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A 20-Year Comparison of Teachers' Agricultural Mechanics Laboratory Management Competency

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Agricultural mechanics laboratory management skills are essential for school-based agriculture teachers who instruct students in an agricultural mechanics laboratory (Bear & Hoerner, 1986). McKim and Saucier (2011) suggested the frequency and severity of accidents that occur in these laboratories can be reduced when these facilities are managed by educators who are competent and knowledgeable in the area of laboratory safety and facility management. This study investigated changes in Missouri agriculture teachers' perceived agricultural mechanics laboratory management competency from 1989 to 2008, percent changes between 1989 and 2008 and effect size were used to describe changes in importance and ability of the selected competencies. Results indicated that teachers in 2008 had more teaching experience than their predecessors, less university semester credit hours of agricultural mechanics instruction, taught courses with greater student enrollment in laboratories that had less working space per student. Further, teachers' perceptions of the importance of agricultural mechanics laboratory management competencies had a negligible change. However, the changes in teachers' perceived ability to perform development, writing, and planning competencies were notable.

Keywords: agricultural mechanics; laboratory management competency; agricultural education, professional development

According to Phipps and Osborne (1988), a total secondary agricultural education program consists of three essential and interdependent components. Classroom and laboratory instruction; independent experiential learning, commonly known as Supervised Agricultural Experience (SAE); and participation in the student leadership organization, specifically the National FFA Organization. Specialized laboratory facilities are often an integral element used for each of these three components (McKim & Saucier, 2011).

Agricultural education laboratories provide opportunities for students to actively engage in scientific inquiry and applications (Osborne & Dyer, 2000. Further, Hubert, Ullrich, Lindner, and Murphy (2003) wrote "agricultural education programs offer many unique hands-on opportunities for students to develop both valuable academic and vocational skills" (p. 1). This is especially true for the instructional area of agricultural mechanics. Phipps, Osborne, Dyer, and Ball (2008) noted that the primary objective of agricultural mechanics education is the development of the abilities necessary to perform the mechanical activities to be completed in agriculture. Johnson, Schumacher, and Stewart (1990) stated that students learn important psychomotor skills in agricultural mechanics education and that much of the instruction takes place in the school agricultural mechanics laboratory.

Laboratories are essential educational tools for agricultural mechanics programs. As Johnson and Schumacher (1989) noted, much of the instruction of agricultural mechanics information takes place in a laboratory setting. Phipps, et al. (2008) estimated that in many courses, the time allocated for instruction in agricultural mechanics comprises 25% to 40% of the total instructional time. However, Saucier, Schumacher, Funkenbusch, Terry, and

Johnson (2008) found that teachers used the laboratory for up to 66% of the allocated instructional time in some agricultural mechanics courses. Shinn (1987) reported that the amount of time devoted to laboratory instruction may comprise one-third to two-thirds of the total instructional time in many secondary agricultural education programs.

More recently, Saucier, Terry, and Schumacher (2009) found that Missouri agricultural educators spent almost 10 hours per week supervising students in an agricultural mechanics laboratory. Bear and Hoerner (1986) noted laboratory experiences are an integral component of agricultural mechanics instruction and efficient management of the school agricultural mechanics laboratories are essential to maximizing student learning. With the amount of instructional time spent in the various agricultural education laboratories (i.e., animal science laboratory, greenhouse, agricultural mechanics laboratory, floral design laboratory, etc.) in the U.S., it is critical that agriculture teachers receive laboratory management education.

According to Hubert, Ullrich, Lindner, and Murphy (2003), "if skill development is the focus of laboratory instruction, then thorough attention to all its components, including safety instruction, is essential" (p. 3). Johnson and Fletcher (1990) stated that agricultural mechanics students are exposed to equipment, materials, tools, and supplies that are potentially hazardous to their health and that could cause injury or death. Shinn (1987) stated that the agricultural mechanics laboratory must be a safe and well organized environment if optimum student learning is to occur. In 1986, Burke described practices associated with efficient laboratory management. He listed the regulation of environmental factors, control of consumable supplies and storage of tools as areas that are important for the efficient and safe management of the agricultural mechanics laboratory. Further emphasizing the importance of safety in the agricultural mechanics laboratory, Swan (1992) noted that instructional safety programs are a must, and therefore, should be of high priority to the instructor. The most important responsibility of the instructor is to ensure the safety of the students.

