Journal of Agricultural Education, 55(2), 184-200.
doi: 10.5032/jae.2014.02184

Laboratory Safety Needs of Kentucky School-Based Agricultural Mechanics Teachers

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Abstract

The frequency and severity of accidents that occur in the agricultural mechanics laboratory can be reduced when these facilities are managed by educators who are competent in the area of laboratory safety and facility management (McKim & Saucier, 2011). To ensure teachers are technically competent and prepared to manage an agricultural mechanics laboratory, teacher educators and state supervisory staff must provide a comprehensive pre-service education and professional development opportunities in the area of agricultural mechanics that improve teacher retention, program continuity, and ensure a future supply of fully qualified and highly motivated teachers (Osborne, 2007; Saucier, Terry, & Schumacher, 2009). In this study, data were collected with a web-based questionnaire designed to determine Kentucky agriculture teachers' perceptions of the importance of 14 agricultural mechanics laboratory safety competencies and their self-assessed ability to perform those competencies. The Borich (1980) Needs Assessment Model was used to assess these teachers' needs. Researchers found subjects were in need of continuing education in the area of laboratory safety. To improve teachers competence, educators should receive professional development through technical workshops, winter and summer conferences, and via webinars (Barrick, Ladewig, & Hedges, 1983; Birkenholz & Harbstreit, 1987; McKim & Saucier, 2011; Saucier, et al., 2009).

Keywords: agricultural mechanics; safety; needs assessment; agricultural education teachers

This manuscript is a product of the Iowa Agriculture and Home Economics Experiment Station, Ames, Iowa. Project No. 3713 and sponsored by Hatch Act and State of Iowa funds.

The need for professional development that improves classroom and laboratory teaching methodologies has continued to exist for school-based agricultural educators (Burris, McLaughlin, Brashears, & Fraze, 2008; Duncan, Ricketts, Peake, & Uesseler, 2006; Joerger, 2002; Roberts & Dyer, 2004). In fact, the *National Research Agenda, Research Priority Area 3* (Doerfert, 2011) suggests that a key outcome for higher education is to provide "a sufficient supply of well-prepared agricultural scientists and professionals [who] drive sustainable growth, scientific discovery, and innovation in public, private, and academic settings" (p. 18). These professionals include school-based agricultural educators. This trend is especially true for

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agricultural educators who utilize an agricultural mechanics laboratory for student instruction and skill acquisition (Saucier & McKim, 2010; McKim & Saucier, 2011; Saucier, et al., 2009). Numerous studies have found that agricultural educators have professional development needs in numerous areas of agricultural mechanics laboratory management (Dyer & Andreasen, 1999; Hubert, Ullrich, Lindner, & Murphy, 2003; Johnson, Schumacher, & Stewart, 1990; McKim & Saucier, 2011; Saucier & McKim, 2010; Saucier et al., 2009; Schlautman & Silletto, 1992; Swan, 1992). To ensure that agricultural mechanics laboratories remain a safe place for student educational enrichment, it is critical that professional development opportunities be offered for teachers who instruct students in these specialized educational facilities (McKim & Saucier, 2011).

It is difficult to argue the need for professional development in agricultural education, yet the results from teacher pre-service training seem to differentiate. Ruhland and Bremer (2002) believed that an increase of support for professional development can assist with the retention of teachers in their first year of teaching. Burris, et al. (2008) found that personal, general, and content efficacy continued to improve from year one to year five of teaching with the implementation of professional development education. It was also concluded in the Burris et al. research that professional development that focused on specific instructional practices increased teachers' use of those practices in the classroom. Specific features, such as active learning opportunities, increased the effect of professional development on teacher's instructional habits towards students (Desimone, Porter, Garet, Yoon, & Birman, 2002).

Teachers need a range of professional development opportunities that will meet their varied and specific needs (Ruhland & Bremer, 2002). These needs consist of an understanding in curriculum development, learning styles, technical areas, teaching methods, teaching techniques, and academic integration methods (Dobbins & Camp, 2000). Furthermore, school-based agricultural educators need appropriate and timely professional development that ensures they are properly equipped to contend with changing conditions in the classroom or laboratory environment (Joerger, 2002). According to a review of literature, modifying the curriculum to meet the changes in technology, effective laboratory teaching methods, and the development of engineering curriculum, were determined as specific agricultural education professional development needs in the area of agricultural mechanics and laboratory management (Custer, & Daugherty, 2009; Peake, Duncan, & Ricketts, 2007; Washburn, King, Garton, & Harbstreit, 2001). After an analysis of secondary students' dissatisfactions with instruction, it was recommended that the profession analyze the area of agricultural mechanics education and seek ways to strengthen it and share the information with stakeholders (Reis & Kahler, 1997).

