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Safety Conditions and Practices in Secondary Agricultural Mechanics Programs

Dustin K. Perry[1], Robert L. Williams[2], Ryan G. Anderson[3]

[1] Graduate Student, Iowa State University, Department of Agricultural Education and Studies, Ames, IA 50011. Email: dkperry@iastate.edu

[2] Associate Professor, Texas A&M University-Commerce, Department of Agricultural Sciences, Commerce, TX 75429. Email: bob.williams@tamuc.edu

[3] Assistant Professor, Iowa State University, Department of Agricultural Education and Studies, Ames, IA 50011. Email: randrsn@iastate.edu

Abstract

The purpose of this study was to determine if secondary agricultural mechanics laboratories were perceived to be safe by the teachers who utilize them. This study also sought to determine the most common safety violations found in a high school agricultural mechanics laboratory. The health belief model was utilized as the framework for this study. A web-based questionnaire using the National Institute for Occupational Safety and Health (NIOSH) checklist for secondary agricultural science laboratories was developed to assess teachers' perceptions regarding safety in their secondary agricultural mechanics laboratory. Four specific areas of concern related to safety practices and conditions in agricultural mechanics laboratories were identified. They included signage, storage of oxygen and fuel gas cylinders, noise levels, and disconnecting switches on arc welding machines.

***Keywords*:** Agricultural Mechanics, Safety, Career Development Event, Secondary Agricultural Education

Introduction

Agricultural mechanics courses are popular among secondary students throughout the United States (Anderson, Velez, & Anderson, 2011). Rudolphi and Retallick (2011) indicated that 90% of agricultural education respondents in Iowa reported having taught agricultural mechanics courses. Saucier, Terry, and Schumacher (2009) and Saucier, Vincent, and Anderson (2011) found that agricultural education teachers were spending roughly nine to ten hours per week in the agricultural mechanics laboratory in Missouri and Kentucky respectively. McKim, Saucier, and Reynolds (2010) indicated that in some states nearly 60% of the curriculum taught in agricultural education courses included agricultural mechanics competencies.

Teachers' attitudes and beliefs towards safety also play a role in students' development. Hubert, Ullrich, Lindner and Murphy (2003) examined the relationship between Texas agricultural education teachers' personal beliefs as they pertained to common agricultural safety practices. The participants felt most strongly about having a properly working fire extinguisher. The second area they felt strongly about was having emergency phone numbers listed by the phone and students wearing personal protection equipment. Additionally, Swan (1993) conducted a study that examined agricultural mechanics safety practices in agricultural science laboratories. He concluded that the instructional techniques most commonly used in safety instruction were demonstrations conducted by students and instructors in the use of power tools. On the other hand, safety manuals, booklets, and worksheets were determined to be the most often used instructional materials by agricultural mechanics instructors. In regards to personal protective equipment (PPE), it was determined that industrial-quality eye protection and welding gloves were the most frequently available safety equipment for use by the students.

In order for agricultural educators to provide a safe laboratory learning environment for their students, they must possess certain skills and knowledge associated with agricultural mechanics laboratory management (Saucier, Schumacher, Funkenbusch, Terry, & Johnson, 2008). Johnson and Schumacher (1989) conducted a study that examined agricultural mechanics specialists' identification and evaluation of agricultural mechanics laboratory management competencies. These experts determined that the top five management competencies of a secondary agriculture teacher included the provision and documentation of safety instruction, the safe storage of hazardous materials, updating course offerings, safely arranging shop equipment, and conducting safety inspections. It was determined that safety was the most important factor in laboratory management. Eleven of the top 18 competencies identified by the respondents were safety related (Johnson & Schumacher, 1989).