In addition to the previously noted studies, others posited that among the most effective instructional techniques reported by teachers, were demonstrations, laboratories, and supervised student projects (Myers & Dyer, 2004)—arguably, the most frequently used methods for teaching agricultural mechanics. Saucier et al. (2008) noted that pre-service and existing teachers must be properly educated in agricultural mechanics laboratory management to provide a safe and efficient laboratory learning environment for agricultural mechanics students. This is especially true with the increased emphasis and scrutiny of Science, Technology, Engineering, and Mathematics (STEM) integration into agricultural education courses, evidenced in the *National Research Agenda, Priority Area 3* (Doerfert, 2011). Thus, safe and efficient laboratory conditions are essential for teachers who integrate core curricula into agricultural education programs (Thompson & Balschweid, 1999; Myers & Dyer, 2004). Unfortunately, many agricultural educators do not receive adequate preparation prior to beginning their teaching careers, or after accepting a teaching position (Foster, 1986), to safely manage an agricultural mechanics laboratory. However, longitudinal comparison of teachers' perceived ability to establish and maintain a safe and efficient laboratory learning environment is not present in the literature.

To guide the theoretical foundation of this study, researchers utilized Bandura's theory of self-efficacy (1997). According to Bandura, self-efficacy is defined as the "beliefs in one's capabilities to organize and execute the course of action required to produce given attainments" (p. 3). Moreover, self-efficacy influences a person's choices, actions, the amount of effort they give, how long they persevere when faced with obstacles, their resilience, their thought patterns and emotional reactions, and the level of achievement they ultimately attain (Bandura, 1986). See Figure 1 for an illustration of the theory of self-efficacy.

According to Knobloch (2008), predetermined beliefs of teachers often influence how they connect academic content in the classroom to real-life applications in the laboratory. Based upon a review of literature, these beliefs are

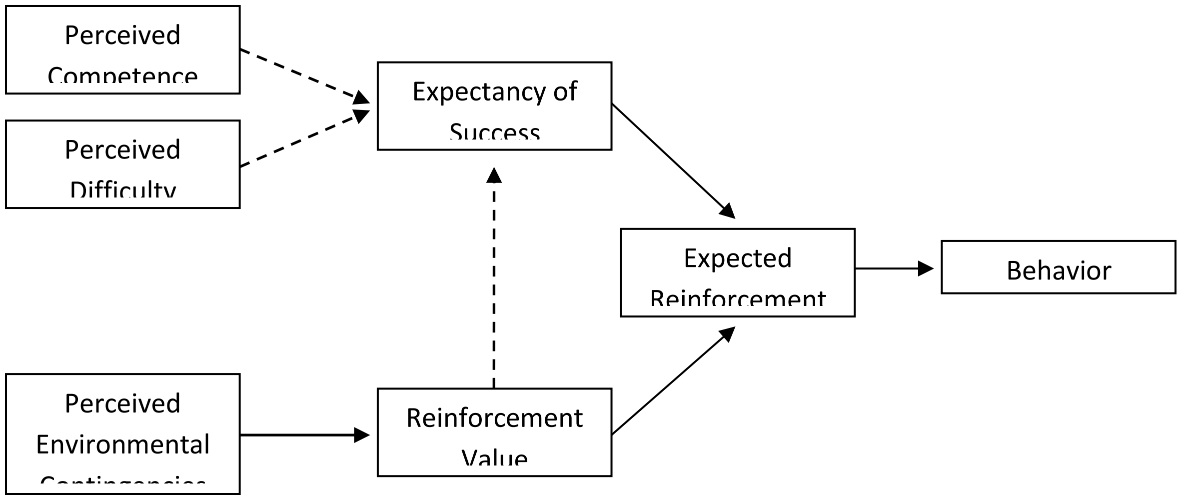

Figure 1. An illustration of the theory of self-efficacy (Bandura, 1997)

developed in part to personal beliefs about the curriculum or content (Borko & Putnam, 1996; Moseley, Reinke, & Bookout, 2002; Pajares, 1992); availability of time, availability of classroom and laboratory instructional resources, level of preparation regarding the content (Thompson & Balschweid, 1999), comfort level with the content, (Knobloch & Ball, 2003), perceived value of the content (Lawrenz, 1985), past experiences with the content area (Calderhead, 1996; Thompson & Balschweid, 1999), teaching environment (Knobloch, 2001) and motivation (Bandura, 1997; Tschannen-Moran, Woolfolk-Hoy, & Hoy, 1998).

