(35.56)	42(46.67)	4.23
9	Bill of Materials	1(1.08)	3(3.23)	17(18.28)	27(29.03)	45(48.39)	4.20
10	Electrical Safety	2(2.25)	8(8.99)	9(10.11)	22(24.72)	48(53.93)	4.19
11	Oxy-acetylene Cutting	2(2.00)	3(3.00)	12(12.00)	44(44.00)	39(39.00)	4.15
12	Plasma Cutting	2(2.25)	4(4.49)	16(17.98)	26(29.21)	41(46.07)	4.12
13	Selection of Materials	1(1.10)	2(2.20)	19(20.88)	38(41.76)	31(34.07)	4.05
14	Wood Working Hand Tools	3(3.13)	2(2.08)	16(16.67)	43(44.79)	32(33.33)	4.03
15	Small Engine Services - 4 Cycle	3(3.33)	4(4.44)	15(16.67)	35(38.89)	33(36.67)	4.01
16	Power and Machinery Safety	5(5.75)	5(5.75)	15(17.24)	23(26.44)	39(44.83)	3.99
17	Construction Skills (Carpentry)	2(2.17)	5(5.43)	18(19.57)	35(38.04)	32(34.78)	3.98
18	Legal Land Descriptions	3(3.26)	4(4.35)	19(20.65)	33(35.87)	33(35.87)	3.97
19	Tractor Safety	5(5.81)	5(5.81)	16(18.60)	23(26.74)	37(43.02)	3.95
20	Small Engine Overhaul	4(4.55)	5(5.68)	15(17.05)	34(38.64)	30(34.09)	3.92
21	Small Engine Services - 2 Cycle	4(4.44)	4(4.44)	19(21.11)	35(38.89)	28(31.11)	3.88
22	Wiring Skills - Switches and Outlets	3(3.30)	9(9.89)	16(17.58)	32(35.16)	31(34.07)	3.87
23	Oxy-acetylene Welding	4(4.04)	4(4.04)	24(24.24)	38(38.38)	29(29.29)	3.85
24	Drawing and Sketching	1(1.15)	5(5.75)	26(29.89)	31(35.63)	24(27.59)	3.83
25	Electrician Tools	3(3.33)	10(11.11)	17(18.89)	37(41.11)	23(25.56)	3.74

(Table 2 continues)

(Table 2 continued)