Even though student safety has been determined to be the most important consideration, accidents still occur. Dyer and Andreasen (1999) reported that a mean of 1.3 major (requiring medical attention) student accidents and 13.3 minor accidents (requiring bandage but not medical attention) occurred per year when high school agricultural programs were examined (as cited in Swan, 1993). Lawver (1992) conducted an analysis of agricultural mechanics safety practices in Texas agricultural education programs. The objective of the study was to identify specific areas of deficient safety practices in order to make recommendations concerning the improvement of safety programs. The mean response when asked to report the number of major accidents (requiring attention by a doctor or a nurse) which had occurred in their agricultural mechanics program during the last five years was 0.8 accidents. The mean number of minor accidents (requiring minor first-aid but no attention by a doctor or a nurse) was 5.7 accidents. Lawver concluded that Texas agricultural education teachers were using recommended safety practices and were providing student safety and emergency equipment but not to the extent warranted by the hazards present. The results indicated that it was apparent that unsafe conditions exist in agricultural mechanics laboratories and that safety program improvement must become a top priority.

Lawver and Fraze (1995) conducted a follow-up study in which they evaluated why accident rates were so high by examining the relationship between accidents and safety attitudes and perceptions of students. Out of the 377 respondents, 13.2% indicated they had been injured in the agricultural mechanics laboratory. When students appeared to have favorable safety attitudes, fewer injuries in the agricultural mechanics laboratory and fewer serious school accidents were reported. It was also determined that teacher carelessness was associated with more incidence of injury in the agricultural mechanics laboratory and more involvement in serious accidents (Lawver & Fraze, 1995). From this study, the researchers concluded that Texas agricultural education teachers needed more preservice and inservice education in the areas of promoting positive safety attitudes and reducing teacher carelessness (Lawver & Fraze, 1995).

Another possible explanation as to why accidents are still occurring in the agricultural mechanics laboratory could be because the safety needs of teachers are not always met. Johnson, Schumacher, and Stewart (1990) found that the greatest inservice needs of agriculture education teachers in Missouri were in the area of safety. Saucier et al. (2009) also concluded that Missouri secondary agriculture education teachers were in need of in-service training in maintaining a safe agricultural mechanics laboratory and storing, handling, and disposing of hazardous materials. Similarly, McKim et al. (2010) determined that secondary agricultural education teachers in Wyoming were in need of inservice education in first aid, correcting hazardous laboratory conditions, and general laboratory safety. Texas school-based agricultural education student teachers were also found to be in need of professional development education in the areas of first aid and safe disposal of hazardous materials (Saucier, McKim, Murphy, & Terry, 2010).

Many states mandate that career-technical schools and institutions have safety and health programs in place, conduct hazard analyses for each career-technical program, do safety inspections and maintenance, and comply with safety and health and environmental regulations. The Safety Checklist Program by the National Institute for Occupational Safety and Health (NIOSH) provides information needed by schools to maintain safe classrooms, shops, and labs for teachers and students in career-technical education. This information can also be used by colleges and universities with occupational safety and health programs. This checklist covers such programs as agricultural mechanics, animal sciences, landscaping, and natural resources (Centers for Disease Control and Prevention & National Institute for Occupational Safety and Health [CDC], 2003).

Due to the nature of the agricultural mechanics laboratory, the inexperience of students who participate, and the proximity to dangerous equipment and chemicals, the potential for injury exists (Dyer & Andreasen, 1999). Woodford, Lawrence, and Bartrug (1993) found that potentially damaging levels of noise occurred during the use of all machines in agricultural mechanics laboratories except the vertical belt sander and bandsaw. Additionally, McKim et al. (2010) concluded that a safe learning environment provided by agricultural teachers is a necessity for students' development of agricultural mechanics related skills. Bruening, Hoover, and Radhakrishna (1991) insisted that of all the duties for which the instructor is responsible, the physical safety of students must come first. While teachers possess general positive attitudes towards safety, the current study sought to determine if the safe attitudes are being put into action.

Theoretical Framework

The health belief model was utilized as the framework for this study. The health belief model originally suggested that people's use of health services was a function of their predisposition to use services. Health beliefs are attitudes, values, and knowledge that people have about health and health services that might influence their perceived need or use of health services (Andersen, 1995). Health beliefs and attitudes towards health practices can easily be adapted to agricultural education teachers' safety practices and attitudes. The model has five dimensions that the researchers linked to agricultural mechanization laboratory safety.

