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Does the Number of Post-secondary Agricultural Mechanics Courses Completed Affect Teacher Competence?

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Abstract

Preparing teachers to teach agricultural mechanics is a difficult task since many topic areas are included in the curriculum. This study examines the effect of the number of college courses taken on a teacher's perceived competence to teach agricultural mechanics. Agricultural education teachers in Iowa ranked themselves according to their perceived, individual competence in 54 skill areas associated with agricultural mechanics curricula. Respondents also indicated the number of agricultural mechanics courses they completed in their teacher preparation program. Teachers who completed one or no courses had low to slight perceived level of competence while teachers who took two or more courses identified a moderate level of perceived competence in agricultural mechanics. Teachers indicating six or more classes completed exhibited a high-perceived competence. A positive correlation was identified between courses completed and perceived competence as the more courses taken the higher the self-perceived competence level of the teacher. To develop the competence of pre-service agricultural education teacher candidates it is recommended to examine the current agricultural mechanics curricula in teacher preparation programs. It is further recommended that professional development be offered in areas identified by agricultural education teachers as having low perceived competence.

Keywords: agricultural mechanics; agricultural education; courses completed; competence; post-secondary

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Creating a teacher education program to prepare secondary agricultural educators is a difficult task, but is not a new issue according to McCulloch, Burris, and Ulmer (2011). One of the ongoing challenges in secondary school settings is keeping technical agricultural content current with emerging industrial trends (Rojewski, 2002). As career competencies change, teacher-educators must also re-evaluate the content within teacher preparation programs (Duncan, Ricketts, Peake, & Uesseler, 2006). The American Association for Agricultural Education (AAAE) national standards for teacher-education in agriculture section 2c states, "programs must be designed to allow teacher candidates to attain competence in basic principles, concepts, and experiential practices" (AAAE, 2001, p. 3).

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The issue of keeping curriculum content areas up to date becomes more complicated when one examines the competencies within each area that an agricultural education teacher must know in order to teach effectively. One such area, according to section 2c subsection B of the AAAE national standards for teacher-education in agriculture specifically states that teacher candidates need to be competent in "agricultural and mechanical systems" (AAAE, 2001, p. 3). To ensure that the program curriculum is up to date teacher educators must consult with content area experts; but who are these experts? According to McCulloch, Burris, and Ulmer (2011), the experts are the secondary agricultural educators teaching the content. In order for teacher preparation programs to provide adequate education, faculty should first identify which skills need to be taught.

Ensuring that agricultural education teachers keep a high level of competence in the realm of agricultural mechanics requires dedication on the part of the secondary teacher and the pre-service agricultural education program. Hubert and Leising (2000) stated "teacher knowledge of agricultural mechanics was in need of improvement both prior to and after accepting teaching positions" (p. 24). Hubert and Leising (2000) also suggested that there is need for sound laboratory and shop management instruction due to the large amount of time spent in a laboratory by an agricultural education teacher. With a large percentage of time spent in an agricultural mechanics laboratory secondary and pre-service agricultural education teacher candidates must have competence in multiple skills in order to teach agricultural mechanics effectively.

Numerous studies regarding agricultural education teachers and their professional development needs have been conducted and show the teacher's desire to increase competence in agricultural mechanics (Fletcher & Miller, 1995; Lester, 2012; McKim, Saucier, & Reynolds, 2010; Peake, Duncan, Rickets, 2007; Saucier & McKim, 2010; Schlautman & Silletto, 1992; Washburn, King, Garton, & Harbsteit, 2001). Saucier, McKim, and Tummons (2012) identified 180 essential agricultural mechanics skills in which beginning agricultural education teachers in Missouri should demonstrate competence before teaching. The 180 essential skills were grouped into 23 categories and ranked by importance. Safety, shielded metal arc welding, handheld power tools, oxygen/acetylene cutting, stationary power tools, and gas metal arc welding were ranked within the top ten categories in the study. Understanding the needs of current agricultural education teachers, the following question should be considered: do the current teacher education programs include these agricultural mechanics competencies?

To develop more competent agricultural education teachers, changes to pre-service agricultural education programs have been suggested. Foster (1986) opined that pre-service agricultural education teacher candidates should participate in early experience programs that expose them to various aspects of teaching agricultural mechanics. Teaching in an agricultural mechanics laboratory is a difficult task for an incompetent agricultural education teacher. To combat this and provide students within a secondary agricultural mechanics class with a safe experience, Johnson, Schumacher, and Stewart (1990) suggested training is needed in a pre-service agricultural education program.

