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Laboratory Safety Practices of New Mexico Agricultural Science Teachers

Steven "Boot" Chumbley[1]

[1] Assistant Professor of Agricultural Mechanics and Education, Eastern New Mexico University, 1500 S. Ave. K, Station 11, Portales, NM 88130 Phone: 210-383-6329 Email: boot.chumbley@enmu.edu

Abstract

To properly assess the application of safety in the agricultural mechanics laboratory, research must be conducted on what safety practices are being used, methods of teaching safety and investigation of safety equipment being used. The purpose of this study was to identify the practices of New Mexico agricultural mechanics teachers for teaching safety and managing a laboratory environment. It was found that at least 30% of all instructional time was devoted to safety. Teachers were found to be the most confident about administering first aid in an emergency. The most common safety equipment found in the agriculture laboratory were items related to eye protection and fire safety. Safety exams and safety demonstrations were the most used instructional tools for teaching safety. The highest level of importance was placed on teaching eye safety and power tool use. The least was put on making safety posters and safety inspections. Teachers felt the most prepared to teach eye safety and the use of welding systems. They felt the least prepared to teach safety laws and develop safety posters. This information is important to the future development of teacher training and in-service which should also be disseminated to campus administrators.

***Keywords*:** agricultural education, agricultural mechanics, laboratory management, safety

Introduction and Review of Literature

Agricultural education and agricultural mechanics teachers have many different types of responsibilities, the most important of which is maintaining laboratory safety. According to previous research, laboratory activities have shown to be a large part of most agricultural education programs (Franklin, 2008; Phipps, Osborne, Dyer & Ball, 2008). Students in agricultural mechanics labs are exposed to metal working, wood working, agricultural machinery, chemicals and other processes which could pose serious injury to the students, teachers and other stakeholders. When utilizing such environments teachers have a responsibility to the students and all stakeholders to teach and maintain a high regard for safety of all who enter the learning laboratory. This is not only a moral obligation for the teacher, but also a legal one (Gliem & Hard, 1988).

Construction, one of the largest industries in the world, is also one of the most dangerous industries in the world (Brunette, 2004; Cheng, Lin & Leu, 2010). A thorough understanding of safety practices and what causes accidents is important for those interested in construction and agricultural mechanics to perform tasks safely. There are many job practices in the agriculture mechanics career field that cross over with practices in the construction industry (i.e. operation of heavy equipment, metal fabrication, etc.). These industries are especially dangerous because they are continually changing, use many different resources and many workers lack the appropriate safety training (Schoonover et al, 2010). A 2011 study illustrated that there was a perceived lack of safety culture and occupational risk assessment (ORA) in these industries that future employees (i.e. career and technology education [CTE] students) need to be familiar with (Pinto, Nunes & Ribeiro, 2011).

Identifying and cultivating a culture of safety in students early is a key to reducing injuries and accidents (Gillen et al, 2013). A Swedish study found that four of the main factors that contribute to safety standards were project characteristics, organization structure, collective group safety values and individual competencies and attitudes (Torner & Pousette, 2009). As CTE instructors, agriculture science teachers have a unique opportunity to cultivate a climate of safety among their students. This early exposure of a culture focused on safety will allow those students entering the construction industry to have appropriate safety competencies and lead to reduced accidents in the workplace. Teachers must be held accountable for students' safety and encouraged to keep safety as a focus in all areas of instruction within agricultural mechanics.

Lawver (1992) found that, while teachers were using recommended safety practices, they were not providing them to the extent warranted when working in such a dangerous environment. This is representative of other studies with similar results of teachers' lack of safety training or appropriate laboratory environments (Johnson, Schumacher & Stewart, 1990). The results of the previously mentioned research help to exhibit the likelihood of unsafe conditions for students that must be addressed. This does not create the organized structure which enforces safety nor does it help to embrace collective group safety values. Areas where agricultural education laboratories have been found to be lacking include the posting of appropriate warning signs, conducting safety inspections and working with students' proper use of personal protective equipment (PPE) (Walter, 2002).

