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Influences on the Perceived Comfort and Training Level of Personal Protective Equipment in the Missouri High School Agricultural Mechanics Laboratory

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Abstract

Agricultural mechanics instruction includes a broad array of machinery, structures, and technical systems, as well as a diverse workforce. Virtually every aspect of agriculture has a mechanics component and a large portion of secondary agriscience curriculum is devoted specifically to teaching agricultural mechanics. Further, the agricultural mechanics laboratory provides students with an opportunity to learn through authentic learning scenarios. The purpose of this research is to investigate Missouri high school agricultural mechanics students' safety knowledge and safety attitudes. Researchers identified an increase in female students enrolling in agricultural mechanics coursework. This study also concludes students perceive they receive minimal training, access, and/or use of hearing and air quality PPE. It was concluded the factors of age, gender, semesters of agricultural mechanics courses, and agricultural education district have limited ability to explain differences in in student's PPE knowledge or PPE comfort. Moreover, researchers identified implications of changing demographics on PPE design and usability, both in the laboratory and the workplace. Future research should be conducted regarding PPE design, transfer of perceptions, and what PPE is needed by both teachers and students.

Keywords: Agricultural mechanics, safety attitudes, personal protective equipment,

Introduction

Agricultural mechanics is operationally defined as the selection, operation, maintenance, servicing, selling, and use of power units, machinery, equipment, structures, and utilities used in agriculture (Herren, 2010). Thus, virtually every aspect of agriculture has a mechanical component and over half of all the agricultural education curriculum taught in some states includes agricultural mechanics competencies (McKim & Saucier, 2011). The diversity with varying machinery, animals, and plant systems coupled with a wide variety of environments means workers must negotiate a multitude of risk during normal operations. Moreover, this risk level is increased when youth, seasonal workers, and older adults are involved in the production of goods and services (*Safety and Health in Agriculture: ILO Code of Practice*, 2011).

Agricultural training for youth often comes in the form of a learning laboratory, such as a greenhouse, animal farm, or agricultural mechanics laboratory (Phipps & Reynolds, 1992). Specifically, the agricultural mechanics laboratory experience is a means to enable students to learn in a safe and controlled environment, thus providing students a place to learn concepts which can

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be transferred to the home and workplace (Langley & Kitchel, 2013). As such, the use of laboratories has been an integral part of agricultural education programs and potentially a powerful context for student learning outcomes to occur (Roberts & Ball, 2009). With previous research identifying the importance of laboratory use in a comprehensive agricultural education program, educators must evaluate the process of teaching students while providing a safe environment for learning.

In the agricultural mechanics laboratory, students learn technical skills in metal working, wood working, agricultural machinery, chemicals, compressed gasses, and electrical equipment; these processes are potentially dangerous to both users and observers (Johnson & Schumacher, 1989). It is the obligation of the instructor to maintain a high regard for the safety of the students while they are in the agricultural mechanics laboratory (Gliem & Miller, 1993). However, research has revealed teachers may not be providing adequate safety equipment when students are working with dangerous equipment (Lawver, 1992; Rasty, Anderson, & Paulsen, 2017). Thus, specific areas regarding safety in the agricultural mechanics laboratory should be investigated (Dyer & Andreasen, 1999).

Conceptual Framework

The conceptual framework for this study was derived from industrial safety research within organizations, and conclusions regarding safety deficiencies in agricultural education expressed by Dyer and Andreasen (1999). In their study, Dyer & Andreasen (1999) expressed 15 safety deficiencies in agricultural education laboratories. The specific framework for this study was centered on one specific safety deficiency and research question posed by Dyer and Andreasen (1999): “What demographic factors influence safety knowledge, attitudes, and practices” (p. 51)? Further defining the safety deficiency, Dyer & Andreasen. (1999) identified geographic background, ethnicity, age, grade level, and gender as possible contributors to the factors influencing safety in the agricultural mechanics laboratory.