In order for safe laboratory instruction to take place, school-based agricultural educators must be competent and knowledgeable in the area of laboratory management (Saucier, et al., 2009). Phipps, Osborne, Dyer, and Ball (2008) wrote that the agriculture teacher is responsible for identifying safety hazards, providing daily safety instruction, and maintaining safe working conditions for students in an agricultural mechanics laboratory. Moreover, the agricultural mechanics laboratory can quickly become an underutilized and unsafe learning environment if ill-prepared teachers are thrust into instruction without adequate pre-service preparation (Hubert, et al., 2003; Newcomb, McCracken, & Warmbrod, 1993). Furthermore, learning cannot take place unless agriculture teachers can provide a safe learning environment for students to develop agricultural mechanics related skills (McKim & Saucier, 2011).

In the state of Kentucky, an educational reform in 1990 developed a new system of accountability for students, teachers, and school districts – mandating 24 hours of professional development for all classroom teachers (Elmore, Abelmann, & Fuhrmann, 1996; Kentucky Department of Education, 2010a). Within the state, agricultural mechanics teachers have not received professional development that was assessed, analyzed, or aligned to educational standards — which is considered the first step in developing effective professional development for teachers (Louks-Horsley, Love, Stiles, Mundry, Hewson, 2003). If the ultimate goal of professional development is to improve the learning outcomes of students (Guskey, 2002), then providing teachers with timely and needed professional development opportunities should be the goal of state supervisory staff and teacher educators (Saucier, et al., 2009). With twenty-years of development and revision to Kentucky academic standards and the increasing change in technology in agriculture mechanics, little professional development education has been offered to Kentucky teachers.

Theoretical Framework

To guide this non-experimental, quantitative study, Bandura's theory of self-efficacy (Bandura, 1997) was used. Bandura defined self-efficacy as the "beliefs in one's capabilities to organize and execute the course of action required to produce given attainments" (p. 3). 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). In the realm of education, teacher self-efficacy is an important concept of understanding teacher motivation (Knobloch & Whittington, 2002). By understanding the way in which a teacher feels about completing an activity, or their self-efficacy level, professional development opportunities can then be developed to address these inadequacies (see Figure 1).

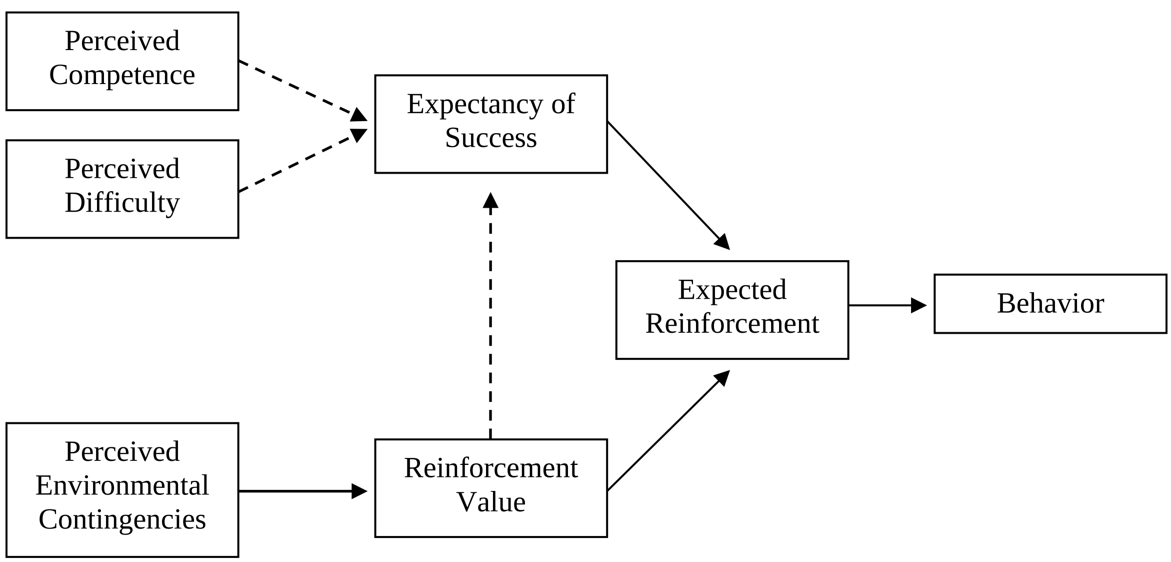

Figure 1. An illustration of the theory of self-efficacy (Bandura, 1997)