The development and performance of teachers is also influenced by the interaction of these personal and environmental factors and the situations in which they teach (Knobloch, 2001). Based upon these principles and the aforementioned review of literature, researchers sought to determine the fundamental foundational change in the need of agricultural mechanics laboratory management professional development in Missouri, as measured by the importance a teacher places on, and their ability to perform, selected agricultural mechanics laboratory management competencies.

Purpose and Research Questions

Agricultural mechanics continues to be one of the most popular courses in Missouri (T. Heiman, personal communication, September 2, 2008). However, more than 20 years have passed since the competence and educational needs of Missouri school-based agricultural mechanics teachers were assessed. Thus, the purpose of this study was to compare the perceptions of school-based agriculture educators in Missouri who manage agricultural mechanics laboratories, between 1989 and 2008, regarding selected agricultural mechanics laboratory management competencies. The following research questions were investigated to accomplish this purpose:

1. What were the personal and professional characteristics of school-based agricultural educators in Missouri who are responsible for managing an agricultural mechanics laboratory, specifically: age, sex, credit hours of agricultural mechanics coursework taken, hours spent supervising students in the agricultural mechanics laboratories per week, overall student enrollment in the agricultural mechanics program, and the largest student enrollment in an agricultural mechanics class?

2. Did Missouri school-based agricultural educators' perceptions of the importance of selected agricultural mechanics laboratory management competencies change from 1989 to 2008?
3. Did Missouri school-based agricultural educators' perceptions of their ability to perform selected agricultural mechanics laboratory management competencies change from 1989 to 2008?

Procedures

"Meta-analysis is a form of secondary analysis of pre-existing data that aims to summarize and compare results from different studies" (Newton & Rudestam, 1999, p. 281). Furthermore, meta-analyses "serve to combine results from multiple studies, and consequently, allow us to diminish our reliance on statistical tests from individual studies" (p. 281). Therefore, a form of meta-analysis was conducted by including the results reported by Johnson in 1989 and data collected as part of this study. Hence, the purpose of this study was to measure perceptual change of the importance of teachers' ability to instruct selected agricultural mechanics laboratory management competencies. The target populations for this study were school-based agriculture teachers responsible for managing an agricultural mechanics laboratory in Missouri, during 1989 and 2008.

In 1989, Johnson noted that 240 school-based agriculture teachers, in Missouri, were responsible for managing an agricultural mechanics laboratory. Of the 240 school-based agriculture teachers, Johnson randomly selected and invited 200 school-based agriculture teachers to participate in a mailed survey that included 50 selected agricultural mechanics laboratory management competencies (Johnson & Schumacher, 1989). After three points of contact, Johnson received 168 (83%) usable responses, which served as the population for the initial point for comparison for this study.

In 2008, the agricultural education district supervisors from the Missouri Department of Elementary and Secondary Education (DESE) identified 424 school-based agriculture teachers, in Missouri, who were responsible for managing an agricultural mechanics laboratory. A simple-random sample of 205 school-based agriculture teachers was selected (Krejcie & Morgan, 1970) and served as the population for the second point of comparison for this study.

For consistency, data collection procedures in 2008 followed similar procedures to those implemented by Johnson in 1989. The data collection instrument used by Johnson in 1989 was initially developed by Johnson and Schumacher in 1988, using the Delphi technique with input from a national panel of agricultural mechanics education experts. Johnson's 1989 instrument was a two-section instrument: The first section contained 50 agricultural mechanics laboratory management competency statements with two, five-point summated rating scales—one reflecting the importance of each competency, the other reflecting the subject's perceived ability to perform each competency. The purpose of the second section was to collect demographic information. Johnson noted a panel of experts was used to assess face validity of the instrument prior to data collection. Johnson further noted Cronbach's alpha coefficients, post hoc, ranged from .63 to .88 (n = 168).

The data collection instrument used to collect data in 2008 was a two-section, modified version of Johnson's 1989 instrument. Modification of the instrument was necessary to split multiple-component (*double-barreled* and *triple barreled*) competencies into single-component competencies; thus, the original 50 competencies were expanded to 70 competencies. The second section of the instrument was designed to collect relevant demographic information from respondents.

The modified instrument used to collect data in 2008 was submitted to a panel of experts to determine face and content validity. The panel of experts (n = 7) was composed of four university faculty members with expertise in agricultural systems management, a university faculty member with expertise in agriculture teacher education, a teacher development specialist from the agricultural education division of DESE, and a university faculty member with expertise in research methods and data collection instrument design. To estimate reliability of the modified instrument, a pilot test composed of randomly selected school-based agriculture teachers (n = 30), not selected to comprise the 2008 comparison sample, yielded acceptable Cronbach's alpha coefficients, as defined by Garson (2008), that ranged from .95 to .97.