To properly assess the application of safety in the agricultural mechanics laboratory, research must be conducted to identify which safety practices are being taught and implemented, methods of teaching safety and investigation of safety equipment available to students and teachers (Bear & Hoerner, 1986). Students have been found to be more safety conscious when teachers demonstrated appropriate safety practices and demonstrated an understanding of safety (Harper, 1984). Instructional practices implemented in both the classroom and laboratory settings are partially based on how teachers choose to teach the curriculum content with the resources allocated to them (Knobloch, 2008). Stressing safety and demonstrating proper safety in an educational laboratory is essential (Burris, Robinson & Terry, 2005). Despite the recognized importance of safety, multiple studies have documented unsafe conditions in agricultural mechanics laboratories (Swan, 1992; Dyer & Andreason, 1999, Saucier, Vincent & Anderson, 2011). According to past research, teachers have been shown to teach based on their past experiences and personal beliefs (Borko & Putnam, 1996; Knobloch & Ball, 2003). Shinn (1987) reinforced the point that agricultural mechanics laboratories must be safe and well organized environments for the highest levels of student learning to take place.

Teachers have been found to use multiple forms of teaching methods when it comes to the instruction of safety practices. The most common methods have been found to be demonstrations, worksheets and videos (Lawver, 1992; Dyer & Andreason, 1999). Teachers were found to place priority on teaching of power tools, hand tools and eye protection (Lawver & Fraze, 1995). The PPE most commonly found in the agricultural education laboratory are industrial quality eye protection, welding hoods and welding gloves (Swan, 1993). While teachers have rated teaching safety as a high priority, their knowledge concerning the management of an agricultural mechanics laboratory has shown to be low.

The majority (85%) of New Mexico agriculture education programs have been found to include an agricultural mechanics component in their courses (Chumbley & Russell, 2011). There has been limited research on the safety and laboratory management practices of New Mexico agricultural mechanics teachers. A recent study on teacher professional development needs (Saucier, Stair & Rosencrans, 2012) concluded that professional development needs were highest for New Mexico agriculture science teachers in the areas of laboratory safety and safety instruction. A review of literature found a similar lack of findings in reference to how safety is taught within these programs (McKim & Saucier, 2011; Saucier et al., 2009). Based on this lack of research it was determined that a need existed to examine the agricultural safety and laboratory management practice of New Mexico teachers. Being able to determine how teachers provide safety instruction and the ways they manage laboratory environments will assist state leaders and teacher educators in providing appropriate training and in-service instruction to their stakeholders. The ultimate benefit from this research will be a safer learning environment for students and others who work with agricultural mechanics programs in the state of New Mexico. Furthermore, this study follows the National Research Agenda, Priority 5: Efficient and Effective Agricultural Programs (Doerfert, 2011).

Theoretical Framework

The theoretical framework for this study was based around the theory of planned behavior (Azjen, 1985), which is an extension of the theory of reasoned action (Fishbein & Azjen, 1975; Azjen & Fishbein, 1980). The theory of reasoned action depicts the psychological process by which attitudes cause behavior (Fishbein, 1967). Both were designed to exhibit the relationship between informational and motivational influences on behavior (Connor & Armitage, 1998). The theory of planned behavior suggests that behavioral intentions can be best viewed as consequences of an individual's attitude. The theory of planned behavior suggests that demographic variables and knowledge influences values and beliefs. These in turn affect attitude, intention and behavior. The theories impact the study of confidence levels and the factors that influence agriculture teacher success in teaching safety in the agricultural education laboratory. The theory of planned behavior represents behavior as a function of behavioral intentions and perceived behavioral control (PBC) (Azjen, 1991). Motivational factors are considered to be indications of how hard people are willing to try and how much of an effort they are planning to exert in order to perform the behavior.

Teacher confidence is routinely linked to Bandura's concept of self-efficacy. This can be described as a teacher's judgment of their capabilities to organize and execute courses of action required to change types of performance (Bandura, 1984). Self-efficacy can enhance or impair performance through their effects on cognitive, affective, or motivational intervening processes. It is important to note that a person's beliefs about their capabilities are not the same as actual ability, but they are closely related. If a person has low efficacy or confidence in a task, then their performance in that task is expected to be low (Bandura, 1997). Conversely, higher ability levels would tend to increase their confidence levels and as a result, their level of performance.