It is important to understand teachers' self-efficacy levels towards the management of agricultural mechanics laboratories. To ensure that teachers are providing safe experiential learning environments for students in these facilities (McKim & Saucier, 2011), it is essential that the professional development needs of teachers be evaluated and further educational opportunities be planned, delivered, and evaluated by teacher educators and state agricultural education leaders (Saucier, et al., 2009). Due to the limited amount of research regarding the agricultural mechanics laboratory management needs of Kentucky agricultural educators and the continual need for research regarding professional development of these specialized teachers (Osborne, 2007), a current assessment of these needs is necessary and should be conducted.

Purpose and Research Objectives

The purpose of this study was to describe the laboratory safety professional development needs of agricultural mechanics teachers in Kentucky who instruct students in an agricultural mechanics laboratory. The following research objectives were investigated to accomplish this purpose:

1. Identify the personal and professional demographic characteristics of Kentucky school-based agricultural mechanics teachers who utilize a laboratory to instruct related courses.
2. Identify the demographic characteristics of agricultural education programs in Kentucky that offer agricultural mechanics courses.
3. Determine the self-perceived level of importance that Kentucky school-based agricultural mechanics teachers place upon selected agricultural mechanics laboratory safety competencies.
4. Determine the self-perceived competence of Kentucky school-based agricultural mechanics teachers, who utilize a laboratory to instruct related courses, regarding selected agricultural mechanics laboratory safety competencies.
5. Determine the professional development needs of Kentucky school-based agricultural mechanics teachers for selected agricultural mechanics laboratory safety competencies.

Procedures

Population

The population for this non-experimental, quantitative study was school-based agricultural mechanics teachers in Kentucky, who taught agricultural mechanics courses in a laboratory setting, during the spring of 2010. By utilizing the state's most current teacher directory and purging duplications and errors, frame error was minimized. Due to the number of subjects and the ease of electronic data collection, a census was conducted to more accurately describe the characteristics of the population and eliminate potential errors associated with subject selection and sampling error.

Instrumentation

The data collection instrument developed by Johnson, Schumacher, and Stewart (1990), and later modified by Saucier, et al. (2009), was used for data collection in this study. A two-section instrument was utilized to address the research questions of this study. The first section of the instrument consisted of a 70 statements with double-matrix response scales. The double-matrix required subjects to respond to each statement twice. One scale was designed to rate the perceived importance of each skill competency (1 = *No Importance*, 2 = *Below Average Importance*, 3 = *Average Importance,* 4 = *Above Average Importance*, 5 = *Utmost Importance*), while the other scale was designed to rate the individual's ability to perform the skill competency (1 = *No Ability*, 2 = *Below Average Ability,* 3 = *Average Ability,* 4 = *Above Average Ability*, 5 = *Exceptional Ability*). The second section of the instrument was used to identify personal, professional, and program characteristics of the respondents and the agricultural education programs in which they taught (age, sex, ethnicity, years of teaching experience, highest degree obtained, largest student enrollment in an agricultural mechanics course)

In 1989, Johnson and Schumacher developed an instrument composed of 50 competencies developed through a modified Delphi technique. Johnson et al. (1990) later modified Johnson and Schumacher's instrument to include a double-matrix format to assess the perceived importance of each competency and the perceived ability of the individual to perform each competency. In 2009, Saucier, et al. modified Johnson et al.'s (1990) instrument by separating multiple-component items into single-component items. As a result, the original 50 competencies were expanded to 70 competencies. This study focused on the results of only the 14 laboratory safety related competencies from the instrument described above.

The design and format of the data collection instrument was guided by the suggestions of Dillman (2007). To determine face and content validity, the researchers used a web-based questionnaire design and delivery service, Hosted Survey™, to create and distribute the instrument to a panel of experts. The panel of experts (*N* = 7) consisted of two faculty members from a regional university that specialized in working with Kentucky teachers in agricultural mechanics, three doctoral graduate students with prior school-based agricultural education teaching experience, an agricultural education faculty member, and an agricultural education faculty member with expertise in instrument development and research methodology. The instrument was deemed valid through this process.