Once validity and reliability were established, the instrument was administered to the 2008 comparison sample. Following Dillman's (2007) recommendations, subjects were contacted five times via email and U.S. mail. Usable responses were received from 110 Missouri school-based agriculture teachers resulting in a 55% response rate. Non-response error was a relevant concern. Therefore, procedures for handling nonrespondents were followed as outlined as *Method 2* in Lindner, Murphy, and Briers (2001): Days to respond was used as the independent variable in regression equations, where the primary variables of interest were regressed on the variable days to respond, which yielded no significant results (p = .603). Despite the lack of significant results, the 55% response rate is a limitation of this study and limits the ability to generalize beyond the respondents.

Data analyses were guided by the recommendations of Cohen (1988), Newton and Rudestam (1999), and Thalheimer and Cook (2002), regarding meta-analysis. Data relative to Johnson's 1989 study were reportedly analyzed using Statistical Analysis System; frequency, percentages, means, and standard deviations were reported. Data relative to the 2008 study were analyzed using SPSS 17.0; frequency, percentages, means, and standard deviations were reported. Double-barreled items from the 1989 study that were subsequently revised in the 2008 study were excluded from the analyses in this study to ensure the most accurate comparisons. Comparative analyses of the 33 competencies that corresponded between the 1989 and 2008 data were conducted using a Microsoft Excel ® spreadsheet for calculating Cohen's d from t-tests, developed by Thalheimer and Cook (2002); Cohen's d and percent change were reported for each competency. Furthermore, interpretations of Cohen's d and percent change were based on Thalheimer and Cook's interpretations.

Results

A comparative summary of the demographic data from 1989 and 2008 was presented in Table 1. On average, school-based agriculture teachers had a greater amount of experience in 2008 than 1989. However, the number of total university semester credit hours of agricultural mechanics coursework was reduced by 35% from 1989 (M = 17.39; SD = 9.93) to 2008 (M = 11.30; SD = 9.81). The average number of hours per week devoted to agricultural mechanics laboratory instruction decreased and the number of students in the largest agricultural mechanics classes increased. The age of agricultural mechanics laboratories increased slightly and the size (ft^2) of agricultural mechanics laboratories decreased slightly. Annual consumable budgets, however, increased on average.

Table 1
Comparative Summary of Selected Personal and Program Characteristics of School-Based Missouri Agriculture Teachers between 1989 and 2008

Characteristics	1989			2008			
	n	*M*	*SD*	*n*	*M*	*SD*	Δ *M*
Total years of teaching experience	168	10.95	8.02	110	12.20	9.18	+1.25
Total university semester credit hours of agricultural mechanics coursework	138	17.39	9.93	100	11.30	9.81	-6.09
Average hours per week devoted to agricultural mechanics laboratory instruction	163	10.14	4.91	107	9.44	7.21	-0.70
Number of students in largest agricultural mechanics class	168	15.39	6.02	106	16.28	6.60	+0.89

(Table 1 continues)

(Table 1 continued)

Characteristics	1989			2008			
	n	*M*	*SD*	*n*	*M*	*SD*	Δ *M*
Average annual number of students receiving agricultural mechanics laboratory instruction	167	50.79	29.12	108	72.27	48.34	+21.48
Age, in years, of agricultural mechanics laboratory	160	21.59	12.11	103	26.41	17.63	+4.82
Size (ft^2) of agricultural mechanics laboratory	150	3,070.05	1,517.71	96	2,973.49	1,815.19	-96.56
Annual agricultural mechanics consumable supply budget ($)	129	2,426.71	2,442.54	96	2,973.49	1,815.19	+473.29
Ft^2 of lab space per student in largest agricultural mechanics class	150	223.02	125.56	110	187.40	130.54	-35.62
Annual consumable budget ($) per agricultural mechanics laboratory student	120	51.18	52.63	82	52.89	50.03	+1.71