Connors and Mundt (2001) reported that the average teacher education program required 43.44 credits of technical agriculture. Burris, Robinson, and Terry (2005) found that pre-service teacher preparation programs include agricultural mechanics requirements as part of the technical agriculture credit program area. The national average number of credits reported by institutions specific to agricultural mechanics ranged from zero hours to twenty hours (Burris, Robinson, & Terry, 2005). Burris et al. (2005) determined the majority of university agricultural education programs required an average of five to eight credits specific to agricultural mechanics. Does this agricultural mechanics curriculum requirement provide adequate time for pre-service agricultural education teacher candidates to develop essential skills to become competent enough to teach?

Another aspect that needs to be examined is the placement of the pre-service teacher candidates after graduating. Would a program graduate be adequately prepared in agricultural mechanics if they were to become employed in a neighboring state of the institution granting the degree? According to Kantrovich (2007), only 72 (9%) of the graduates seeking employment as an agricultural education teachers in 2005-2006 school year traveled to a neighboring state to find employment. Research has shown the importance of agricultural mechanics by secondary (Saucier & McKim, 2010) and post-secondary educators (Burris, Robinson, & Terry, 2005), but do teacher preparation programs adequately prepare pre-service agriculture teacher candidates to successfully teach agricultural mechanics?

Conceptual Framework

The model for teacher preparation in agricultural education (Whittington, 2005) served as the conceptual framework for this study and is based upon the philosophical foundations of agricultural education teacher education: experiential learning, problem–based teaching, social cognition, and reflective practice. In this framework, post-secondary coursework is aligned with the National Council for Accreditation of Teacher-Education (NCATE) standards, Interstate New Teachers Assessment and Support Consortium (INTASC) principles, Praxis criteria for licensure, and the American Association for Agricultural Education (AAAE) standards. These standards guide program graduates to achieve the goal to obtain the necessary knowledge, skills, and disposition for entry into the teaching profession (see Figure 1).

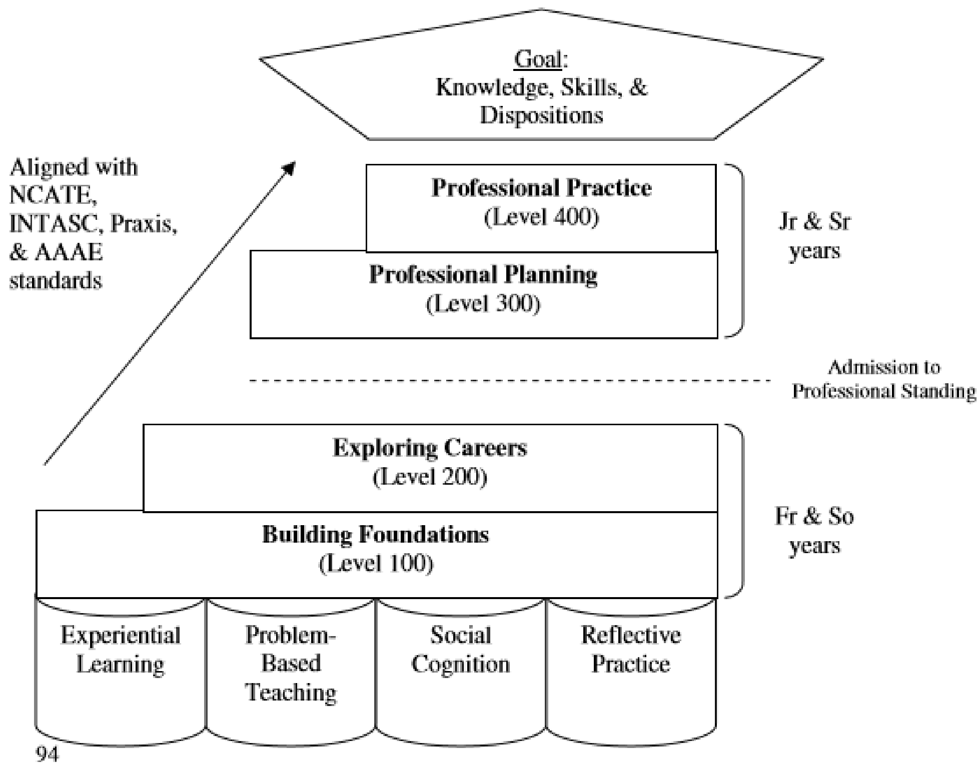

Figure 1. The model for teacher preparation in agricultural education (Whittington, 2005, p. 94).