Furthermore, it has long been suggested that agricultural mechanics laboratories be used to enhance the ability of learners while developing skills and demonstrating real-world scenarios (Langley et al., 2013; Phipps et al., 1992, Oomes & Jurshak, 1978). To simulate real-world scenarios instructors are using industrial tools and procedures (Chumbley et al., 2103; Johnson et al., 1989). Therefore evaluating safety within the educational setting may need to closely reflect safety evaluation in the industrial setting. In the industrial setting one of the most significant issues is ensuring a high level of occupation health (Clarke, 2010), and one of the frameworks many modern safety evaluations rely on is centered on Safety Climate (Clarke, 2010). Safety climate is a summary of perceptions that employees share about their work environment (Zohar, 1980). In the agricultural mechanics laboratory the students would be the equivalent of employees, and the teacher would be serving in the role of a manager or upper administrator. Safety climate also measures areas of safety concern, or potential areas of concern before an accident occurs. Many traditional measures of safety in potentially dangerous places use lagging indicators to evaluate safety. In reality lagging indicators measure the failure of the safety system due to someone having to be injured for measurement to occur (Cohen, 2002). Moreover, safety climate literature suggest measures of day-to-day operations can be analyzed across five consistent themes: perceptions of management, environmental risk, competence, work pressure, and safety systems (Flin, R., Mearns, K., O’Connor, P., & Bryden, R., 2000). For this particular study researchers focused on two of the themes, competence and safety systems. The theme of competence within safety climate refers to a person’s qualifications, skills, and knowledge associated with given task (Flin et al., 2000). Likewise the theme of safety system has been broadly defined as management systems, safety officials, safety equipment, and safety policies (Flin et al., 2000). As such, safety items related to both themes could be a critical part of the instructional approach taken by those teaching in the agricultural mechanics laboratory. More importantly, evaluating both the competence and the safety systems could help teachers identify areas of concern before an accident occurs.

Safety evaluation literature uses terms such as knowledge, competence, comfort, familiarity, safety attitudes, equipment, and safety systems to describe a variety of measures. For this study identifying characteristics of *safety competence* and *safety systems* within an agricultural mechanics laboratory was essential to the conceptual framework for this study. *Safety competence* was operationalized as the perceived level of training students received regarding Personal Protective Equipment (PPE) while in the agricultural mechanics laboratory. *Safety systems* were operationalized as the perceived level of comfort while using PPE or safety equipment in the agricultural mechanics laboratory.

Further, training can be defined as a planned process aiming to directly influence the individual's knowledge, ability, and attitudes (Vidal-Salazar, Hurtado-Torres, & Matías-Reche, 2012). As such, training students in the agricultural mechanics laboratory is an extension of the agricultural education classroom; thus, many of the same factors influencing conventional classroom lessons exist in the agricultural mechanics laboratory. Tracey, Hinkin, Tannenbaum, and Mathuey (2001) suggested careful consideration must be given to a seemingly infinite number of variables including sequencing, opportunities for practice, and variables outside the training context. Further, Tracey et al. (2001) found that variables outside of the training context, such as age, gender, location, and prior experiences can impact both performance and knowledge transfer during a training program.

Meanwhile, comfort is a relative term which is usually determined by a combination of physiological and physical factors (Akbar-Khanzadeh, Bisesi, & Rivas, 1995). As such, improper fit, added weight, and out of fashion style or color make much PPE undesirable to wear. Industrial accident analysis research regarding eye protection suggested workers have barriers to using PPE when comfort is in question (Lombardi, Verma, Brennan, & Perry, 2009). Further, Akbar-Khanzadeh et al. (1995) suggested workers will oppose wearing PPE devices because of discomfort. Likewise, production agriculture research with adult populations have echoed industrial construction PPE concerns sighting comfortability of PPE as having a strong influence on personal decisions to use/not use PPE (Carpenter, Lee, Gunderson, & Stueland, 2002; Mukhopadhyay, 2009). Adding to the complexity of safety climate are the findings of Vredenburgh, (2002) that only about 10% of accidents are caused by machine failure, and most accidents are caused by unsafe acts by humans. With the identification of a potentially hazardous environment, suggestions of variables to examine regarding safety attitudes, and the notion that safety deficiencies may be identified prior to an accident, research is needed within the agricultural mechanics laboratory regarding the influences on student's decisions regarding PPE.