		NI	SI	MI	I	VI	
Rk	Skill	*f*(%)	*f*(%)	*f*(%)	*f*(%)	*f*(%)	*M*
26	Tractor Maintenance	5(5.88)	5(5.88)	21(24.71)	30(35.29)	24(28.24)	3.74
27	Fasteners	3(3.37)	7(7.87)	26(29.21)	28(31.46)	25(28.09)	3.73
28	GTAW Welding (TIG)	3(3.57)	11(13.10)	17(20.24)	31(36.90)	22(26.19)	3.69
29	Use of Survey Equipment	4(4.49)	9(10.11)	19(21.35)	37(41.57)	20(22.47)	3.67
30	Concrete	2(2.27)	8(9.09)	28(31.82)	29(32.95)	21(23.86)	3.67
31	Tractor Service	5(5.88)	8(9.41)	23(27.06)	28(32.94)	21(24.71)	3.61
32	Electricity Controls	4(4.49)	12(13.48)	22(24.72)	30(33.71)	21(23.60)	3.58
33	Service Machinery	5(5.88)	7(8.24)	27(31.76)	29(34.12)	17(20.00)	3.54
34	Tractor Driving	7(8.24)	10(11.76)	23(27.06)	23(27.06)	22(25.88)	3.51
35	Machinery Operation	5(5.88)	9(10.59)	28(32.94)	26(30.59)	17(20.00)	3.48
36	Machinery Selection	5(5.95)	8(9.52)	30(35.71)	26(30.95)	15(17.86)	3.45
37	Tractor Operation	5(5.95)	11(13.10)	28(33.33)	23(27.38)	17(20.24)	3.43
38	Plumbing	7(8.24)	11(12.94)	22(25.88)	30(35.29)	15(17.65)	3.41
39	Computer Aided Design (CNC)	5(6.17)	12(14.81)	27(33.33)	22(27.16)	15(18.52)	3.37
40	Types of Electrical Motors	4((4.60))	23(26.44)	16(18.39)	25(28.74)	19(21.84)	3.37
41	Soldering	6(6.67)	13(14.44)	27(30.00)	30(33.33)	14(15.56)	3.37
42	Oxy-acetylene Brazing	5(5.32)	16(17.02)	31(32.98)	24(25.53)	18(19.15)	3.36
43	Cleaning Motors	6(7.23)	19(22.89)	16(19.28)	26(31.33)	16(19.28)	3.33
44	Fencing	9(10.98)	15(18.29)	18(21.95)	21(25.61)	19(23.17)	3.32
44	Tractor Selection	5(6.10)	15(18.29)	26(31.71)	21(25.61)	15(18.29)	3.32
46	Tool Conditioning	8(9.64)	13(15.66)	26(31.33)	19(22.89)	17(20.48)	3.29
47	Differential Leveling	7(8.86)	14(17.72)	21(26.58)	26(32.91)	11(13.92)	3.25
48	Tractor Overhaul	6(7.14)	15(17.86)	27(32.14)	24(28.57)	12(14.29)	3.25
49	Oxy-propylene Cutting	13(16.05)	8(9.88)	23(28.40)	23(28.40)	14(17.28)	3.21
50	Metallurgy and Metal Work	7(8.14)	12(13.95)	34(39.53)	23(26.74)	10(11.63)	3.20
51	Pipe Cut. And Threading	7(8.54)	18(21.95)	23(28.05)	22(26.83)	12(14.63)	3.17
52	Profile Leveling	8(10.13)	14(17.72)	26(32.91)	22(27.85)	9(11.39)	3.13
53	Cold Metal Work	8(9.64)	18(21.69)	26(31.33)	22(26.51)	9(10.84)	3.07
54	Hot Metal Work	8(9.64)	19(22.89)	27(32.53)	21(25.30)	8(9.64)	3.02

Note. Rk = Rank. NI = not important, SI = slightly important, MI = moderately important, I = important, VI = very important. *n* = 79 to 94 usable responses. *M* = Weighted Frequency Mean.

The goal of research objective three was to describe the perceived competence of Iowa agriculture teachers to teach agricultural mechanics skills. No skills had a majority of respondents rating the topic as *Very Strongly Competent.* Conversely, 11 skills had a majority of respondents rating them as either *No Competence* or *Little Competence*. These skills included Computer Aided Design, Profile Leveling, Hot Metal Work, Cleaning Electrical Motors, Cold Metal Work, Differential Leveling, Oxy-propylene Cutting, Electrical Motor Types, GTAW Welding (TIG), Metallurgy, and Electric Controls.

Weighted frequency means were calculated for 54 independent agricultural mechanics topics with respect to perceived teaching competence. For each respondent, a response of *Very Strong Competence* received a weighted score of five, *Strong Competence* received four, *Moderate Competence* received three, *Little Competence* received two, and *No Competence* received one. Weighted scores for each skill were summed and divided by the number of respondents for that item to calculate a weighted frequency mean. Frequencies and percentages of respondents are displayed in Table 3.

Research objective four was to determine the discrepancy between agricultural mechanics topic importance and the competence to teach agricultural mechanics topics as perceived by Iowa secondary agriculture teachers. Professional development need was determined by the mean weighted discrepancy score (MWDS). Discrepancy scores were calculated in Excel according to the Borich (1980) needs assessment model. Discrepancy scores were calculated for each respondent for each skill. MWDS are displayed in Table 4.