The researchers specifically built this study upon the building foundations portion of the model by examining if the number of classes taken at the post-secondary level provided a strong enough foundation for the agricultural education teachers to teach agricultural mechanics competencies. Because many agricultural education preparation programs required only three courses in agricultural mechanics for teacher certification (Hubert & Leising, 2000), it is important to determine the most appropriate strategy of incorporating agricultural mechanics into agricultural education teacher preparation programs to ensure competent program graduates. Due to the limited research in the area of agricultural mechanics preservice teacher preparation and the continual need for research regarding best practices with teacher education programs, a current assessment of teachers' preparation was warranted.

Purpose and Objectives

The purpose of this study was to describe the perceptions of secondary agricultural education teachers concerning personal competence to teach selected agricultural mechanics skills based on the number of agricultural mechanics college courses taken. The study was also intended to describe the relationship between the number of post-secondary courses taken and the agricultural education teachers' perceived agricultural mechanics competence. This research purpose aligns with the National Career and Technical Education Research Agenda (Lambeth, Elliot, & Joerger, 2008) research problem area (RPA) 1: Knowledge Base for Teaching and Learning, specifically relating to the research objective (RO) 1.2 Professional Preparation. The specific research activities (RA) addressed includes RA 1.2.1: Teacher Competence and RA 1.2.2: CTE Teacher-education. This research also aligns with section 2c subsection B of the AAAE national standards for teacher-education in agriculture, which specifically states that teacher candidates need to be competent in agricultural and mechanical systems (Doerfert, 2011). The following objectives were identified to address the purpose of this study.

1. Describe self-perceived level of competence of secondary agricultural education teachers in teaching agricultural mechanic skills.
2. Describe the number of post-secondary agricultural mechanics courses completed by Iowa agricultural education teachers.
3. Describe the relationship between teacher competence and the number of post-secondary courses taken in agricultural mechanics at a two and four year college.

Methods

This descriptive study used survey research methods to summarize characteristics, attitudes, and opinions to accurately describe a norm (Ary, Jacobs, Razavieh, & Sorensen, 2006). This is a smaller portion of a larger study that used a researcher-modified, paper-based questionnaire designed to address the objectives of this study. The instrument contained three sections. Section one included 54 skills related to agricultural mechanics. Skills were separated into five constructs, including: Mechanic Skills, Structures/Construction, Electrification, Power and Machinery, and Soil and Water. Respondents were asked to use a five-point summated rated - scale to rate the perceived personal competency level in teaching each skill. Section two consisted of 15 demographic questions relating to the teacher's educational and teaching background, and section three included nine questions about program and school characteristics. Content validity was determined by a team of five university faculty members with expertise in the fields of agricultural mechanics and agricultural education. Following the suggestions of Dillman, Smyth, and Christian (2009), the initial electronic version of the instrument was pretested through a pilot study with a group of twelve agricultural education teachers in a nearby state. Suggestions from the 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 competency per construct area were mechanics skill (α = 0.95), structures/construction (α = 0.96), electrification (α = 0.95), power and machinery (α = 0.98), and soil and water (α = 0.85).

Data were collected through a census study conducted during the Iowa agricultural education teachers' conference. The participants of this study were the secondary agricultural education teachers who attended this conference. The population was purposely targeted because of the respondents' likelihood to be involved in annual 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. 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 agricultural education teachers in Iowa. However, due to the purposively selected sample, data from this study should be interpreted with care so as not to extrapolate beyond the target population. Data were coded and analyzed using JMP Pro Version 9.0.0.