Purpose and Objectives

The purpose of this research was to investigate how selected demographic variables explained variation in Missouri high school agricultural mechanics students' safety knowledge and safety attitudes. This study aligns with the AAAE National Research Agenda research question five: What methods, models, and programs are effective in preparing people to work in a global agriculture and natural resource workforce (Roberts, Harder, & Brashears, 2016), and research priority three, sufficient scientific and professional workforce that addresses the challenges of the 21st century (Stripling & Ricketts, 2016). The following research objectives were generated to guide this study:

1. Describe the demographic characteristics (age, gender, semesters of agricultural mechanics courses, and agricultural education district) of the Missouri high school agricultural mechanic students.
2. Describe the Missouri high school students' perceived training level regarding Personal Protective Equipment while in the agricultural mechanics laboratory.
3. Describe Missouri high school students' perceived comfort level regarding Personal Protective Equipment while in the agricultural mechanics laboratory.
4. Describe any linear relationship existing among Missouri high school agricultural mechanics students' perceived level of training regarding Personal Protective Equipment and selected demographic variables of Agricultural Education district, age, grade level, and gender.

   Ho_1: Variations in age, gender, semesters of agricultural mechanics courses, and agricultural education district) will not explain a significant ($p > .05$) proportion of variance in perceived level of training regarding Personal Protective equipment.

   Ha_1: Variations in age, gender, semesters of agricultural mechanics courses, and agricultural education district) will each explain a significant ($p < .05$) proportion of variance in perceived level of training regarding Personal Protective equipment.

5. Describe any linear relationship existing among Missouri high school agricultural mechanics students' perceived level of comfort regarding Personal Protective Equipment and selected demographic variables of Agricultural Education district, age, grade level, and gender.

   Ho_2: Variations in age, gender, semesters of agricultural mechanics courses, and agricultural education district) will not explain a significant ($p > .05$) proportion of variance in perceived level of comfort regarding Personal Protective equipment.

   Ha_2: Variations in age, gender, semesters of agricultural mechanics courses, and agricultural education district) will each explain a significant ($p < .05$) proportion of variance in perceived level of comfort regarding Personal Protective equipment.

Methodology

This quantitative, *ex post facto* study utilized descriptive and relational research methods. Descriptive research methods were used to "produce information on groups and phenomenon that already exist" such as students and teachers (Fink, 2003, p. 33). Furthermore, many studies describe social phenomenon based on form, structure, activity, changes over time, and any relationship to other phenomenon (Gall, Gall, & Borg, 2003). The author determined the agricultural mechanics students were a time and place sample of the population (Oliver & Hinkle, 1982); therefore, the use of inferential statistics was justified, as the current agricultural mechanics student population could be considered representative of future populations of agricultural mechanics students in Missouri. One way to gather information about groups of people and to describe any occurrences within groups is through the use of survey data (Fink, 2003). Following literature on research design, this study used a self-administered instrument to gather data regarding safety perceptions of Missouri high school students.

Population

The target population was all Missouri high school agriculture students enrolled in courses involving competencies related to the Power, Structural, and Technical Systems (PSTS) area of the Common Career Technical Core Standards (N = 21,486). The selection criterion established *a priori* was the agricultural education district each program represented and agriculture programs offering courses with competencies related to the PSTS area of the Common Career Technical Core in the 2013-2014 school year. Thirty agricultural education programs were invited to participate in the study based on the agricultural education district represented and the requirement of providing courses with PSTS competencies. Agricultural education programs were selected using a stratified random sample. Stratified sampling is used when sub-groups of a population are evident (Fink, 2003). Within the Missouri agriculture education program, there are six districts across the state. Thus, having districts broken down by geographical region and evidence to suggest varying curriculum components and learning outcomes, the six agricultural education districts served as the strata for this study. Further, five agricultural education programs from each district were randomly selected to receive information regarding the study.

Of the 30 agriculture programs identified, 24 individual school districts fulfilled the eligibility requirements and granted permission to access both their agriculture teacher and students. Of the 24 districts, 21 teachers across representing 15 school districts agreed to participate in this study. Upon agreeing to participate, each teacher provided the number of students eligible to participate based on the requirement of being enrolled in a course where agricultural mechanics competencies had already been taught for the 2013-2014 school year. Thus, access to a sample of 742 (n = 742) students across all six Missouri agricultural education districts was established. Initially, 573 responses were returned providing a response rate of 77.2%. After data entry a final usable student sample of 548 (n = 548) was available for data analysis. Therefore, a final response rate of 73.85% was achieved. Twenty-five student responses were unusable due to incomplete questionnaires, response set data, or entire section(s) being incomplete. Student data were considered unusable if respondents: a) failed to complete an entire section(s) of the questionnaire or b) circled entire columns within the questionnaire.