Table 3

Agricultural Mechanics Areas of Highest Perceived Ability to Teach

		NC	LC	MC	SC	VSC	
Rk	Skill	*f*(%)	*f*(%)	*f*(%)	*f*(%)	*f*(%)	*M*
1	Welding Safety	4(4.04)	8(8.08)	15(15.15)	30(30.30)	41(41.41)	3.98
2	Construction and Shop Safety	4(4.26)	10(10.64)	16(17.02)	30(31.91)	33(35.11)	3.84
3	Wood Working Power Tools	3(3.13)	8(8.33)	24(25.00)	34(35.42)	25(26.04)	3.74
4	Wood Working Hand Tools	4(4.17)	9(9.38)	26(27.08)	27(28.13)	28(29.17)	3.70
5	SMAW Welding (Arc)	4(4.08)	9(9.18)	28(28.57)	33(33.67)	24(24.49)	3.65
6	Bill of Materials	5(5.38)	11(11.83)	17(18.28)	40(43.01)	19(20.43)	3.62
7	GMAW Welding (Mig)	5(5.26)	15(15.79)	25(26.32)	28(29.47)	23(24.21)	3.51
8	Oxy-acetylene Cutting	5(5.00)	13(13.00)	26(26.00)	37(37.00)	18(18.00)	3.51
9	Legal Land Descriptions	6(6.52)	18(19.57)	23(25.00)	26(28.26)	20(21.74)	3.39
10	Construction Skills (Carpentry)	8(8.70)	14(15.22)	24(26.09)	27(29.35)	19(20.65)	3.38
11	Mechanical Safety	7(7.69)	18(19.78)	20(21.98)	26(28.57)	20(21.98)	3.37
12	Selection of Materials	7(7.69)	12(13.19)	23(25.27)	37(40.66)	11(12.09)	3.37
12	Small Engine Safety	9(10.00)	14(15.56)	18(20.00)	33(36.67)	16(17.78)	3.37
14	Tractor Safety	9(10.47)	18(20.93)	14(16.28)	25(29.07)	21(24.42)	3.36
15	Tractor Driving	11(12.94)	15(17.65)	14(16.47)	26(30.59)	20(23.53)	3.34
16	Small Engine Services - 4 Cycle	9(10.00)	14(15.56)	25(27.78)	28(31.11)	14(15.56)	3.27
17	Power and Machinery Safety	12(13.79)	17(19.54)	16(18.39)	24(27.59)	20(22.99)	3.26
18	Oxy-acetylene Welding	8(8.08)	17(17.17)	27(27.27)	36(36.36)	11(11.11)	3.25
19	Plasma Cutting	10(11.24)	15(16.85)	24(26.97)	33(37.08)	10(11.24)	3.20
20	Drawing and Sketching	8(9.20)	14(16.09)	32(36.78)	19(21.84)	14(16.09)	3.20
21	Concrete	9(10.23)	18(20.45)	23(26.14)	23(26.14)	15(17.05)	3.19
22	Tractor Operation	10(11.90)	18(21.43)	18(21.43)	24(28.57)	15(17.86)	3.19
23	Small Engine Overhaul	11(12.50)	16(18.18)	24(27.27)	24(27.27)	13(14.77)	3.14
24	Fasteners	11(12.36)	16(17.98)	24(26.97)	26(29.21)	11(12.36)	3.11
25	Small Engine Services - 2 Cycle	8(8.89)	16(17.78)	30(33.33)	27(30.00)	7(7.78)	3.10

(Table 3 continues)

(Table 3 continued)