As adapted for this study, these theories suggest that agricultural mechanics teachers past experiences and characteristics influence their decisions to teach specific safety standards in their courses. This may also have an effect on how teachers deliver instruction on these specific topics. By understanding teacher confidence and perceptions of teaching safety, researchers will more likely be able to determine how confident teachers are to successfully implement these concepts into their courses and agriculture programs.

Purpose and Research Objectives

The purpose of this study was to identify the practices of New Mexico agricultural science teachers for teaching safety and managing an agricultural mechanics laboratory environment. The following objectives guided this study:

1. To determine demographic and safety characteristics of New Mexico agricultural science teachers.
2. To identify the instructional methods and materials used by New Mexico agricultural science teachers to teach agricultural safety.
3. To investigate perceptions held by New Mexico agricultural science teachers concerning the importance of agricultural mechanics safety instruction and practices.
4. To determine the availability of selected safety equipment and emergency items in agricultural mechanics laboratories.

Methodology

The target population for this descriptive study was New Mexico secondary agricultural science teachers who offered an agricultural mechanics component within their programs. A list of teachers was obtained from the New Mexico public education department. Dillman's Tailored Design Method (2007) guided the collection of data and correspondence with census participants. The researcher identified 98 agriculture science teachers in the state. Those teachers who identified themselves as teaching at least one course in an agricultural mechanics laboratory (N = 75) were contacted. Teachers were asked to complete an online survey through Surveymonkey, an online survey software tool. Subjects were contacted up to five times through e-mails from the researcher. There were thirty-eight respondents (n = 38) to the survey, resulting in a response rate of 51%. Comparison of early and late responders revealed no significant ($p < .05$) difference. Non-response error was not an overt concern due to the descriptive nature of this study. As such, the results are applicable to the respondents and are not overly generalizable to the non-respondents.

The instrument used for this study was one previously employed by Lawver (1992) to assess safety practices of teachers in Texas. This instrument is a modified version of an original instrument developed by Hoerner and Kessler (1989). The instrument used in this study has been successfully exercised in similar studies of other states (Johnson & Fletcher, 1990; McKim, Saucier & Reynolds, 2010). To ensure face and content validity a panel of experts (*N* = 9) consisting of five university faculty and four agricultural science teachers were consulted. Recommendations to update language in the instrument were considered and integrated into the instrument. A pilot test was used with a similar population to estimate reliability. Cronbach's alpha coefficients were used to measure internal consistency in order to establish reliability. The pilot test data revealed a reliability Cronbach's alpha coefficient of .623. Nunnally (1967) suggested that Cronbach's alpha coefficients of .5-.6 are acceptable in the early stages of research. Reliability of the pre-test and final instruments is reported in Table one.

Table 1. Pilot Test and Final Instrument Reliability Scores

Instrument	Cronbach's Alpha
Pilot Test	.623
Final Instrument	.860

Part one of the instrument focused on demographic information and the safety materials most readily used and available in the agricultural science laboratory. This included information about years of teaching experience, college hours in agricultural mechanics, number of students enrolled in the program, what certifications the teacher had received concerning safety and average number of courses taught. The instrument also sought to identify the number of major and minor accidents that occurred in the agricultural mechanics laboratory. Injuries in the lab can vary greatly based on the type of work being performed and environment. Major injuries were characterized as injuries that resulted in a student not being able to effectively perform laboratory duties for more than one day after the injury. Examples provided to teachers included second degree burns, concussions, major falls and broken bones. The researcher felt this was important as employers with 10 or more employees are required by the Occupational Safety and Health Administration (OSHA) to report similar information.

The second section solicited responses concerning most commonly used safety practice and instructional methods utilized for teaching safety. This included questions concerning availability of PPE, proper equipment storage, instructional strategies used, instructional materials most often used and other questions related to safety in the agricultural mechanics laboratory. This section of the survey concluded with questions pertaining to teacher's perceptions of safety in the agricultural mechanics laboratory.