This same instrument was used in a previous study of school-based secondary agricultural education mechanics teachers in Missouri (Saucier, et al., 2009). The Cronbach's alpha for the 10 constructs included in that instrument ranged from .87-.90, indicating a high level of confidence in the reliability of the instrument. Additionally, the researchers of this study conducted a *post hoc* reliability estimate using Cronbach's alpha coefficients. Reliability estimates ranged from .88 to .93 (*n* = 87). See Table 1 for a definition of each construct.

Table 1

Definitions of Agricultural Mechanics Laboratory Management Constructs (Saucier et al., 2009)

Construct	Definition
Laboratory and equipment maintenance	Maintenance activities that an agriculture teacher must perform to keep the laboratory and equipment in working order
Laboratory safety	Activities that an agriculture teacher must perform to maintain a safe laboratory learning environment
Laboratory teaching	Educational activities conducted in the laboratory by the agriculture teacher to ensure academic and vocational success
Program management	Activities conducted by the agriculture teacher to plan, guide, assess, and evaluate the agricultural mechanics program
Tool, equipment, and supply management	Activities conducted by the agriculture teacher to ensure that all tools, equipment, and supplies are secured and in proper quality and quantity to facilitate the learning process

Methods

Dillman's (2007) electronic data collection protocol was followed for this study. After five points of contact, a response rate of 35.01% (*n* = 87) was obtained. Non-response error was a relevant concern; therefore, procedures for handling non-respondents were followed as outlined as *Method 1* in Lindner, Murphy, and Biers (2001). An independent samples *t* test indicated that no significant differences ($p < .05$) existed between the early and late respondents based on their perceptions of the importance of, or their ability to perform, each of the agricultural mechanics laboratory management competencies. Early respondents were defines as individuals who completed the instrument prior to the first reminder to complete the instrument, the late respondents were selected from the respondents who completed the instrument after the final reminder and the end of data collection. External validity did not threaten the generalizability of the findings of this study to the target population (Lindner, et al.).

Data Analysis

Data were analyzed using SPSS® version 18.0 for Windows™ based computers. In determining the appropriate analysis of the data, the primary guidance was scales of measurement as outlined by Ary, Jacobs, Razavieh, and Sorensen (2006). The first research objective sought to describe the selected characteristics of school-based agricultural mechanics teachers in Kentucky; thus, frequencies and percentages for gender, level of academic degree attained, and type of teacher certification program were calculated. In addition, mean and standard deviations were calculated for age, years of teaching experience, university semester credit hours earned in agricultural mechanics coursework, and hours spent weekly supervising student work in the agricultural mechanics laboratory. The second objective sought to describe selected characteristics of agricultural education programs in Kentucky that offered agricultural mechanics courses. Means and standard deviations were calculated for the following characteristics: annual student enrollment for agricultural mechanics courses, student enrollment per agricultural mechanics course, age of agricultural mechanics laboratory, size of the agricultural mechanics laboratory.

The third research objective sought to describe the perceived importance of selected agricultural mechanics laboratory safety competencies by school-based agricultural mechanics teachers while the fourth research objective sought to describe school-based agricultural mechanics teachers' perceived ability to perform selected agricultural mechanics laboratory safety competencies. Means and standard deviations were calculated for all variables associated with these objectives.

The fifth research objective sought to prioritize the agricultural mechanics laboratory safety competencies that need improvement through professional development, as perceived by school-based agricultural mechanics teachers in Kentucky. To determine the professional development needs of the respondents, the Borich (1980) needs assessment model was utilized to determine the discrepancy (importance level and ability level) for each competency. In accordance with this model, a Mean Weighted Discrepancy Score (MWDS) was calculated for each competency using the following formula:

$$\text{MWDS} = \frac{[(\text{Importance Rating} - \text{Ability Rating}) \times (M \text{ Importance Rating})]}{\text{Number of Observations}}$$

A large mean MWDS represents greater in-service needs, while smaller scores represent lesser in-service needs (Borich, 1980).