The first dimension, perceived susceptibility, refers to a person's subjective perception of the risk of contracting a health condition (Strecher & Rosenstock, 1997). In regards to safety in the agricultural mechanics laboratory, this refers to an instructor's perception of a student getting involved in an accident. This perception could have little to no effect on the instructor's willingness to allow the student to participate, or it could be so intense that the instructor refuses to allow the student to participate.

The second dimension, perceived severity, refers to the feelings concerning the seriousness of contracting an illness of both clinical consequences and possible social consequences (Strecher & Rosenstock, 1997). This dimension, paired with the first, can further hinder an instructor's willingness to allow a student to participate in agricultural situations that pose threats to their physical well-being.

The third dimension, perceived benefits, refers to a potential course of action that could be taken depending upon whether or not an individual believes the actions will be an effective way of reducing the possibility of threat (Strecher & Rosenstock, 1997). This means that if the instructor does not believe that allowing a student to participate in said action will result in a reduction of threat level; he/she will not be allowed to participate.

Perceived barriers, the fourth dimension, refers to how the potential negative aspects of an action may result in impeding a recommended behavior (Strecher & Rosenstock, 1997). In agricultural mechanics laboratory safety, this is essentially taking shortcuts to save time or money at the cost of safety.

Cues to action, cues that trigger specific reactions, also come into play. Cues to action could be as simple as safe behavior signs. Other variables such as demographics may affect an individual's perception (Strecher & Rosenstock, 1997).

The final dimension, self-efficacy, refers to one's ability to feel in themselves the competency required to implement a change once they realize a specific change is required in order to not feel threated any more (Strecher & Rosenstock, 1997). This often requires long-term changes.

Purpose and Research Objectives

The purpose of this study was to determine if secondary agricultural mechanics laboratories are perceived to be safe by the teachers who utilize them, as well as determine if teachers who specialize in agricultural mechanics perceive their laboratories to be safer than those who do not specialize in agricultural mechanics. This study also sought to determine what teachers perceived to be the most common safety violations were that could be found in a high school agricultural mechanics laboratory. This study was guided by the following research objectives:

1 Determine if the agricultural mechanics laboratories are safe as perceived by teachers who use them.
2 Identify the safe practices being observed by students and teachers in agricultural mechanics laboratories.

Procedures

Population

For this study, teachers who trained teams for the state Agricultural Mechanics CDE were considered “specialized” as agricultural mechanics instructors, while teachers who trained teams for the state Nursery/Landscape CDE were considered as “non-specialized” in agricultural mechanics. The population for this study consisted of a group of 32 secondary agricultural education teachers whose teams participated in the [State] Agricultural Mechanics CDE and 32 secondary agricultural education teachers whose teams did not participate in the [State] Agricultural Mechanics CDEs. The second group was selected from the list of the participants in the [State] Nursery/Landscape CDE. The Nursery/Landscape CDE was the only CDE that was comprised of agricultural education instructors who did not prepare an agricultural mechanics CDE team that participated at the state competition. An assumption was made that agricultural education teachers who trained Nursery/Landscape CDE teams had access to and utilized agricultural mechanics laboratories but specialized in another area of agricultural education instruction. It was also assumed that agricultural education teachers who trained state level Agricultural Mechanics CDE teams did specialize in agricultural mechanics instruction and were considered experts.

Instrumentation

A web based questionnaire developed using the National Institute for Occupational Safety and Health (NIOSH) checklist for secondary agricultural science laboratories was developed on SurveyMonkey.com to assess teachers’ perceptions regarding safety in their secondary agricultural mechanics laboratory. The NIOSH checklist is primarily based on Occupational Safety and Health Administration (OSHA) and Environmental Protection Agency (EPA) regulations (CDC, 2003). Additionally, the checklist takes into account specific regulations that are in place for workers or students under the age of 18. The researchers narrowed down the extensive checklist to focus on seven categories: personal protection equipment (PPE), compressed gasses, flammable and combustible liquids, portable hand and power tools, noise, welding and cutting with oxygen-fuel gas, and welding with arc-welding equipment. The questionnaire also included a background section to collect demographic information for the respondents.