Findings

Objective One

The first objective sought to determine demographic characteristics of the agricultural education programs and teachers who were teaching agricultural mechanics classes. The average respondent had 10.5 years of teaching experience. The most novice teacher had taught for one semester while the most senior teacher had taught for 31 years. The average teacher had received a minimum of 12 hours of college-level agricultural mechanics coursework and had been enrolled in a shop type class in high school. All teachers had at least three hours of postsecondary agricultural mechanics courses. Teachers maintained liability insurance ranging in amounts from no insurance up to $1 million. All programs surveyed were found to have an agricultural mechanics laboratory with an average size found to be between 1,000-2,000 square feet. Some other characteristics of the programs sampled are found in table two.

Table 2. Agricultural Mechanics Program Demographics

Characteristic	*M*	*Min*	*Max*
# students in agriculture program	79	9	300
# of agricultural mechanics courses taught	2	1	7
Average class size	13	4	30

The researcher found most teachers (84.2%) were certified in first aid and felt qualified to use it in an emergency (81.6%). The two most common safety certifications teachers had obtained included the National Center for Construction Education and Research (NCCER) and Occupational Safety & Health Administration (OSHA) safety certifications. Some other safety certifications teachers stated as having included: EMT-B, first responder, defensive driving and a safety certification from the American Welding Society (AWS). Teachers felt “moderately” to “very well prepared” to provide safety instruction in their classes (76.6%). It was found that 71.1% of teachers kept a written report of all accidents in the agricultural mechanics shop. The researcher asked participants to list the average number of major and minor accident occurrences in the agricultural science laboratory. These findings are found in table three.

Table 3. Average Number of Accidents Found Within the Agricultural Mechanics Laboratory

Type of Accident	*M*	*Min*	*Max*
Major	0.50	0	4
Minor	3.92	0	25

Objective Two

The second objective was to identify instructional methods and materials used for teaching safety in the laboratory environment. Teachers devoted a range of times to safety, with 44.7% of teachers spending less than one third of their time devoted to safety, while 42.1% spent between one third and one half of their time in instruction of safety topics and 13.1% used over half of instructional time on safety topics. To teach safety, teachers were found to be split between teaching it as a separate unit (36.8%), integrating safety lessons into each instructional unit (23.7%) or teaching safety equally as a separate unit and integrated within units (39.5%).

Teachers were found to use a variety of instructional techniques and materials to teach laboratory safety. The most common lessons were demonstration lessons with power tools (92%) and hand tools (92%) as well as assessments on laboratory safety exams (92%). Less than 30% of the teachers taught students how to set up cleaning schedules or designate clean up foremen. When asked what materials they used to teach safety to their students, respondents were most likely to take advantage of hands-on safety materials (89.5%), worksheets (78.9%), videos (78.9%) and computer programs (50%). Other instructional materials included transparencies, safety instructional sheets and textbooks.

Objective Three

Participants were asked to rank the importance of various agricultural safety instructional topics or practices. Value of each topic was measured on a Likert-type scale ranging from 1-5. Participants felt using eye protection was the most important topic. They felt teaching students how to develop safety posters was the least important topic. The values were rated from five "much importance" to one "little importance". Table four presents a rank order listing of the most important to least important topics identified by the teachers.

Table 4. Teachers' Perceptions of Importance of Safety Topics

Safety Topic	*M*	*SD*
Using industrial quality eye protection	4.68	0.66
Electrical safety	4.57	0.69
Power tool safety	4.32	1.02
Administration of safety exams	4.24	0.82
Welding exhaust systems	4.13	1.12
Hand tool safety	3.82	1.18
Using accident report forms	3.82	1.16
Laboratory safety inspections	3.76	0.94
Developing safety posters	2.87	0.99

Responding teachers were asked to rate how well prepared they were to provide safety instruction related to various instructional topics. They responded on five point scale with 5 being "very well prepared" to 1 being "poorly prepared". Respondents felt the best prepared to teach the proper use of industrial quality eye protection. They felt the least prepared to teach students the state safety laws regarding agricultural mechanics. Teacher's preparedness to teach various safety topics is listed in ranked order within table five.