		NC	LC	MC	SC	VSC	
Rk	Skill	*f*(%)	*f*(%)	*f*(%)	*f*(%)	*f*(%)	*M*
26	Electrical Safety	11(12.36)	23(25.84)	19(21.35)	18(20.22)	17(19.10)	3.08
27	Tractor Maintenance	11(12.94)	22(25.88)	17(20.00)	22(25.88)	14(16.47)	3.07
28	Machinery Operation	11(12.94)	22(25.88)	17(20.00)	27(31.76)	10(11.76)	3.03
29	Tractor Service	10(11.76)	24(28.24)	20(23.53)	20(23.53)	13(15.29)	3.02
30	Service Machinery	13(15.29)	20(23.53)	18(21.18)	23(27.06)	12(14.12)	3.01
31	Wiring Skills (Switches and Outlets)	14(15.38)	21(23.08)	21(23.08)	23(25.27)	12(13.19)	2.98
32	Machinery Selection	12(14.29)	22(26.19)	23(27.38)	19(22.62)	9(10.71)	2.89
33	Global Positioning Systems (GPS)	7(7.78)	19(21.11)	46(51.11)	15(16.67)	4(4.44)	2.89
34	Electrician Tools	15(16.67)	22(24.44)	22(24.44)	20(22.22)	11(12.22)	2.89
35	Fencing	9(10.98)	23(28.05)	26(31.71)	21(25.61)	5(6.10)	2.88
36	Oxy-acetylene Brazing	16(17.02)	23(24.47)	21(22.34)	24(25.53)	7(7.45)	2.81
37	Tractor Selection	12(14.63)	23(28.05)	23(28.05)	22(26.83)	3(3.66)	2.77
38	Use of Survey Equipment	15(16.85)	22(24.72)	34(38.20)	16(17.98)	3(3.37)	2.67
39	Tractor Overhaul	16(19.05)	25(29.76)	22(26.19)	17(20.24)	5(5.95)	2.65
40	Soldering	16(17.78)	26(28.89)	25(27.78)	18(20.00)	4(4.44)	2.64
41	Plumbing	16(18.82)	25(29.41)	24(28.24)	18(21.18)	3(3.53)	2.62
42	Electricity Controls	16(17.98)	30(33.71)	21(23.60)	19(21.35)	3(3.37)	2.58
43	Tool Conditioning	18(21.69)	22(26.51)	26(31.33)	16(19.28)	1(1.20)	2.52
44	Metallurgy and Metal Work	14(16.28)	32(37.21)	23(26.74)	14(16.28)	2(2.33)	2.51
45	GTAW Welding (TIG)	16(19.05)	31(36.90)	22(26.19)	15(17.86)	2(2.38)	2.49
46	Pipe Cut. And Threading	21(25.61)	20(24.39)	23(28.05)	16(19.51)	2(2.44)	2.49
47	Oxy-propylene Cutting	24(29.63)	25(30.86)	16(19.75)	15(18.52)	5(6.17)	2.44
48	Types of Electrical Motors	17(19.54)	32(36.78)	24(27.59)	9(10.34)	4(4.60)	2.43
49	Cold Metal Work	18(21.69)	32(38.55)	21(25.30)	12(14.46)	1(1.20)	2.36
50	Cleaning Motors	17(20.48)	32(38.55)	22(26.51)	7(8.43)	3(3.61)	2.35
51	Differential Leveling	18(22.78)	29(36.71)	27(34.18)	5(6.33)	2(2.53)	2.31

(Table 3 continues)

(Table 3 continued)

		NC	LC	MC	SC	VSC	
Rk	Skill	*f*(%)	*f*(%)	*f*(%)	*f*(%)	*f*(%)	*M*
52	Hot Metal Work	20(24.10)	32(38.55)	22(26.51)	10(12.05)	1(1.20)	2.29
53	Profile Leveling	20(25.32)	31(39.24)	22(27.85)	5(6.33)	2(2.53)	2.23
54	Computer Aided Design (CNC)	31(38.27)	28(34.57)	14(17.28)	7(8.64)	1(1.23)	2.00

Table 4

Teaching Competencies Ranked by MWDS as Perceived by [State] High School Agriculture Instructors