Data were analyzed by using non-parametric statistics, more specifically Pearson's χ^2 test. The purpose behind using this particular test was that the perceived competency rating is categorical in nature. When looking for a relationship between two variables where one or both are categorical, a chi-squared test is recommended (Gravetter, & Wallnau, 2009; Coolidge, 2006). A three-celled design was used to conduct this analysis. This decision was made when the original chi-squared test matrices resulted in cells with a frequency below five. With frequencies below five Coolidge (2006) recommends collapsing one or both of the factors into two or three cells. For the objectives in this study the categories for level of competency include very strong, strong, moderate, some, and no need. These were collapsed into three categories: high (very strong and strong), moderate (moderate), and low (some and no need). The interval variable number of post-secondary agricultural mechanics courses taken ranged from zero to thirteen. Those were collapsed into three categories which included zero, one, and two or more. By collapsing these categories the cell frequencies were raised and allowed the chi-squared test to be more sensitive to the differences between the cells (Coolidge, 2006). By having a matrix that is three by three, Cramer's *V* was appropriate to evaluate the effect size (Gravetter & Wallnau, 2009).Since this was a census study, it is limited from being generalizable beyond the study participants. By employing a purposive sampling technique, generalizability is limited to the targeted population (Ary et al., 2006).

Results

The first research objective sought to describe the perceived competence of Iowa agricultural education teachers to teach agricultural mechanics skills on a scale of zero (no competence) to four (very competent). Agricultural education teachers identified the structures and construction skills as the construct that had the highest average perceived competence (M = 3.46). Electrification had the lowest average perceived competence (M = 2.65) of the five constructs. Overall, agricultural education teachers on average in Iowa perceived themselves as moderately competent across all five constructs included in this study. Figure 2 shows each of the five constructs in relation to each other with respect to average perceived competence by construct.

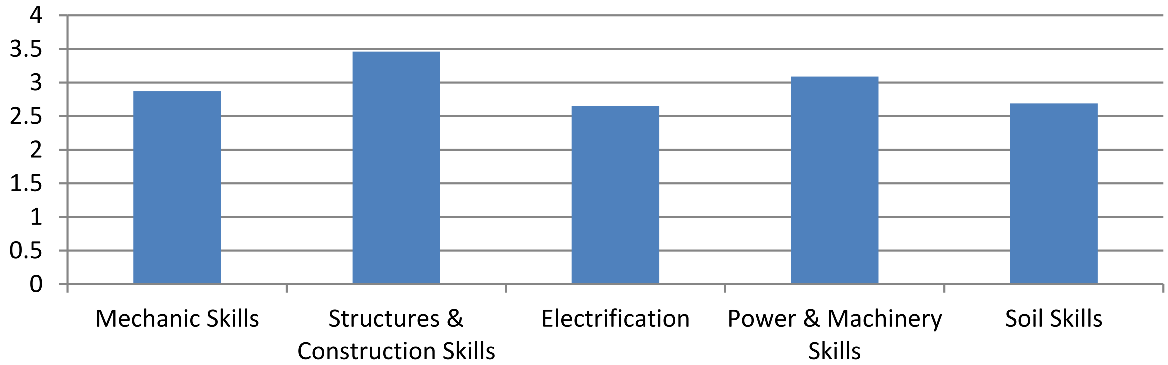

Figure 2. Average perceived competence for each agricultural mechanics construct

Objective 2 sought to describe the amount of post-secondary courses taken by Iowa agricultural education teachers. Responses ranged from zero to thirteen courses. The highest percentage (34.95%, *n* = 36) of agricultural education teachers took no post-secondary courses related to agricultural mechanics. Just over 29% (*n* = 30) of agricultural education teachers responded that they completed one post-secondary course. The other 35.92% (*n* = 37) of responses ranged between two and thirteen post-secondary agricultural mechanics courses completed. Table 1 summarizes the frequencies and percentages of courses completed by respondents.

Table 1

Number of Post-Secondary Agricultural Mechanics Courses Completed by Iowa agricultural education teachers (n=103)

# of Courses Completed	*f*	%
0	36	34.95
1	30	29.13
2	9	8.74
3	9	8.74
4	7	6.80
5	2	1.94
6	6	5.83
9	1	0.97
10	2	1.94
13	1	0.97

Pearson's χ^2 was used to determine the relationship between the individual agricultural mechanics competencies and the number of post-secondary agricultural mechanics courses taken for objective three. The five competency levels of very strong, strong, moderate, some, and no need were re-grouped into three categories prior to determining the relationship: low (no need and some), moderate (moderate), and high (strong and very strong). The number of post-secondary classes taken was also grouped into three categories: zero classes, one class, two or more classes. The critical value for χ^2, ($df = 4$) for this study was 9.49. The competencies that had a critical value over 9.49 were considered statistically significant. The effect size of the relationship between the two variables, agricultural mechanics competence, and the number of post-secondary agricultural mechanics courses completed was examined by calculating Cramer's *V* on the χ^2 statistic. The standards proposed by Cohen (1988) were used to interpret the Cramer's *V* statistic. When calculating the Cramer's *V* statistic the degrees of freedom (*df**) is calculated by taking (Row-1) or (Column-1), whichever is smaller. By Cohen's standards (*df** = 2) the relationships found range from medium (0.21) to large (0.35) effect. Of the 54 content areas identified on the census study, approximately 30% (*n*=16) displayed a significant relationship as illustrated in Table 2.