A comparative summary of perceived importance of agricultural mechanics laboratory management competencies between 1989 and 2008 was listed in Table 2. The competency with the greatest percent increase in perceived importance of agricultural mechanics laboratory management competencies between 1989 and 2008 was *maintaining computer based records* with a large increase (%Δ = 29) and a large effect size (*d* = .99). *Making minor repairs to the agricultural mechanics laboratory facility* had the next greatest percent change in perceived importance (%Δ = 15; *d* = .46), followed by *making major agricultural mechanics lab equipment repairs* (%Δ = 14; *d* = .40), both of which had a medium increase in percent change and medium effect size. The agricultural mechanics laboratory management competencies with the greatest percent decrease in perceived importance of agricultural mechanics laboratory management competencies between 1989 and 2008 were *developing procedures for efficient storage/distribution of consumable supplies* (%Δ = -8; *d* = .43) and *silhouetting tool/equipment cabinets* (%Δ = -8; *d* = .27), which indicated a small decrease for both competencies, with a medium and small effect size respectively.

Table 2
A Comparison of Missouri School-Based Agriculture Educators' Perceptions of the Importance of Selected Agricultural Mechanics Laboratory Management Competencies Changed from 1989 (*n* = 168) *to 2008* (*n* = 110)

Competencies	1989		2008		Cohen's d	%Δ
	M	*SD*	*M*	*SD*		
Maintaining computer based student academic records	2.91	1.06	3.74	0.99	0.81	29
Making minor repairs to the agricultural mechanics laboratory facility	3.19	1.09	3.66	0.89	0.46	15
Making major agricultural mechanics lab equipment repairs	3.66	0.88	3.99	0.77	0.40	9
Developing a written statement of agricultural mechanics lab policies/procedures	3.73	0.88	4.01	0.84	0.33	8
Developing a maintenance schedule for agricultural mechanics equipment	3.58	0.79	3.82	0.77	0.31	7

(Table 2 continues)

(Table 2 continued)

Competencies	1989		2008		Cohen's d	%Δ
	M	*SD*	*M*	*SD*		
Maintaining the agricultural mechanics laboratory in compliance with OSHA standards	3.85	0.92	4.11	0.92	0.28	7
Developing an accident reporting system	4.14	0.92	4.39	0.85	0.28	6
Arranging for a professional service person to make major equipment repairs	3.71	0.97	3.92	0.90	0.22	6
Administering first aid	4.22	0.83	4.42	0.87	0.24	5
Properly installing and maintaining safety devices and emergency equipment	4.42	0.74	4.60	0.66	0.25	4
Diagnosing malfunctioning agricultural mechanics lab equipment	4.18	0.79	4.33	0.74	0.20	4
Promoting laboratory safety by color coding equipment/marking safety zones/posting appropriate safety signs and warnings	3.89	0.95	4.03	0.90	0.15	4
Developing educational projects/activities for students	3.92	0.73	4.02	0.71	0.14	3
Developing a system to document achievement of student competencies	3.71	0.86	3.82	0.81	0.13	3
Developing procedures to facilitate the storage/checkout/security of tools/equipment	3.77	0.87	3.87	0.85	0.12	3
Installing stationary power equipment	3.58	0.96	3.69	0.75	0.12	3
Developing a procedure to bill students for materials used in project construction	4.01	0.84	4.10	0.81	0.11	2
Developing a procedure to ensure proper agricultural mechanics lab clean up	4.14	0.82	4.22	0.76	0.10	2
Making minor agricultural mechanics equipment repairs	4.12	0.81	4.20	0.70	0.10	2
Estimating time required for students to complete projects/activities	3.58	0.79	3.66	0.77	0.10	2
Performing routine maintenance of agricultural mechanics lab equipment	4.11	0.72	4.18	0.74	0.10	2
Arranging equipment in the agricultural mechanics lab to enhance safety/efficiency/learning	4.20	0.73	4.26	0.67	0.09	1
Recognizing characteristics of quality tools/equipment	4.14	0.76	4.20	0.68	0.08	1
Developing a rotational plan to move students through agricultural mechanics skill areas	3.73	0.82	3.75	0.83	0.02	1
Developing objective criteria for evaluation of student projects/activities	4.01	0.66	4.03	0.73	0.03	0
Developing an identification system to deter tool/equipment theft	4.03	0.91	4.05	0.82	0.02	0
Inventorying shop tools, equipment and supplies	4.03	0.78	4.02	0.79	0.01	0
Utilizing technical manuals to order replacement/repair parts for agricultural mechanics lab equipment	3.89	0.83	3.90	0.86	0.01	0
Maintaining healthy environmental conditions in the laboratory	4.26	0.77	4.20	0.76	0.08	-1
Constructing welding booths, work benches, storage areas, etc.	3.76	0.85	3.66	0.88	0.12	-3
Updating agricultural mechanics course offerings	3.94	0.81	3.71	0.87	0.28	-6