Rank	Construct	MWDS	Imp Rank	Comp Rank	*n*
1	Global Positioning Systems (GPS)	5.71	8	33	89
2	Electrical Safety	4.67	10	26	87
3	Computer Aided Design (CNC)	4.51	39	54	80
4	GTAW Welding (TIG)	4.39	28	45	84
5	Small Engine Safety	4.02	4	12.5	89
6	Mechanical Safety	3.79	6	11	90
7	Use of Survey Equipment	3.63	29	38	88
8	Plasma Cutting	3.61	12	19	88
9	Electricity Controls	3.58	32	42	89
10	Wiring Skills (Switches and Outlets)	3.44	22	31	91
11	Welding Safety	3.41	1	1	98
12	GMAW Welding (Mig)	3.40	5	7	95
13	Electrician Tools	3.20	25	34	90
14	Small Engine Services - 2 Cycle	3.17	21	25	88
15	Types of Electrical Motors	3.13	40	48	86
16	Cleaning Motors	3.12	43	50	80
17	Differential Leveling	3.04	47	51	78
18	Small Engine Overhaul	3.02	20	23	87
19	Small Engine Services - 4 Cycle	2.93	15	16	89
20	SMAW Welding (Arc)	2.85	3	5	97
21	Plumbing	2.81	38	41	85
22	Power and Machinery Safety	2.80	16	17	87
23	Profile Leveling	2.77	52	53	78
24	Construction and Shop Safety	2.66	2	2	92
25	Selection of Materials	2.64	13	12	89
26	Oxy-acetylene Cutting	2.64	11	8	99
27	Soldering	2.49	41	40	88
28	Tool Conditioning	2.48	46	43	81
29	Oxy-propylene Cutting	2.46	49	47	81
30	Tractor Maintenance	2.42	26	27	85
31	Construction Skills (Carpentry)	2.39	17	10	90
32	Legal Land Descriptions	2.37	18	9	92
33	Drawing and Sketching	2.30	24	20	85
34	Oxy-acetylene Welding	2.29	23	18	99
35	Bill of Materials	2.26	9	6	91

(Table 4 continues)

(Table 4 continued)

Rank	Construct	MWDS	Imp Rank	Comp Rank	*n*
36	Tractor Safety	2.25	19	14	86
37	Fasteners	2.23	27	24	87
38	Hot Metal Work	2.22	54	52	83
39	Cold Metal Work	2.22	53	49	83
40	Metallurgy and Metal Work	2.22	50	44	85
41	Pipe Cut. And Threading	2.19	51	46	81
42	Wood Working Power Tools	2.12	7	3	94
43	Tractor Service	2.00	31	29	85
44	Tractor Overhaul	1.90	48	39	84
45	Machinery Selection	1.85	36	32	84
46	Oxy-acetylene Brazing	1.81	42	36	91
47	Service Machinery	1.79	33	30	85
48	Tractor Selection	1.74	44.5	37	82
49	Concrete	1.66	30	21	86
50	Fencing	1.50	44	35	82
51	Machinery Operation	1.47	35	28	85
52	Wood Working Hand Tools	1.33	14	4	94
53	Tractor Operation	0.73	37	22	84
54	Tractor Driving	0.49	34	15	85

Conclusions and Discussion

The purpose of this study was to describe the perceptions of Iowa secondary agricultural educators regarding the importance and capability of teaching selected agricultural mechanics skills in a formal secondary setting. Research objective one sought to describe the demographic characteristics of Iowa agricultural education teachers. The typical agriculture teacher in Iowa was male (67.0%) and held a bachelor’s degree (62.1%) as their highest level of education. He was the single agricultural teacher (90.0%) employed in a rural school district (79.2%) and had fewer than 10 years (52.4%) of teaching experience. The characteristics of teachers in this study were similar to data compiled by the Iowa Department of Education (2010) which reported the following demographic characteristics of Iowa agriculture teachers (n = 195): gender (male = 71.9%, female = 28.1%), highest degree earned (bachelor’s = 61.5%), teaching experience (less than 10 years = 42.5%). In a recent study of Iowa agricultural teachers (n = 137), Rudolphi and Retallick (2011) reported gender demographics for males (73.0%) and females (27.0%). Although results and recommendations from this study are specific to agricultural education in Iowa, other states, especially those with local control of education, may also benefit from the conclusions and recommendations that follow.

Research objective two addressed the perceived importance of teaching specific agricultural mechanics skills at the secondary level. Among the 10 skills perceived to be most important, five related to safety: Welding Safety, Construction Site & Shop Safety, Small Engine Safety, Mechanical Safety, and Electrical Safety. These results support the conclusions of Dyer and Andreason’s (1999) synthesis of research which suggested that questions of content and methodology are secondary to those of safety in the agricultural mechanics laboratory.