In accordance with Dillman, Smyth, and Christian (2009), the questionnaire was checked for content validity through a review conducted by a panel of experts. The panel consisted of pre-service and current agricultural education teachers who were not eligible to participate in the study as well as two teacher educators with agricultural mechanization backgrounds. Following this review process, suggestions for improvement were taken into consideration and slight modifications were made to the questionnaire. The NIOSH safety checklist had previously been pilot tested and deemed reliable (CDC, 2003). Therefore, the researchers did not conduct a pilot study to further establish reliability.

Methods

Dillman, Smyth, and Christian (2009) data collection methods were utilized for this study. Eligible teachers were sent an introductory e-mail including details about the design and importance of the study, as well as contact information of the researchers. A second e-mail sent contained two hyperlinks, one of which took recipients to the questionnaire and the other which allowed recipients to decline participation, was sent the next day. One week later, recipients who had not yet completed the survey were sent the first follow-up e-mail that stressed the importance of their contribution and provided the same two hyperlinks to encourage participation. Two weeks after the initial email with links to the questionnaire was sent, a personalized letter was sent to those recipients who had still not provided responses. A final invitation containing the two original hyperlinks was sent via email to non-respondents three weeks after the initial email was sent. Data collection was open for a total of five weeks.

The introductory email was sent to 64 teachers who were determined eligible to participate in the study. However, four of these teachers, two from each group, had blocked attempts to contact them. Of the remaining 60 recipients, 26 teachers responded, providing a 43.3% response rate. Of those respondents, three partially incomplete questionnaires were received. Therefore, some of the data will be reported with only 23 respondents. Thirteen of the respondents trained teams that participated in the state Agricultural Mechanics CDEs and ten trained teams that participated in the state Nursery/Landscape CDEs. Data was analyzed using SPSS 17.0. Due to anonymity, telephone calls were not conducted to accommodate for nonresponse error. Instead, it was assessed by comparing responses from the first 12 respondents to the last 11 with regard to the yes/no questionnaire items. No significant difference ($\alpha = 0.05$) was found between the two groups. While Lindner, Murphy, and Briers (2001) recommend this statistical procedure as an acceptable method for testing for nonresponse error, it should be noted that this approach has limitations due to the small sample size.

Findings

Research Objective #1

The first research objective addressed was whether or not agricultural mechanics laboratories are perceived by teachers who use them as safe working environments. A frequency analysis (Table 1) indicated four areas of concern. Areas of concern occurred when 50% or more of the responses indicated a specific safety practice or condition was not reported for the teachers' agricultural mechanics laboratories. Over 80% of all respondents indicated that their facilities do not have all of the proper signage indicating the required personal protective equipment required for each work area alerting students of potential hazards. Only 15.4% of the respondents specializing in agricultural mechanics indicated having proper shop signage, while 20% of respondents not specializing in agricultural mechanics indicated having proper signage. Even though the respondents not specializing in agricultural mechanics indicated safer practices than the respondents specializing in agricultural mechanics concerning the storage of fuel gas cylinders, both faired low with negative responses of 50% and 66.7% respectively.

Almost 90% of all respondents indicated not having a continuing effective hearing conservation program. Furthermore, none of the respondents who did not specialize in agricultural mechanics indicated having any hearing conservation programs for the criteria listed. Just under than 70% of the respondents specializing in agricultural mechanics indicated not having a disconnecting switch with overcurrent protection located at or near each arc welding machine. The respondents not specializing in agricultural mechanics indicated a safer environment at 55.6% not having a disconnect switch, but this percentage is still not in the acceptable range.