Table 2

Effect Size between Teacher Competence and College Courses Taken

Competency Area	*n*	*M*	*SD*	χ^2	*V*
Legal Land Descriptions	93	3.39	1.2	18.94	0.32
Electrical Safety	88	3.08	1.32	16.76	0.31
Cleaning Motors	81	2.35	1.02	16.69	0.32
Oxy-Acetylene Cutting	99	3.51	1.09	15.44	0.27
Small Engine – 4 cycle	90	3.27	1.19	15.06	0.29
Oxy-Acetylene Welding	99	3.25	1.11	14.88	0.27
Wiring Skills	91	2.98	1.28	14.72	0.28
Use of Survey Equipment	90	2.67	1.06	14.51	0.28
Pipe Cut & Thread	82	2.49	1.14	14.4	0.29
Oxy-Acetylene Brazing	91	2.81	1.22	14.32	0.28
Small Engine Safety	90	3.37	1.23	12.49	0.26
Cold Metal Work	84	2.36	1.01	12.48	0.27
Electrician Tools	90	2.89	1.27	12.13	0.26
Small Engines Overhaul	88	3.14	1.24	10.37	0.24
GMAW Welding (Mig)	96	3.51	1.17	9.53	0.22
Tool Conditioning	83	2.52	1.07	9.5	0.24

*Note: df**=2. *df** is calculated by taking (Row-1) or (Column-1), whichever is smaller. $p < .05$

Conclusions and Discussion

Findings from this study lead to several conclusions. First, it can be concluded that agricultural education teachers in Iowa feel that they are adequately prepared to teach agricultural mechanics. Agricultural educators in Iowa identified themselves most prepared in the construct area of structures and construction skills. Similarly, Lester (2012) indicated that Arizona agricultural education teachers also had a high-perceived competency in the areas of woodworking and project construction. Conversely, the results from Peake, Duncan, and Ricketts (2007) who studied the general competencies of agricultural education teachers in Georgia, reported that respondents perceived themselves to be less competent to teach construction than other areas of agricultural mechanics.

It can be further concluded that the agricultural education preparation program in Iowa taught a majority of the same constructs as other states, therefore program graduates would be adequately prepared to teach agricultural competencies in neighboring states. It is important that teacher preparation programs continue to teach similar content in order to fill the job vacancies across the nation (Kantrovich, 2007). The difference in agricultural mechanics curricula in teacher preparation programs is still important to consider because the program must reflect the needs of individual states in addition to ensuring the competence of program graduates to teach in other states.

The purpose of objective two was to describe the number of post-secondary courses completed by Iowa agricultural education teachers. The underlying issue being examined was if the number of agricultural mechanics courses taken was adequate for pre-service agricultural education teacher candidates to gain competence to enable them to teach agricultural mechanics. Research has shown the national average agricultural mechanics credits required by teacher preparation programs ranged from five and eight credits (Burris et al., 2005). Another conclusion from this study is that a majority (88%, *n* = 91) of agricultural education teachers in Iowa completed less than the national average of required credits in agricultural mechanics, yet respondents still believed that the level of competence was adequate to teach agricultural mechanics competencies. When looking at the model for teacher preparation in agricultural education (Whittington, 2005), is enough time given for coursework to create a foundation in agricultural mechanics if pre-service agricultural education teacher candidates only have three credit hours of exposure?