Teachers responding to this study perceived four metals-related skills to be among 10 of the least appropriate topics for the secondary setting. These skills included Hot Metal Work, Cold Metal Work, Metallurgy, and Oxy-propylene Cutting. Follow-up research may be necessary to determine why teachers believe these, and other low-rated skills from this study are not appropriate for agricultural mechanics curriculum. Do teachers perceive these skills to no longer be relevant, or do they believe these skills should be taught as part of other CTE areas? Do the low-ratings of these skills indicate a lack of exposure to these skills in teachers' pre-service training programs?

Research objective three sought to describe perceived competence of teaching agricultural mechanics skills at the secondary level. Skills related to structures and carpentry were well represented with five such skills surfacing in the list of skills with the 10 highest perceived competency ratings. These skills included Construction Site & Shop Safety, Woodworking – Power Tools, Woodworking – Hand Tools, Bill of Materials, and General Carpentry & Construction Skills. These results diverge somewhat from the findings of Peake, Duncan, and Ricketts (2007) who studied the general competencies of agriculture teachers in Georgia, and reported that respondents (n = 209) perceived themselves to be less competent to teach construction than they were to teach technology, welding, and electricity. This study found teachers in Iowa perceived themselves to be least competent in computer aided design, both profile and differential leveling, and hot metal work. This aligns with a study of agriculture teachers in Louisiana, which found deficiencies in computer and software specific skills (Kotrlik, Redmann, Harrison, & Handley, 2000).

Research objective four sought to determine discrepancies between the importance of agricultural mechanics content areas and the capability to teach those content areas as perceived by secondary agricultural educators. This study identified global positioning systems, electrical safety, computer aided design, and TIG welding as having the most need for professional development. This is in line with the results of Saucier, Tummons, Terry, and Schumacher (2010) who studied agricultural educators in Missouri (n = 383), and reported global positioning systems to be the technical competency with the highest perceived need for in-service. Similarly, in a more general study of Georgia teachers (n = 209), Peake, Duncan, and Ricketts (2007) identified curriculum integration of agriculture technology advances as the highest need for in-service. This study also contributes to the national trend indicating a need for increased emphasis on emerging agriculture technology in both professional development and teacher preparation programs.

Recommendations and Implications

Researchers recommend the findings of this study be taken into account as teacher educators in Iowa plan professional development courses for secondary teachers. The specific needs with the highest ranking should be given priority when planning and developing programs for current teachers. As three of the five areas of highest need are relatively new, professional development opportunities for in-service teachers should focus on more recently developed areas such as global positioning systems, computer aided design, and TIG welding. In addition, coordinators of teacher preparation programs in Iowa should take advantage of in-service teacher perceptions by ensuring pre-service teachers are exposed to those skills found near to top in Table 2, which were identified as important. Conversely, the same coordinators may consider giving less credence to those skills found near the bottom in Table 2. While this study is specific to Iowa, it is also recommended that other states continue to examine their professional development and teacher preparation programs to determine if similar needs exist in their states as well.

Recommendations for study replication include review and modification of the survey instrument. Researchers suspect instrument length may have led to decreased quality of responses. The exceptionally high Cronbach's alpha coefficients (importance = .97, competence

= .98) may indicate the presence of redundant items. A factor analysis may yield insight into regrouping or eliminating certain skill areas. Review by industry experts may also identify new skill areas that should be added to the instrument. Although generalization was not a goal of this study, those limitations are present and stem from the purposive nature of participant selection.

Recommendations for future research include investigation and refinement of the need for GPS related training regarding the type, depth, and specific content in greatest need. An exploration of the bipolar nature of related results, such as welding and metal work may be warranted as well. Research into the reasons behind teachers' belief that both profile and differential leveling are unimportant may shed light on their unfavorable perceptions of an otherwise commonly used skill. Additional research should compare the results of this study, and similar studies that have addressed teacher perceptions, to the perceptions of content importance as perceived by industry experts. Development of Curriculum for Agricultural Science Education™ (CASE™) in Agricultural Technology and Systems is scheduled to begin in 2014 (The National Council for Agricultural Education, 2012). Arguably, data synthesized from studies of both in-service teachers and industry experts should serve as a reference for developers of these curriculum modules.