Findings

Research Objective # 1

The average respondent was 37 (M = 37.47; SD = 10.90) years of age and had taught school-based agricultural education courses for more than 11 years (M = 11.56; SD = 9.15). On average, the respondents complete 10 university semester credit hours of agricultural mechanics coursework (M = 10.08; SD = 8.73) as a part of their bachelor's degree. Additionally, teachers reported that they supervise student work in the agricultural mechanics laboratory for an average rate of more than 9 hours (M = 9.17; SD = 7.64) per week (see Table 2).

Table 2

Selected Personal Demographics of School-based Agricultural Mechanics Teachers in Kentucky (*n* = 87)

Characteristic	*M*	*SD*	Min	Max
Age	37.47	10.90	23	58
Years of teaching experience	11.56	9.15	0	33
University semester credit hours earned in agricultural mechanics coursework	10.08	8.73	0	60
Hours spent supervising student work in the agricultural mechanics laboratory weekly	9.17	7.64	0	35

To further describe the population, a summary of selected personal, professional, and program demographic characteristics of Kentucky school-based agricultural mechanics teachers were identified. The respondents consisted of 70 (80.50%) male and 17 (19.50%) female teachers (see Figure 2). As outlined in Table 3, the majority (*f* = 52; 59.80%) of these teachers indicated that they possessed a master's degree and were certified to teach agricultural education courses (*f* = 87; 100.00%).

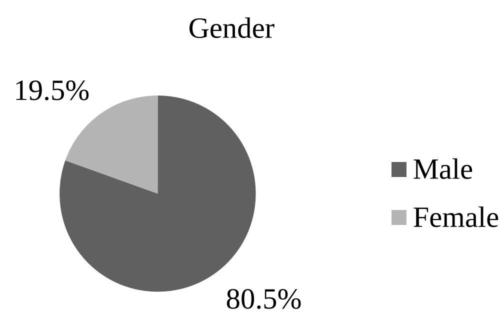

Figure 2. Gender of Kentucky school-based agricultural educators who manage an agricultural mechanics laboratory

Table 3

Education Levels of School-based Agricultural Mechanics Teachers in Kentucky (*n* = 87)

Degree Attained	*f*	%
Bachelors	18	20.70
Masters	52	59.80
Specialist	14	16.10
Doctoral	1	1.10
Other	2	2.30

Research Objective # 2

The average annual student enrollment for all agricultural mechanics courses per program was 91 students per year (*M* = 91.04; *SD* = 69.05). Respondents indicated that the average student enrollment in their agricultural mechanics classes was more than 25 students (*M* = 25.97; *SD* = 5.95). Teachers also reported that the average age of the agricultural mechanics laboratory was slightly more than 27 years of age (*M* = 27.48; *SD* = 13.75) and was 2,645 square feet in size

(*M* = 2,645.82; *SD* = 5,826.98). So, the total number of students enrolled in all agricultural mechanics courses and the size of the agricultural mechanics laboratory (ft^2), each student was provided with 85.14 ft^2 (*SD* = 77.33 ft^2) of laboratory workspace. The average consumable budget for agricultural mechanics programs was reported to be $1,849.32 (*SD* = $2,223.01). Therefore, the consumable budget spent per student in a Kentucky agricultural mechanics program was $24.19 (*SD* = $26.92). See Table 4 for a summary of these data.

Table 4

Selected Demographics of School-based Agricultural Education Programs in Kentucky (*n* = 87)

Characteristic	*M*	*SD*	Min	Max
Average student enrollment in agricultural mechanics courses	25.97	5.95	7	35
Total student enrollment in agricultural mechanics courses	91.04	69.05	13	360
Size of agricultural mechanics laboratory (ft^2)	2,029.38	1,581.34	200	12,000
Size of agricultural mechanics laboratory work space per student (ft^2)	85.14	77.33	10	545
Age of the agricultural mechanics laboratory	27.48	13.75	1	55
Consumable budget ($)	1,849.32	2,223.01	0	10,000
Consumable budget ($) per student	24.19	26.92	0	133

The largest amount of Kentucky school-based agricultural educators indicated that they instruct students at schools located in rural communities (*f* = 48; 55.20%) where total student enrollment in the agricultural education program is between 150 to 249 students (*f* = 34; 39.10%). Additionally, these teachers work in a two teacher agricultural education program (*f* = 49; 56.30%) and teach in a school that utilizes a seven period per day class schedule (*f* = 30; 34.50%). A summary of the results indicated above are illustrated in Table 5.