(Table 2 continues)

(Table 2 continued)

Competencies	1989		2008		Cohen's d	%Δ
	M	*SD*	*M*	*SD*		
Silhouetting tool/equipment cabinets	3.44	0.95	3.17	1.04	0.27	-8
Developing procedures for efficient storage/distribution of consumable supplies	4.35	0.78	4.02	0.77	0.43	-8

Note: Scale: 1 = no importance, 2 = below average importance, 3 = average importance, 4 = above average importance and 5 = utmost importance. Relative size of Cohen's *d*: negligible effect > = -0.15 to < .15; small effect > = .15 to < .40; medium effect > = .40 to < .75; large effect > = .75 to < 1.10; very large effect > = 1.10 to < 1.45; huge effect > 1.45. Relative Size of percent change: huge decrease < -75; very large decrease < = -50 and > -75; large decrease < = -30 and > -50; medium decrease < = -15 and > -30; small decrease < = -5 and > -15; negligible change > = -5 and < 5; small increase > = 5 and < 15; medium increase > = 15 and < 30; large increase > = 30 and < 50; very large increase > = 50 and < 75; huge increase > 75.

A comparative summary of perceived ability to perform agricultural mechanics laboratory management competencies between 1989 and 2008 are listed in Table 3. The competency with the greatest percent increase in perceived ability to perform agricultural mechanics laboratory management competencies between 1989 and 2008 was *maintaining computer based records* with a large increase (%Δ = 35) and a large effect size (*d* = .97). *Developing a written statement of agricultural mechanics lab policies/procedures* was the competency with the next greatest percent change in perceived ability to perform (%Δ = 11; *d* = .44), which indicated a small increase in percent change and medium effect size.

The agricultural mechanics laboratory management competencies with the greatest percent decrease in perceived ability to perform agricultural mechanics laboratory management competencies between 1989 and 2008 were *making minor agricultural mechanics lab equipment repairs* (%Δ = -5; *d* = .26) and *developing procedures to facilitate the storage/checkout/security of tools/equipment* (%Δ = -3; *d* = .12), which similar to perceptions of most competencies (*n* = 21), was a negligible decrease. Additionally, the Cohen's *d* value associated with *making minor agricultural mechanics lab equipment* indicated a small effect size which was the only notable effect size of the items with negative percent change values (*n* = 6). See Table 3.

Table 3

A Comparison of Missouri School-Based Agriculture Educators' Perceptions of their Ability to Perform Selected Agricultural Mechanics Laboratory Management Competencies Changed from 1989 (*n* = 168) *to 2008* (*n* = 110)

Competencies	1989		2008		Cohen's d	%Δ
	M	*SD*	*M*	*SD*		
Maintaining computer based student academic records	2.83	1.05	3.81	0.96	0.97	35
Developing a written statement of agricultural mechanics lab policies/procedures	3.38	0.81	3.75	0.89	0.44	11
Developing a procedure to ensure proper agricultural mechanics lab clean up	3.55	0.82	3.91	0.80	0.44	10
Developing an accident reporting system	3.57	0.83	3.91	0.88	0.40	10
Estimating time required for students to complete projects/activities	3.08	0.71	3.38	0.83	0.40	10
Developing a system to document achievement of student competencies	3.10	0.79	3.41	0.88	0.38	10

(Table 3 continues)

(Table 3 continued)