References

Anderson, S. M., Velez, J. J., & Anderson, R. G. (2011). Using the health beliefs model to comparatively examine the welding safety beliefs of postsecondary agriculture education students and their non-agricultural education peers. *Proceedings of the 2011 AAAE Research Conference 38,* 288-301.

Ary, D., Jacobs, L., Razavieh, A., & Sorensen, C. (2006). *Introduction to research in education*. (7th ed.). Belmont, CA: Wadsworth Publishing.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191-215. doi:10.1037/0033-295X.84.2.191

Bandura, A. (1997). *Self–efficacy: The exercise of control.* New York, NY: W. H. Freeman and Company.

Borich, G. D. (1980). A needs assessment model for conducting follow-up studies. *The Journal of Teacher Education,31*(3), 39-42. doi:10.1177/002248718003100310

Burris, S., Robinson, J. S., & Terry, R., Jr. (2005). Preparation of pre-service teachers in agricultural mechanics. *Journal of Agricultural Education, 46*(3), 23–34. doi:10.5032/jae.2005.03023

Dillman, D. A., Smyth, J. D., & Christian, L. M. (2009). *Internet, mail, and mixed-mode surveys: The tailored design method (3rd ed.).* Hoboken, NJ: John Wiley & Sons, Inc.

Doerfert, D. L. (Ed.) (2011). *National research agenda: American Association for Agricultural Education's research priority areas for 2011-2015.* Lubbock, TX: Texas Tech University, Department of Agricultural Education and Communications.

Duncan, D. W., Ricketts, J. C., Peak, J. B., & Uesseler, J. (2006). Teacher preparation and in-service needs of Georgia agriculture teachers. *Journal of Agricultural Education, 47*(2), 24–35. doi:10.5032/jae.2006.02024

Dyer, J. E., & Andreasen, R. J. (1999). Safety issues in agricultural education laboratories: a synthesis of research. *Journal of Agricultural Education, 40*(2), 46-54. doi: 10.5032/jae.1999.02046

Foster, R., Bell, L. & Erskine, N. (1995). The importance of selected instructional areas in the present and future secondary agricultural education curriculum as perceived by teachers, principals, and superintendents in Nebraska. *Journal of Agricultural Education, 36*(3), 1-7. doi:10.5032/jae.1995.03001

Garton, B. L., & Chung, N. (1997). An assessment of the inservice needs of beginning teachers of agriculture using two assessment models. *Journal of Agricultural Education, 38*(3), 51-58. doi:10.5032/jae.1997.03051

Gliem, J. A., & Gliem, R. R. (2003). Calculating, interpreting, and reporting Cronbach's alpha reliability coefficient for Likert-type scales. *Proceedings of the 2003 Midwest Research to Practice Conference in Adult, Continuing, and Community Education*, 82-88.

Hubert, D. J., & Leising, J. G. (2000). An assessment of agricultural mechanics course requirements in agricultural teacher education programs in the United States. *Journal of Southern Agricultural Education Research, 50*(1), 18–26.

Iowa Department of Education (2010). FY10 Iowa High School Agricultural Education Contract Summary. Retrieved from https://docs.google.com/a/Iowa.edu/viewer?a=v&pid =sites&srcid=dGVhbWFnZWQuY29tfHd3d3xneDpmZjI4Mzc4OWViMjM0M2Q

Iowa Department of Education (2011). How the Iowa Education System Works. Retrieved from http://educateIowa.gov/index.php?option=com_content&task=view&id=277&Itemid=1

Knobloch, N. & Ball, A. (2003). An examination of elementary teachers' and agricultural literacy coordinators' beliefs related to the integration of agriculture. Retrieved from http://www.agriculturaleducation.org/ LinkPages/AgLiteracyK8.asp.

Knobloch, N.A. (2008). Factors of teacher beliefs related to integrating agriculture into elementary school classrooms. *Agriculture and Human Values, 25,* 529-539. doi:10.1007/s10460-008-9135-z

Kotrlik, J. W., & Drueckhammer, D. C. (1987). The importance of selected external factors and programmatic components in planning vocational agriculture programs. *The Journal of Agricultural Education*, *28*(4), 26-31, 49. doi:10.5032/jaatea.1987.04026

Kotrlik, J. W., Redmann, D. H., Harrison, B. C., and Handley, C. S. (2000). Information technology related professional development needs of Louisiana agriscience teachers. *Journal of Agricultural Education, 41*(1), 18-29. doi:10.5032/jae.2000.01018

Laird, S. C., & Kahler, A. A. (1995). Present and future emphasis of secondary school agricultural mechanics programs in the United States. *Proceedings of the 22nd Annual National Agricultural Education Research Meeting.* 318-329.