Table 5. Agricultural Education Teachers' Preparedness to Provide Safety Instruction

Safety Topic	*M*	*SD*
Using industrial quality eye protection	4.05	0.98
Welding exhaust systems	3.74	1.33
Electrical safety	3.71	1.06
Setting clean up schedules	3.47	1.06
Accident report forms	3.39	1.03
Color coding shop equipment	3.16	1.20
Administering safety laws	2.92	1.15
Developing safety posters	2.79	1.04
Understanding state safety laws	2.79	1.04

Objective Four

To aid teachers in demonstrating safety, they must have the appropriate materials. The goal of the fourth objective was to determine the availability of selected safety equipment and emergency items in the agricultural mechanics laboratory. The most common safety materials and practices involved the use of fire extinguishers, industrial quality eye protection, welding gloves, properly marked exits, fire alarms and eye wash stations. Safety posters, respirators and hard hats were the least common safety materials found in the agricultural mechanics laboratories. Table six identifies the most prevalent safety equipment found in the agricultural mechanics laboratory.

Teachers were also asked to respond to the use of eye protection in their educational laboratories. Spectacles (ANSI Z87+) with side shields and full face shields were the most common types of eye protection found in the laboratory environment. Most teachers were found to provide eye protection to the students at no cost. The types of eye protection most often found in the agricultural mechanics lab and how teachers managed their use are listed in table seven.

Table 6. Safety Equipment Used in the Agricultural Education Laboratory

Safety Practices	%	*f*
Fire extinguishers	97.4	37
Industrial quality eye protection	94.7	36
Welding gloves	94.7	36
Exits marked	92.1	35
Safety cabinets for flammable liquids	86.8	33
Fire alarm	81.6	31
Welding exhaust system	81.6	31
Eye wash station	73.7	28
Fire blanket	73.7	28
Hearing protection	73.7	28
Screens/curtains on welding booths	73.7	28
Shop coat or overalls	71.1	27
Welding apron or jacket	63.2	24
Safety guards on all equipment	60.5	23
Marked safety zones	50.0	19
Eye protection regulations posted	47.4	18
Safety posters near power tools	44.7	17
Respirators	31.6	12
Hard hats	26.3	10

Table 7. Eye Protection Uses in the Agricultural Education Laboratory

Eye Protection Uses	%	*f*
Most Common Types Used		
Spectacle with side shields	89.5	34
Full face shields	84.2	32
Goggles	76.3	29
Spectacles without side shields	39.5	15
Ways Eye Protection Provided		
Furnished at no cost to student	78.9	30
Students furnish their own	13.2	5
Furnished for a rental fee	7.9	3

Conclusions

The average agricultural mechanics teacher in New Mexico has over ten years teaching experience with 12 hours of college coursework in college agricultural mechanics courses. The majority of these teachers taught at least two courses with a mechanics component and an average size of 13 students. Most teachers in the state were certified in first aid and felt confident to use their first aid training in an emergency. The most common safety certifications teachers had were through NCCER or OSHA. Most teachers felt “moderately” to “well prepared” to teach safety and kept accident reports on file. This information is important as it represents the dedication to safety of agricultural education teachers in New Mexico.

Respondents were found to spend at least a third of their instructional time teaching safety. Most commonly these safety lessons were being equally taught as a separate unit and integrated within other units (i.e. teaching power tool safety while teaching tool identification). This is important as it shows teachers were continually reinforcing the safety practices learned throughout the school year. This instruction was primarily provided in the form of worksheets, safety exams and demonstrations. According to the Theory of Planned Behavior, behavioral intentions can be best viewed as consequences of an individual's attitude (Azjen, 1991). In this situation, this attitude can potentially be linked to the teachers' confidence levels in teaching safety.