Competencies	1989		2008		Cohen's	%
	M	*SD*	*M*	*SD*	d	Δ
Developing a rotational plan to move students through agricultural mechanics skill areas	3.26	0.86	3.58	0.84	0.38	10
Administering first aid	3.35	0.92	3.68	0.95	0.36	10
Developing procedures for efficient storage/distribution of consumable supplies	3.45	0.74	3.75	0.73	0.41	9
Developing a maintenance schedule for agricultural mechanics equipment	3.05	0.81	3.33	0.85	0.34	9
Promoting laboratory safety by color coding equip-ment/marking safety zones/posting appropriate safety signs and warnings	3.26	0.86	3.53	0.95	0.30	8
Maintaining the agricultural mechanics laboratory in compliance with OSHA standards	3.20	0.87	3.41	0.92	0.24	7
Developing objective criteria for evaluation of student projects/activities	3.42	0.77	3.60	0.78	0.23	5
Arranging for a professional service person to make major equipment repairs	3.57	0.93	3.75	0.85	0.20	5
Arranging equipment in the agricultural mechanics lab to enhance safety/efficiency/learning	3.68	0.74	3.81	0.80	0.17	4
Developing a procedure to bill students for materials used in project construction	3.64	0.88	3.77	0.90	0.15	4
Diagnosing malfunctioning agricultural mechanics lab equipment	3.48	0.62	3.60	0.79	0.17	3
Recognizing characteristics of quality tools/equipment	3.75	0.71	3.87	0.85	0.16	3
Developing educational projects/activities for students	3.51	0.73	3.62	0.88	0.14	3
Performing routine maintenance of agricultural mechan-ics lab equipment	3.73	0.75	3.83	0.92	0.12	3
Constructing welding booths, work benches, storage areas, etc.	3.80	0.70	3.88	0.88	0.10	2
Inventorying shop tools, equipment and consumable supplies	3.75	0.84	3.82	0.80	0.09	2
Making agricultural mechanics lab equipment repairs	3.32	0.93	3.40	1.10	0.08	2
Utilizing technical manuals to order replacement/repair parts for agricultural mechanics lab equipment	3.70	0.86	3.76	0.92	0.07	2
Updating agricultural mechanics course offerings	3.39	0.75	3.43	0.88	0.05	1
Silhouetting tool/equipment cabinets	3.32	0.99	3.35	0.94	0.03	1
Properly installing and maintaining safety devices and emergency equipment	3.90	0.80	3.89	0.82	0.01	0
Making minor repairs to the agricultural mechanics laboratory facility	3.52	0.92	3.48	0.98	0.04	-1
Maintaining healthy environmental conditions in the laboratory	3.66	0.86	3.63	0.75	0.04	-1
Installing stationary power equipment	3.52	0.84	3.49	0.96	0.03	-1
Developing an identification system to deter tool/equipment theft	3.53	0.90	3.45	0.89	0.09	-2

(Table 3 continues)

(Table 3 continued)

Competencies	1989		2008		Cohen's d	%Δ
	M	*SD*	*M*	*SD*		
Developing procedures to facilitate the storage/checkout/security of tools/equipment	3.36	0.85	3.26	0.80	0.12	-3
Making minor agricultural mechanics lab equipment repairs	4.06	0.79	3.84	0.96	0.26	-5

Note. Scale: 1 = no ability, 2 = below average ability, 3 = average ability, 4 = above average ability and 5 = exceptional ability. Relative size of Cohen's *d*: negligible effect > = -0.15 to < .15; small effect > = .15 to < .40; medium effect > = .40 to < .75; large effect > = .75 to < 1.10; very large effect > = 1.10 to < 1.45; huge effect > 1.45. Relative Size of percent change: huge decrease < -75; very large decrease < = -50 and > -75; large decrease < = -30 and > -50; medium decrease < = -15 and > -30; small decrease < = -5 and > -15; negligible change > = -5 and < 5; small increase > = 5 and < 15; medium increase > = 15 and < 30; large increase > = 30 and < 50; very large increase > = 50 and < 75; huge increase > 75

Conclusions/Implications/Recommendations

School-based agricultural mechanics teachers in Missouri, on average had more years of teaching experience in 2008 than their predecessors in 1989. Conversely, the number of university semester credit hours of agricultural mechanics coursework received during pre-service education has decreased. Although slightly reduced, school-based agricultural mechanics teachers continued to devote more than 11 hours per week, on average, to agricultural mechanics laboratory instruction. Larger class sizes and smaller agricultural mechanics laboratory size resulted in a reduced amount of space per student. On average, budgets increased; however, budgets varied greatly in 1989 and 2008. In 1989, the average agricultural mechanics consumable supply budget was $2,426; in 2008 the average budget increased to $2,900. Although the average budget increased between 1989 and 2008, by nearly $500, the average agricultural mechanics consumable supply budget would have needed to increase to $4,349, to account for the 2.82% annual inflation over the nearly 20 year period—an increase of $1,923 to account for inflation alone (DollarTimes, 2010), rather than $500. Therefore, the increased amount of average budgets is misleading and concerning given the increased number of students enrolled.