Table 1. Specific Areas of Concern Related to Safety Practices and Conditions in Agricultural Mechanics Laboratories

Question	Specialized			Non-Specialized		
		f	%		*f*	%
Are all lab shop entrances, areas, and equipment requiring the use of PPE devices, posted with a sign indicating this requirement?	Yes No	2 11	15.4 84.6	Yes No	2 8	20.0 80.0
Are oxygen and fuel gas cylinders separated by a minimum of 20 feet when in storage?	Yes No	4 8	33.3 66.7	Yes No	5 5	50.0 50.0
Does the school administer a continuing effective hearing conservation program when noise exposure equals or exceeds 85 dBA as an 8-Hour time weighted average?	Yes No	2 10	16.7 83.3	Yes No	0 7	0.0 100.0
Is a disconnecting switch with overcurrent protection located at or near each arc welding machine that does not have a switch?	Yes No	4 9	30.8 69.2	Yes No	4 5	44.4 55.6

Note: *f* varies due to non-usable responses

Research Objective #2

The second research objective addressed was whether or not safe practices were conducted by students and teachers in agricultural mechanics laboratories. There were ten questions in the questionnaire directly related to safety training and associated practices of students in the agricultural mechanics laboratory. As shown in Table 2, the majority of respondents indicated that their students received specific safety training and demonstrated safe practices. However, there were areas that were noticeably low. Both groups indicated that only 62% of their students wore protective footwear whenever the potential of foot injuries were present. Additionally, two respondents, one from each group, indicated that not all students who will be using the agricultural mechanization laboratory have received training on the required PPE. All of the respondents specializing in agricultural mechanics indicated requiring their students to wear appropriate eye protective devices while participating or observing activities which present a potential eye safety hazard. However, only 80% of the respondents not specializing in agricultural mechanics reported students wearing eye protection. Notably, only 86.4% of the total respondents indicated their students actually using the PPE selected. Approximately 66.7% of the respondents specializing in agricultural mechanics indicated that students engaged in gas-shield arc-welding were acquainted with “Recommended Safe Practices for Gas-Shield Arc-Welding.”

Table 2. Specific Areas of Concern Related to Student Safety Training and Practices in Agricultural Mechanics Laboratories

		Specialized			Non-Specialized	
Question		*f*	%		*f*	%
Do students use the PPE selected?	Yes	11	84.6	Yes	8	88.9
	No	2	15.4	No	1	11.1
Has each student, who is required to use PPE, been provided with training?	Yes	12	92.3	Yes	9	90.0
	No	1	7.7	No	1	10.0
Have the trained students demonstrated an understanding of the training and the ability to use PPE properly before performing work requiring it?	Yes	12	92.3	Yes	8	88.9
	No	1	7.7	No	1	11.1
Is protective footwear used wherever there is danger of foot injuries?	Yes	8	61.5	Yes	5	62.5
	No	5	38.5	No	3	37.5
Are appropriate protective gloves used wherever there is the danger to hands of exposure to hazards?	Yes	12	92.3	Yes	8	88.9
	No	1	7.7	No	1	11.1
Are students issued and required to wear appropriate eye protective devices while participating or observing activities which present a potential eye safety hazard?	Yes	13	100.0	Yes	8	80.0
	No	0	0.0	No	2	20.0
Are all students trained and evaluated competent in the use of welding apparatus?	Yes	13	100.0	Yes	10	100.0
	No	0	0.0	No	0	0.0
Are students properly instructed and qualified to operate arc-welding equipment?	Yes	13	100.0	Yes	10	100.0
	No	0	0.0	No	0	0.0
Are students engaged in gas-shield arc-welding acquainted with Recommended Safe Practices for Gas-Shield Arc-Welding?	Yes	8	66.7	Yes	8	80.0
	No	4	33.3	No	2	20.0
Is the student required to report any equipment defects or safety hazards and to discontinue use until safety has been assured?	Yes	13	100.0	Yes	10	100.0
	No	0	0.0	No	0	0.0

Note: *f* varies due to non-usable responses

Conclusions

Research Objective #1

The intent of the first objective was to determine if agricultural mechanics laboratories were perceived by teachers who use them as safe working environments. It was determined that four areas of safety in the secondary agricultural mechanics laboratories needed improvement. These areas included signage, storage of oxygen and fuel gas cylinders, noise levels, and power-disconnect switches on arc-welding machines. Even though they were all negative responses, respondents not specializing in agricultural mechanics reported having a safer environment than those specializing in agricultural mechanics respondents in three of the four areas. The only one where they scored lower was in the hearing conservation program section.