Lambeth, J. M., Elliot, J., & Joerger, R. (2008). The national career and technical education research agenda. *Techniques, 83*(7).

Lawrenz, F. (1985). Impact on a five week energy education program on teacher beliefs and attitudes. *School Science and Mathematics, 85*(1), 27-36. doi:10.1111/j.1949-8594.1985.tb09593.x

McCulloch, A., Burris, S., & Ulmer, J. (2011) Do we have the right recipe? A study of current teachers' perceptions on the needed ingredients for adequate teacher preparation. *Proceedings of the American Association for Agricultural Education Research Conference 38*, 449-462.

McKim, B.R., Saucier, P.R., & Reynolds, C.L. (2010). Laboratory management in-service needs of Wyoming secondary agriculture teachers. *Proceedings of the 2010 Western Region of the American Association for Agricultural Education Research Conference*, 129-142.

Miller, L. E., & Smith, K. L. (1983). Handling nonresponse issues. *Journal of Extension, 21*(5), 45 – 50.

National Research Council (1988). *Understanding Agriculture: New Directions for Education*, Washington DC: National Academy Press.

Pate, M. L., Warnick, B. K., & Meyers, T. (2012). Determining the critical skills beginning agriculture teachers need to successfully teach welding. *Career and Technical Education Research, 37*(2), 171-184. doi:10.5328/cter37.2.171

Peake, J. B., Duncan, D. W., & Ricketts, J. C. (2007). Identifying technical content training needs of Georgia agriculture teachers. *Journal of Career and Technical Education, 23*(1), 44-54.

Reis, R., & Kahler, A.A. (1997). Factors influencing enrollment in agricultural education programs as expressed by Iowa secondary agricultural education students. *Journal of Agricultural Education, 38*, 38-48. doi:10.5032/jae.1997.02038

Rojewski, J. W. (2002). Preparing the workforce of tomorrow: A conceptual framework for career and technical education. Journal of Vocational Education Research, 27(1), 7-35.

Rosencrans, C., Jr., & Martin, R. A. (1997). The role of agricultural mechanization in the secondary agricultural education curriculum as viewed by agricultural educators. *Proceedings of the 24th Annual National Agricultural Education Research Meeting*, 253-262.

Rudolphi, J. M. & Retallick, M. S. (2011). Integration and needs of Iowa high school agricultural educators regarding agricultural safety and health education. *Proceeding of the 2011 American Association for Agricultural Education Research Conference 38,* 303-316.

Saucier, P. R., Terry, R., Jr., & Schumacher, L. G. (2009). Laboratory management professional development needs of Missouri agriculture educators. *Proceedings of the Southern Region of the American Association for Agricultural Education Conference,* 176 – 191.

Saucier, P. R., Tummons, J. D., Terry, R., Jr. & Schumacher, L. G. (2010). Professional development inservice needs of Missouri agricultural educators. *Proceedings of the 2010 AAAE Southern Region Conference,* 422-434. Orlando, FL.

Saucier, P. R., Vincent, S. K., & Anderson, R. G. (2011). Agricultural mechanics laboratory safety: Professional development needs of Kentucky school-based agricultural educators. *Proceedings of the 2011 American Association for Agricultural Education Research Conference 38,* 187-202.

Shinn, C. G. (1998). Transforming agricultural mechanics curriculum through expert opinion to model technologies in foods, environmental, and natural resource systems. *Proceedings of the 25th Annual National Agricultural Education Research Meeting 25,* 270-282.

The National Council for Agricultural Education (2012). CASE curriculum for agricultural science education proposed course development timeline. Retrieved from http://case4learning.org/curriculum/development-timeline.html