Table 5

Selected Demographics of School-based Agricultural Education Programs in Kentucky (*n* = 87)

Characteristics	*f*	%
School location		
Rural (population under 5,000)	48	55.20
Small Urban (population 5,001 to 20,000)	29	33.30
Urban (population 20,001 or more)	10	11.50
Total student enrollment in agricultural education program		
1-74 students	3	3.40
75-149 students	23	26.40
150-249 students	34	39.10
250 or more students	27	31.00
Number of teachers within agricultural education program		
One	21	24.10
Two	49	56.30
Three or more	17	19.50
Type of class scheduling system		
A/B block scheduling	8	9.20
4 x 4 block scheduling	8	9.20
6 periods per day	15	17.20
7 periods per day	30	34.50
8 periods per day	2	2.30
Other	24	27.60

Research Objective(s) # 3, 4, & 5

The construct category *Laboratory Safety* was operationally defined by Saucier, et al. (2009, p. 13) as "all activities that an agriculture teacher must perform to maintain a safe laboratory learning environment for students." Research objective three sought to describe Kentucky school-based agricultural mechanics teachers' perceived levels of importance of selected competencies of agricultural mechanics laboratory safety. *Providing students safety instruction* (*M* = 3.83; *SD* = 0.46), *administering first aid* (*M* = 3.51; *SD* = 0.66), and *correcting hazardous laboratory conditions* (*M* = 3.49; *SD* = 0.70) were perceived to be the three competencies with the highest levels of importance by the respondents. The three competencies that were perceived to have the least importance were: *promoting laboratory safety by color coding equipment/marking safety zones/ posting appropriate safety signs and warnings* (*M* = 2.70; *SD* = 0.82), *arranging equipment in the agricultural mechanics lab to enhance safety/efficiency/learning* (*M* = 3.13; *SD* = 0.76), and *maintaining healthy environmental conditions in the laboratory* (*M* = 3.14; *SD* = 0.82). The mean level of importance that respondents placed upon the 14 laboratory safety competencies were 3.33 (*SD* = 0.73), or average importance, and the mean level of importance for each competency ranged from 2.70 to 3.83. (see Table 6)

Research objective four sought to describe teachers' perceived ability to perform selected agricultural mechanics laboratory safety competencies. Mean values of school-based agricultural mechanics teachers' perceived ability to perform selected competencies ranged from 2.26 to 3.28. Teachers' perceived themselves as possessing an average ability to perform 86% (*n* = 12) of the 14 laboratory safety competencies. Respondents' perceived themselves as possessing a below average ability to complete the two constructs: *promoting laboratory safety by color coding equipment/marking safety zones/ posting appropriate safety signs and warnings* (*M* = 2.26; *SD* =

0.77) and *maintaining the agricultural mechanics laboratory in compliance with Occupational Safety and Health Administration (OSHA) standards* (*M* = 2.32; *SD* = 0.88). However, teachers' perceived themselves as possessing an average ability to perform the remaining 12 competencies. The three competencies in which the respondents perceived their ability to be the highest were: *providing students safety instruction* (*M* = 3.28; *SD* = 0.74), *selecting protective equipment for student use* (*M* = 3.05; *SD* = 0.75), and *developing an accident reporting system* (*M* = 2.85; *SD* = 0.87). Please see Table 6 for a summary of the results.

In the laboratory safety construct, the average MWDS was 1.67. In this construct, the laboratory management competency *correcting hazardous laboratory conditions* ranked as the highest in-service need with a MWDS of 2.10. The laboratory management competency with the least need for in-service education in this construct was *promoting laboratory safety by color coding equipment/marking safety zones/posting appropriate safety signs and warnings* with a MWDS of 0.99. These data are presented in Table 6.

Table 6

Mean Weighted Discrepancy Scores for Competencies Related to Laboratory Safety (*n* = 87)