Instrumentation

To gather data for this study, researchers created a paper pencil questionnaire. The safety equipment included in this study was derived based on two studies: Ulrich, Pavelock, Mueller, and Harrell (2005) and (Chumbley, Gill, & Chesher, 2013). In these two studies, PPE used and available was reported by students and teachers, respectively. With this data, researchers were able to determine the safety equipment students are recognizing as being available, and being actively used. Thus, an instrument based on previous literature was developed.

The instrument contained 11 items, representing five categories arranged in a single column. Flanking each item was a Likert-type scale aimed at gathering data regarding student perceptions of the level of training and comfort for specific PPE while in the agricultural mechanics laboratory. Each item employed a 4-point scale with a fifth option of Not Available (N/A). The scale regarding the perceived level of training while using specific PPE used the following anchors: 1 = *No Training*, 2 = *Minimal Training*, 3 = *Moderate Training*, 4 = *Advanced Training*, N/A = *PPE Equipment Not Used*. The scale regarding the perceived level of comfort while using specific PPE used the following anchors: 1 = *No Comfort*, 2 = *Slight Comfort*, 3 = *Mostly Comfortable*, 4 = *Extremely Comfortable*, N/A = *PPE Equipment Not Used*.

Demographic characteristics were a vital part of this study. Specifically, the conceptual framework for this study suggested specific demographic variables might influence safety knowledge and attitudes in the agricultural mechanics laboratory. This study investigated the demographic variables of age, semesters of agricultural mechanics courses taken (grade level), agricultural education district (geographic background), and gender, as suggested in previous studies in which the conceptual framework was based.

According to Field (2009), an instrument cannot be reliable if the validity is askew. Consequently, for this study a panel of nine experts were ask to examine the face and content validity of the instrument and make suggestions for ways to improve the accuracy of the instrument. Recommended changes were made to the instrument and panel members were ask to give the instrument a final review. Upon approval, the instrument was deemed valid to measure the designated variables in the study.

The reliability of the instrument was estimated through the use of a pilot study with a similar group of students not involved with the study. Sixty-two instruments were sent to the pilot test population. Responses from 58 students were gathered for an initial response rate of 93.54%. This pilot test involved test-retest for reliability analysis. As such respondents were initially asked two questions: 1) While in high school, were they enrolled in a course where they received instruction in agricultural mechanics? 2) Were they willing to retake the survey in approximately 10 days? Of the 58 respondents, 25 met both criteria and submitted usable data. Fink (2003) asserts 10 or more people are needed to complete the instrument so reliability estimates can be calculated.

The last PPE items of the instrument were estimated for reliability using test-re-test method producing a percent agreement ranging from .94 to .86. According to Rubin and Babbie (2009), percent agreement above .80 are acceptable.

Data Collection and Analysis

Consistent with the literature on research design, a tailored, mailed approach of data collection was employed to gather information necessary to accomplish the purpose and objectives of the study (Dillman, 2007). To gain access to the 30 schools selected for this study, the researchers gathered contact information via the published state directory. Upon retrieving the contact information, each school was contacted by email informing them of the study. Two persons were contacted: first the principal/superintendent to gain permission to access the school district teacher(s) and students, and secondly the agriculture teacher(s) to gain permission to use their agricultural education program in this study. Each agriculture teacher gave permission for data to be collected from themselves as well as their students during a routine school day. Further, researchers sought and received permission from the local Institutional Review Board (IRB) to collect data in such a manner. Local teachers were provided with instructions pertaining to instrument distribution as well as instructions regarding non-participation. Teachers were informed that students should be provided opportunity to withdraw any or part of their information with no penalty. Data were collected from students one time via a mailed questionnaire. Each school was mailed a packet containing instructions, student instruments, IRB approval letters, and a return envelope with prepaid postage attached. Schools not returning the instrument packets within the first ten business days were contacted by telephone to encourage them to return the completed instruments for evaluation.