These results confirmed previous studies. Gliem and Miller (1993) found that some schools were not taking the necessary steps to bring the safety awareness of students to an acceptable level, even when the issues could be resolved by using relatively inexpensive safety materials and procedures such as color coded tools and safety zones. Having all laboratory and shop entrances, areas, and equipment requiring personal protection equipment posted with a sign indicating this requirement was also suggested as an inexpensive way to bring safety awareness to students. Further light can be shed on this issue by examining it through the cues to action dimension of the health beliefs model. The health beliefs model suggests that simple signals, such as shop safety signs, provide cues that reinforce safe behaviors.

Another issue that this study revealed was the lack of effective hearing conservation programs. This coincided with Woodford et al. (1993). Furthermore, Woodford et al. (1993) also determined that 70% of the students examined reported that they never wore hearing protection when around machinery. Even though students are not typically exposed to damaging noise levels that exceed OSHA standards, secondary schools appear to have a need for hearing conservation programs to prevent hearing damage that could occur in the agricultural mechanics laboratories. Providing adequate hearing protection would support the perceived benefits dimension of the health beliefs model.

Research Objective #2

The second research objective was used to determine if safe practices were reported by students and teachers in agricultural mechanics laboratories. There were ten questions in the questionnaire that specifically addressed student safety instruction and practices. The majority of the respondents indicated that the students under their supervision were taking the necessary steps to practice safe behavior. Only two respondents indicated that their students were not issued and required to wear appropriate eye protective devices. These findings were in agreement with previous work done on the subject. Swan (1993) found that eye protection and welding gloves were the most frequently available safety equipment for student use. The results indicated that over 90% of respondents claimed that their students used protective gloves and eye protection when potential hazards were present.

It appears that secondary agricultural mechanics instructors are taking some of the necessary steps to keeping their students safe. However, according to the perceived barriers dimension of the health beliefs model there is still room for improvement in this area. The percentage of students using the selected PPE should be 100 percent. Wearing protective footwear falls into this category. Only 61.9% of respondents reported requiring their students to wear the proper protective footwear. Further research should investigate what types of footwear students and teachers are wearing while teaching in the agricultural mechanics laboratory. It is possible that the teachers are requiring students to wear boots or leather shoes, but not requiring steel-toed boots as required by NIOSH.

Recommendations & Implications

It was determined that there were four specific areas of concern related to safety practices and conditions in agricultural mechanics laboratories. They included signage, storage of oxygen and fuel gas cylinders, noise levels, and disconnecting switches on arc-welding machines. It is the recommendation of the researchers that NIOSH create and distribute laboratory safety signage that should be required in all agricultural mechanization laboratories. The researchers also highly recommend that local gas distribution centers work with their agricultural education instructors to ensure all cylinders are stored properly. The researchers recommend a study be conducted to measure the noise levels in agricultural mechanization laboratories to determine the amount of noise that both students and teachers are being exposed to. The researchers suggest that further investigation be targeted at determining why these four areas are not being addressed.

The participants of the study should be commended for their efforts to provide safety training to their students. However, the researchers are highly concerned that there are teachers who admittedly reported that they do not require their students to wear safety glasses in potentially hazardous conditions. It is also alarming that they reported students do not wear proper PPE while working in the laboratory. These items are indicators that the instructors are acknowledging that they are allowing unsafe environments to exist. The health beliefs model suggests that attitudes dictate actions. It is the researchers' interpretation that the agricultural education teachers agree that safety is important, but some fail to truly believe that is important based on their actions.

Another area for further investigation should be to determine if there is a difference between self-reported agricultural mechanics laboratory safety practices and conditions compared to observations of agricultural mechanics laboratory safety practices and conditions conducted by an independent observer trained in laboratory safety. The researchers also recommend teacher education programs work with state teachers associations to deliver safety workshops at state teacher workshops.

Implications for teachers of agricultural mechanics include the need for increased awareness and ongoing emphasis on the use of all PPE devices, especially hearing protection devices. More attention needs to be placed on safety apparatus awareness through agricultural mechanics professional development. Teacher development programs should emphasize the importance of safety in order to allow educators the opportunity to develop the competencies required to implement change, as detailed in the self-efficacy dimension of the health beliefs model.

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