			Importance		Competence	
Rank	Competency	MWDS	$\overline{X}$	*SD*	$\overline{X}$	*SD*
1	Correcting hazardous laboratory conditions.	2.10	3.49	0.70	2.72	0.85
2	Properly installing/maintaining safety devices/emergency equipment (e.g., fire extinguishers, first aid supplies, machine guards, etc.)	2.03	3.38	0.74	2.60	0.84
3	Maintaining the agricultural mechanics laboratory in compliance with Occupational Safety and Health Administration (OSHA) standards.	2.00	3.18	0.84	2.32	0.88
4	Administering first aid.	1.94	3.51	0.66	2.82	0.86
5	Providing students safety instruction.	1.81	3.83	0.46	3.28	0.74
6	Conducting regular safety inspections of the laboratory.	1.80	3.26	0.72	2.56	0.92
7	Safely handling hazardous materials (e.g., flammables, acids, and compressed gas cylinders.)	1.69	3.43	0.76	2.83	0.81
8	Developing an accident reporting system.	1.67	3.44	0.74	2.85	0.87
8	Maintaining protective equipment for student use (e.g., safety eyewear.)	1.67	3.34	0.74	2.74	0.78
10	Maintaining healthy environmental conditions in the laboratory (e.g., temperature, light, ventilation.)	1.54	3.14	0.82	2.53	0.79
11	Arranging equipment in the agricultural mechanics lab to enhance safety/efficiency/learning.	1.40	3.13	0.76	2.59	0.86
12	Documenting student safety instruction.	1.37	3.31	0.75	2.83	0.77
13	Selecting protective equipment for student use (e.g., safety eyewear.)	1.33	3.48	0.66	3.05	0.75
14	Promoting laboratory safety by color coding equipment/marking safety zones/posting appropriate safety signs and warnings.	0.99	2.70	0.82	2.26	0.77
	Mean rating for scales (Importance & Ability)		3.33	0.73	2.71	0.82
	Average MWDS for the laboratory safety construct	1.67				

Note: Importance Scale: 1 = *No Importance*, 2 = *Below Average Importance*, 3 = *Average Importance*, 4 = *Above Average Importance*, 5 = *Utmost Importance*; Ability Scale: 1 = *No Ability*, 2 = *Below Average Ability*, 3 = *Average Ability*, 4 = *Above Average Ability*, 5 = *Exceptional Ability*.

Conclusions, Implications, and Recommendations

Research Objective # 1 & 2

Kentucky school-based agriculture teachers varied greatly in experience from zero to 33 years, over half held a master's degree, and over 80% were male. Additionally, teachers indicated that students in their laboratories work in a space that is almost 85 square feet, and on average, spend almost $25 per student on laboratory consumables. Furthermore, participants reported having less pre-service instruction in agricultural mechanics coursework than their current counter-parts in Missouri (Saucier, et al., 2009). However, due to the relative low response rate of this study, caution should be taken to avoid extrapolating the results of this study beyond the respondents, regardless of the attempt of the researchers to handle non-response error using *Method 1* as suggested in the literature (Lindner, Murphy, & Biers, 2001).

According to the guidelines for Kentucky agricultural education programs, which are outlined in the *Facilities Guide for Career and Technical Education* (Kentucky Department of Education, 2010b), an agricultural mechanics laboratory should be 2,000 square feet and/or provide 120 square feet per student—which would equate to just fewer than 17 students in the typical Kentucky agricultural mechanics laboratory. Phipps et al. (2008) suggest that students should have 150 square feet of workspace in an agricultural mechanics laboratory, based upon the reported agricultural mechanics laboratory size of just over 2,000 square feet, this would equate to just over 13 students in the typical agricultural mechanics laboratory in Kentucky. While the findings in this study suggest that the laboratory size reported by the participants meets the standards set forth in the *Facilities Guide for Career and Technical Education* (Kentucky Department of Education), the amount of square footage per student does not. The respondents reported an average enrollment of 26 students in agricultural mechanics courses. This suggests that there are twice as many students in the space provided as recommended by Kentucky guidelines. Overcrowding is not new to public schools, nor is diminished learning outcomes in overcrowded classes—the larger issue in agricultural mechanics laboratories being overcrowded is safety (Dyer & Andreasen, 1999; Ready, Lee, & Welner, 2004). Does the lack of space per student in the laboratory increase their chance of being involved in an accident? Should class enrollment in agricultural mechanics courses be limited to a safe student/space requirement? Does academic attainment and success increase if enrollment in these courses is set at a safe level? These questions and others are grounds for future research. Based upon the results of this study, the researchers recommend that agricultural mechanics teachers work with their respective administrators to reduce the number of students in an agricultural mechanics laboratory to increase student learning and student safety.