Findings

Objective one was to describe the demographic characteristics (age, gender, semesters of agricultural mechanics courses, and agricultural education district) of the Missouri high school agricultural mechanic students (see Table 1). The average student respondent is 16.3 (*SD* = 1.06) years old with the youngest student respondent being 14 years of age and the oldest being 19. Further, slightly over three quarters (78.8%, *f* = 427) of the students in the sample were male.

Table 1

Age Distribution of Respondents (n = 548)

Age in Years	*Frequency* (%)	
14	18	(3.30%)
15	81	(15.10%)
16	212	(39.40%)
17	140	(26.00%)
18	79	(14.70%)
19	8	(1.50%)

The average student in this study reported they had been enrolled in three semesters of agricultural mechanics courses (see Table 2). Additionally, almost 85% of the respondents indicated having four or fewer semesters of agricultural mechanics courses.

Table 2

Distribution of Semester Long Agricultural Mechanics Courses Taken (n = 548)

Semesters	*Frequency* (%)	
1	114	(21.30%)
2	195	(36.50%)
3	27	(5.10%)
4	115	(21.50%)
5	3	(0.60%)
6	47	(8.80%)
7	5	(0.90%)
8	20	(3.70%)
9	0	(0.00%)
10	8	(1.50%)

The Northeast district as defined by the Missouri Agricultural Education districts make up almost one third (32.7%) of the student respondents, followed by the Southwest and Central Districts. Further, two of the six agricultural education districts represented less than 12% (*f* = 64) of the total number of respondents (see Table 3).

Table 3

Agricultural Education District Distribution of Respondents (n = 548)

Agricultural Education District	Frequency (%)	
Northeast	179	(32.70%)
Southwest	124	(22.60%)
Central	102	(18.60%)
Northwest	79	(14.40%)
Southeast	30	(5.50%)
South Central	34	(6.20%)

Objective two sought to describe the Missouri high school students' perceived training level regarding PPE while in the agricultural mechanics laboratory. To better describe the data, researchers categorized various types of PPE into five categories: General PPE, Hot Metal Working PPE, Fire Suppression Equipment, Air Quality PPE, and Hearing PPE. Student respondents indicated they perceive to have at least *moderate* levels of training regarding four out of five categories of PPE with mean scores ranging from M = 2.59 (SD = 1.15) in Air Quality PPE to M = 3.42 (SD = 0.72) in Hot Metal Work PPE . Students indicated they perceive the fifth category, General PPE, as having had advanced training in this area (M = 3.62, SD = 1.73). However, 25% (f = 141) and 33% (f = 181) of students indicated Air Quality PPE and Hearing PPE were not available or they did not use them. Further, an additional 14% (f = 76) of students using Air Quality PPE perceived there to be no training. Likewise, over 9% (f = 51) of those using Hearing PPE perceive there to be no training available. Consequently, students perceive to have an overall perceived level of PPE training of M = 3.32 (SD = .65), thus corresponding to an overall feeling of *moderately trained*. A complete distribution of PPE training level perceptions can been see in Table 4.

Table 4

Perceived PPE Training Levels of Missouri High School Agricultural Mechanics Students (n = 548)

PPE Training Areas	Mean	Standard Deviation
General PPE	3.62	1.73
Hot Metal Work PPE	3.42	0.72
Fire Suppression PPE	3.14	0.92
Hearing PPE	3.00	1.10
Air Quality	2.59	1.14
Overall Perception	3.32	0.65

**Note:* Anchors are as follows 1 = *No Training*, 2 = *Minimal Training*, 3 = *Moderate Training*, 4 = *Advanced Training*, N/A= *Not Used*

Objective three sought to describe Missouri high school students' perceived comfort level regarding PPE while in the agricultural mechanics laboratory. To better describe the data presented, researchers categorized various types of PPE into five categories: General PPE, Hot Metal Working PPE, Fire Suppression Equipment, Air Quality PPE, and Hearing PPE. Students indicated they perceived to be *extremely comfortable* while using PPE for only two categories of PPE, *metal work* (*M* = 3.53; *SD* = .55), and *general* PPE (*M*= 3.66; *SD* = .58). Further, students indicated the perceived comfort level declined only slightly feeling mostly comfortable while using PPE regarding fire suppression (*M* = 3.39; *SD* = .82), hearing PPE (*M* = 3.22; *SD* = 1.02), and air quality PPE (*M*= 2.77; *SD* = 1.16). A complete distribution of perceived comfort level can be seen in Table 5. Consequently, students perceive to have an overall perceived level of PPE comfort of *M* = 3.46 (*SD* = .53), thus corresponding to an overall feeling of *mostly comfortable*.