An agricultural mechanics class deals with a variety of topics that all require some type of specific safety component. Participants felt the most confident to provide safety instruction on the use of eye protection, welding exhaust systems and electrical safety. On the other hand, they felt the least prepared to provide instruction on developing safety posters and state laws surrounding safety. According to Bandura's Self-Efficacy Theory, a person's beliefs about their capabilities are not the same as actual ability, but they are closely related. If low efficacy or confidence is present in a teacher when performing a task, then their ability to perform said task is expected to be low (Bandura, 1997). These findings imply that teachers may not be placing emphasis on certain safety topics due to their lack of knowledge and self-efficacy in those topic areas. It can be inferred that teachers simply didn't want to put much time into the development of safety posters, as this is a common item that can be purchased for the laboratory.

Teachers felt the most important safety topics were eye protection, safety exams and electrical safety. These findings are consistent with Swan (1993). They felt the use of accident report forms and safety inspections were the least important skills to teach. We felt it was important, as mentioned in the literature review, to develop a culture of safety and continuous occupational risk assessment when teaching students who may pursue a career in the construction industry. To better understand why teachers place emphasis on certain areas and not on others, the researchers recommend further research be done assessing the teachers' self-efficacy levels in reference to their safety knowledge.

Teachers were found to be lacking in their knowledge of state laws and the implementation of important safety procedures. This is reflective of similar findings by Dyer and Andreason (1999). Teachers should be encouraged to incorporate clean up schedules and safety inspections into their courses. State leaders and teacher trainers are encouraged to solicit "buy in" from teachers for these safety practices. One way to accomplish this is to include these subjects in undergraduate or graduate agriculture education and agricultural mechanics courses. This brings up the question as to whether teachers focused on those specific safety concepts that were emphasized during their undergraduate teacher training. State leaders and teacher trainers should encourage new teachers to implement lessons involving the understanding and application of state laws into their courses. This can be accomplished by having agricultural mechanics specific meetings during state teacher in-service by state safety professionals.

The most common safety items found in the agricultural science laboratory were fire extinguishers, industrial quality eye protection, welding gloves, properly marked exits and chemical storage cabinets. Teachers indicated that full face shields or spectacles with side shields were the preferred eye protection. PPE, specifically safety spectacles, were commonly provided to the students at no cost. The least common safety items were eye protection regulations, safety posters, respirators or hard hats. Teacher's perceived self-efficacy in developing safety posters was low which, according to Bandura (1984), may have an effect on teacher's not developing safety posters for their educational laboratories.

Recommendations

The researcher felt there were several recommendations based on the findings of this study. There needs to be an increase of training for teachers in regards to state laws surrounding safety. To reinforce this instruction, state leaders and university supervisors are advised to offer in-service on these specific topics. College agricultural mechanics courses should require students to research safety laws, develop warnings for the lab and practice using accident report forms. An evaluation should be done on agricultural mechanics programs within the state of New Mexico to make sure those specific subjects teachers felt little preparation in are being addressed. Funds should be sought to provide safety posters and regulations to be posted within the educational laboratory. Research should be continued to determine barriers to teachers using recommended safety practices in agricultural mechanics.

Safety instruction within an agricultural science laboratory is an important aspect of any successful program. New laws and increased accountability have placed additional importance on safety standards in the agricultural science learning laboratory. To ensure these measures are met, teachers are required to teach appropriate safety and demonstrate safe work habits. Effective agricultural mechanics teachers should strive to cultivate a safety culture within the classroom and laboratory. School administrators need to take a more active role in making sure students are working in a safe environment. There should be training for administrators within the areas of identifying appropriate safety practices within the agricultural mechanics laboratory. This study can be expanded and used to compare results between states and within teacher groups.

Agricultural mechanics courses continue to be an extremely popular subject. Our students deserve qualified teachers in well-equipped learning laboratories who empower a culture of safety within their courses. The learning environments need to encourage real world experiences. These habits must be expected from every student. Requiring everyone who enters the shop to practice safety will make it easier for students to be successful in a safe learning environment. It is important to recognize that the findings of this study must be limited to those who participated and may not necessarily be reflective of all programs. Nonetheless, the results of this study provide baseline data to understand how and what type of safety practices are being taught in the area of agricultural mechanics laboratories in New Mexico.

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