Twenty-two of the 33 agricultural mechanics laboratory management competencies had a negligible percent change in perceived importance between 1989 and 2008. Similarly, the percent change in perceived ability of school-based agriculture teachers to perform agricultural mechanics laboratory management competencies between 1989 and 2008 was also negligible for 21 of the 33 competencies. The greatest increases in percent change in perceived ability to perform agricultural mechanics laboratory management competencies were related to development, writing, and planning; arguably, competencies that can be classified as core laboratory management skills and knowledge.

Conversely, the second, third, and fourth greatest increases in percent change in perceived ability to complete agricultural mechanics laboratory management competencies require applied skills or knowledge of applied practices. Arguably, if school-based agriculture teachers who manage an agricultural mechanics laboratory are receiving less pre-service agricultural mechanics preparation, teaching in laboratories with more students who are allotted less space, accidents are more likely to occur. Therefore, we recommend that professional development opportunities be developed and offered to teachers in Missouri who manage these specialized laboratories in the areas of the most need: Safety, including administering first aid, OSHA laboratory safety standards, repairing and maintaining tools, and equipment that function safely for student use.

The *National Research Agenda, Priority 3*, suggested that "a sufficient supply of well-prepared agricultural scientists and professionals drive sustainable growth, scientific discovery, and innovation in public, private, and academic settings" (Doerfert, 2011, p. 18). These professionals include school-based agriculture teachers who must possess essential knowledge and skills in order to help aid in the development of a future workforce who can address societal and industry challenges (Doerfert, 2011). As society looks toward the future, it is imperative that "individuals must be well prepared for discovery science, teaching and learning, science, technology, engineering, and mathematics (STEM) integration…" (Doerfert, 2011, p.18). Acknowledging a review of literature, we recommend professional development opportunities be offered that not only aid school-based agricultural educators in acquiring the knowledge and skills needed to manage an agricultural mechanics laboratory but also in preparing a future workforce. Multiple in-service opportunities should be developed with the professional in mind, i.e., offering workshops that meet the scheduling needs of teachers and those that have high impacts on academic and career and technology skill acquisition for student learners. We further recommend a diverse array of professional development topics be offered including workforce development, safety, and STEM integration. Specifically, workshops designed to teach educators about the best practices for instructing STEM competencies to student learners within the various agricultural education curriculums currently found in many states. Many STEM integrated concepts are relevant to agricultural mechanics and can be instructed in a laboratory setting.

According to Osborne (2007), "well designed professional development experiences, based upon teacher career stage, may improve teacher retention and program continuity" (p. 20). Additionally, literature suggests that "practicing teachers must have continuing access to high quality professional development programs" (Osborne, p. 20). Acknowledging the work of Osborne and others (Barrick et al., 1983; Birkenholz & Harbstreit, 1987; Saucier et al., 2008; Saucier et al., 2009), we recommend that a longitudinal study of pre-service and in-service secondary agriculture teachers' perceived importance of agricultural mechanics laboratory management competencies and their ability to perform the competencies would provide teacher education programs "an additional gauge of the adequacy of agricultural mechanics curriculum in their pre-service teacher education program" (McKim & Saucier, 2011, p.84). Moreover, studies similar to this one should be conducted periodically in each state to ensure that the continuing education needs of teachers are met in the area of laboratory management and preparing a future workforce.

Recognizing that knowledge and technology related to agricultural mechanics constantly evolves and the average years of teaching experience of Missouri agriculture teachers is only 12 years, we recommend that a comprehensive assessment of professional development be conducted in each state, every five years, to address teacher professional development needs. Furthermore, these opportunities should be tailored for teachers based upon career stage, sex, location, and be facilitated by state supervisory staff or teacher educators and delivered by experienced teachers or industry professionals. These workshops should be delivered around the state of Missouri at local high schools and university campuses during times of the year that are convenient for teachers—summer, winter break, and during the annual teacher professional development conference. If the overall goal of education is to aid in the development of a future workforce that can meet the needs of 21st century employers, industry professional development partnerships should be investigated to determine if industry-delivered workshops (eg., Lincoln Electric welding workshop, Stihl or Briggs and Stratton small gas engine workshop, CASE institute) can also adequately meet the in-service needs of school-based agriculture teachers.

As a result of this study and other recent studies in Missouri, state-funded professional development staff have offered both centralized and regional professional development opportunities to teachers in the area of agricultural mechanics skill acquisition, i.e., agricultural electrification, and laboratory management. These workshops have been offered at the various post-secondary institutions in Missouri, at local high schools, and at the summer teachers' conference. A continued effort is needed in Missouri to meet the ever growing demands of teachers through 21st-century professional development opportunities.

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