It should also be noted that the consumable budgets for programs in Kentucky are roughly $25 per student; which is significantly lower than the $52 budgeted for students in Missouri (Saucier, et al., 2009). The reduction in budget may lead agricultural mechanics teachers to cut out selected safety items or elect to utilize cheaper versions of safety equipment. For example, a teacher may elect to use traditional welding helmets and not utilize auto-darkening helmets; this may increase the student's potential exposure to arc flashes. The reduced budgets may also lead to students using equipment that are unsafe or potentially dangerous. Teachers may currently be using traditional table saws because they do not have the budget to replace them with a modern table saw that has the safety features that are found on a Sawstop ® table saw. The researchers recommend that teachers work with their school administrators to develop a plan to identify damaged and/or potentially unsafe equipment and replace them with modern, safe equipment. Teachers who continue to use unsafe equipment, such as a traditional table saw, are placing students in a potentially dangerous situation that may lead to accidents and possibly position the teacher/administration into being named liable in a lawsuit for professional negligence.

Furthermore, the average Kentucky agricultural education program has 91 students who complete an agricultural mechanics course annually. This number suggests that agricultural mechanics is still a popular and relevant course in Kentucky secondary agricultural education programs. Teacher education programs should recognize the important role of agricultural mechanics and ensure that pre-service teachers are adequately educated to instruct agricultural mechanics courses, supervise SAE projects for the nine hours a week that has been reported, and be able to identify and prevent potential safety hazards in the agricultural mechanics laboratory.

However, many research questions still persist concerning safety in the agricultural mechanics laboratory. Do teachers know or understand their content knowledge level of laboratory safety? Who evaluates the agricultural mechanics laboratory at the school in which they teach? Is the laboratory at the school in which they teach a safe student learning environment? Can a lack of pre-service education in the area of agricultural mechanics contribute to an unsafe laboratory environment? Does the currently required, post-secondary, coursework, provide adequate education in laboratory safety practices? These questions and others are grounds for future research.

Research Objectives # 3, 4, & 5

Numerous studies have found that agricultural educators have professional development needs in the area of agricultural mechanics laboratory management (McKim & Saucier, 2011; Saucier & McKim, 2010; Saucier, et al., 2009). Additionally, Saucier, et al. (2009) suggested that research be conducted to determine the educational needs of teachers concerning laboratory management and the safety of agricultural laboratories. As result, the researchers have identified several agricultural mechanics laboratory management competencies that relate to laboratory safety: *correcting hazardous laboratory conditions*, *properly installing/maintaining safety devices/emergency equipment (e.g., fire extinguishers, first aid supplies, machine guards, etc.),* and *maintaining the agricultural mechanics laboratory in compliance with OSHA standards* as the highest professional development needs of the participants in this study. Based upon these results and Bandura's theory of self-efficacy (1997), teacher's self-reported efficacy levels should be incorporated in designing professional development workshops that concern agricultural mechanics laboratory safety. The researchers further recommend that the Kentucky Department of Education provide professional development workshops on agricultural mechanics laboratory safety that are led or assisted by an Occupational Safety and Health Administration (OSHA) compliance officer. This will ensure that participants can identify and correct safety hazards in their respective laboratories.

Due to the popularity of the courses and the potential dangers and hazards that exist in an agricultural mechanics laboratory, it is critical that pre-service and in-service education programs be provided for teachers who manage these facilities. Such programs should be offered with frequency and variety and should be delivered in formats and at times that will have the greatest impact upon the largest number of teachers. Additionally, these programs should focus on the needs of teachers based upon career stage and avoid a *cookie-cutter* approach for all. Providing teachers could accomplish this goal with professional development offered during the winter and summer breaks and agricultural education laboratory management courses offered for continuing education or university graduate course credit. Online, self-directed courses, or webinars, might also be an option for teachers with travel limitations. Winter and summer workshops focusing on agricultural mechanics should be offered at regional locations throughout the state of Kentucky and could be located at suitable university or public school facilities.

Additionally, teacher education programs that are graduating unprepared agricultural education teachers to teach agricultural mechanics are also putting themselves in jeopardy of being named negligent in a lawsuit. If these programs are truly developing fully qualified and highly motivated educators (Osborne, n.d.), then why are teachers, who do not possess laboratory safety and agricultural mechanics technical skills, considered for teacher certification? It is recommended that teacher education programs review and potentially revise existing pre-service programs, include courses in the area of laboratory management for agricultural education students, and develop a teacher induction program that will aid existing teachers in the areas of agricultural mechanics laboratory safety and management. It is also recommended that teacher educators make at least one on-site safety evaluation visit with first year teachers to assist in identifying unsafe and or potentially hazardous laboratory conditions.

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