The goal of objective three was to describe the relationship between teacher competence and the amount of post-secondary courses completed by the respondents. It can be concluded that agricultural educators need additional time in the teacher preparation program in order to gain adequate competence in areas such as electricity, small engines, metal work, and oxy-acetylene processes. Fifty-six percent (*n* = 9) of the competencies that showed a significant relationship with the number of courses completed were ranked by respondents as 26 out of 54 or lower in perceived competence. This is understandable when 35% (*n* = 36) of agricultural education teachers indicated that they didn't complete any post-secondary courses related to agricultural mechanics. Conversely, the other 44% (*n* = 7) of competency areas that demonstrated a significant relationship with the number of post-secondary courses completed were ranked 25 out of 54 or higher in perceived competence. Are the content areas in which agricultural education teachers demonstrated a perceived high competence areas of interest that create personal desire to learn more about the content area? Are these areas that the agricultural education teacher never thought they would have to teach? Alternatively, are the areas that contain newer technology, such as GPS and TIG welding that was not taught during their teacher preparation program?

It can be concluded that agricultural education teachers are finding other avenues to gain competence in the areas of electricity, small engines, oxy-fuel processes, and metal work beyond the teacher preparation program. Since only 30% (*n* = 16) of the competency areas have shown a correlation with the number of post-secondary courses taken, where are the pre-service agricultural education teacher candidates gaining perceived competence? Foster (1986) posited that one place that pre-service agricultural education teachers were learning agricultural mechanics content was during the student-teaching internship. Since a relationship was found between the numbers of courses taken with teacher's perceived competence levels in agricultural mechanics, it can be concluded that pre-service programs should allow ample time for pre-service agricultural education teacher candidates to gain competence in agricultural mechanics. Given the opportunity to complete more courses, the pre-service agricultural education teacher candidates will have an opportunity to enhance their agricultural mechanics competency.

One potential challenge that teacher education programs could face is trying to add additional coursework into an already full bachelor's degree program. Faculty must prioritize coursework within the program of study and determine where additional coursework might fit. Furthermore some programs may have to reconfigure course requirements to incorporate an additional course in agricultural mechanics if there is no elective course availability built into the program requirements.

Implications and Recommendations

This study has implications for pre-service teacher education programs, for professional development of in-service teachers, and for further research. The researchers acknowledge that the findings from this study are limited to the agricultural education teachers that participated due to the purposive sampling method used in this study. However, states with similar agricultural education teacher demographics may find the following recommendations helpful.

This study asked participants how many courses in agricultural mechanics they completed, but did not ask from which department the courses were offered or if the instructor had prior experience teaching at the secondary level. Researchers recommend examining the effect of agricultural mechanics courses being taught by outside departments such as agricultural engineering on student knowledge. Burris, Robinson, and Terry (2005) found that nearly 46% ($n = 34$) of required agricultural mechanics courses were taught outside of the teacher preparation department. Would taking an agricultural mechanics course housed in another department have a different effect on agricultural educator competence than a course housed within agricultural education? Are engineers teaching these courses? Do the course's purposes provide instruction needed in order to enable the pre-service teacher candidates to teach the content in a secondary setting? This information would help agricultural education preparation programs across the nation to understand more about the interaction between out-of-department courses on pre-service teacher candidate competence in agricultural mechanics.

It is also recommended that those in charge of planning professional development activities for secondary agricultural education teachers take into consideration the areas of lowest perceived competence. These areas included emerging technology such as computer aided design, survey skills, TIG welding, and metal working related skills as deemed appropriate for the secondary level. It is also recommended that the agricultural education teacher preparation faculty examine current curricula to determine if the needs of the current agricultural education teachers are being covered with the new generation of agricultural education teachers to ensure a strong foundation in agricultural mechanics.

An additional area that should be explored is the frequency in which agricultural education teachers participate in agricultural mechanics courses, attend workshops, and seek further avenues to stay current with the changing facets of agricultural mechanics. Once these questions are answered a program can be improved so that it is able to increase teacher competence (Hubert & Leising, 2000), laboratory management skills (Johnson, Schumacher, & Stewart, 1990), and agricultural mechanics instruction in the pre-service agricultural education program as well as professional in-service development activities in Iowa as suggested by previous studies.

It is further recommended that for those looking at replicating this study to review and consider instrument modification. One aspect of the survey that may have led to lower quality responses was its length. Additionally, collaborating with other in-state institutions and industry is needed to identify the most appropriate competency areas to include in the instrument for the given locale.

Another area that should be researched is the effect of local control on building a strong foundation in agricultural mechanics. Does local control allow teachers the flexibility to cover the most critical skills or does it act as a crutch to avoid teaching areas of agricultural mechanics in which the educator is less competent? Finally, researchers should examine if the pre-service preparation program at Iowa State University covers the most frequently taught topics that locales request the agricultural education teachers be able to teach.

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