Table 5

Perceived PPE Comfort Levels of Missouri High School Agricultural Mechanics Students (n = 548)

PPE Comfort Levels	Mean	Standard Deviation
General PPE	3.66	0.58
Hot Metal Work PPE	3.53	0.55
Fire Suppression PPE	3.39	0.82
Hearing PPE	3.22	1.02
Air Quality	2.77	1.16
Overall Comfort	3.46	0.53

Note: Anchors are as follows 1 = *No Comfort*, 2 = *Slight Comfort*, 3 = *Mostly Comfortable*, 4 = *Extremely Comfortable*, N/A = *PPE Equipment Not Used*.

However, at least 25% (*f* = 134) of students in the agricultural mechanics laboratory indicated hearing PPE and air quality PPE were not available or not used in their laboratory (see Table 6).

Table 6

Availability of Hearing and Air Quality PPE among Missouri High School Agricultural Mechanics Students (n = 548)

PPE Comfort Levels	Available f (%)	Not Available f (%)
Hearing PPE		
Equipment in laboratory	367 (66.97%)	181 (33.03%)
Training	414 (75.55%)	134 (24.45%)
Air Quality PPE		
Equipment in laboratory	407 (74.27%)	141 (25.73%)
Training	414 (75.55%)	134 (24.45%)

Objective four sought to describe any linear relationship that existed among Missouri high school agricultural mechanics students' perceived level of PPE training as influenced by selected demographic variables (Agricultural Education district, age, semesters of agricultural mechanics courses taken, and gender). Researchers utilized a forward stepwise multiple regression to test the null hypothesis, which stated the variables of Agricultural Education district, age, semesters of agricultural mechanics courses taken, and gender, did not explain a significant ($p > 0.05$) proportion of variance in students' perceived level of PPE equipment training. Stepwise regression is useful in exploratory research where literature suggest one variable could influence another (Field, 2009).

The regression analysis resulted in a statistically significant ($F_{(1,482)}=6.675$, $p < 0.01$, adjusted $R^2 = 0.012$) model. Only one dependent variable, age, was a significant ($p < 0.05$) predictor of variance in PPE equipment training. However, age only explained about 1% of the variance in the students' overall perceived level of PPE training. All other variables were excluded from the model (see Table 7). Therefore, researchers accepted the null hypothesis, as gender, semesters in agricultural mechanics coursework, and FFA district did not explain significant ($p > 0.05$) proportions of variance in student's perceived level of PPE equipment training.

Table 7.

Stepwise Multiple Regression Analysis of Missouri High School Students' Perceived Level of PPE Training as predicted by age (n = 484).

Variable	*Adj.* R^2	□	*t*	*p*	*d*
Constant			4.758	0.01*	
Gender			0.689	0.49	
Semesters of Ag Mech			1.527	0.13	
FFA District			0.064	0.95	
Age	0.012	0.117	2.584	0.01*	0.24

Note. $F_{(1,482)}=6.675$; $p \leq 0.05$. Gender coded as 1=male, 2=female, *(p<.05)

Objective five sought to describe any linear relationship that existed among Missouri high school agricultural mechanics students' perceived level of PPE comfort as influenced by selected demographic variables (Agricultural Education district, age, semesters of agricultural mechanics courses taken, and gender). Researchers utilized a forward stepwise multiple regression to test the null hypothesis, which stated the variables of Agricultural Education district, age, semesters of agricultural mechanics courses taken, and gender, did not explain a significant ($p > 0.05$) proportion of variance in students' perceived level of PPE comfort.

The overall model was significant ($F_{1,510}=4.91$, $p=0.027$). Again, age was the only dependent variable which explained a significant ($p < 0.05$) proportion of variance in PPE Comfort (see Table 8). The variables of Agricultural Education district, semesters of agricultural mechanics courses taken, and gender did not meet inclusion criteria for the stepwise regression model. Therefore, researchers failed to reject the null hypothesis, as Agricultural Education district, age, semesters of agricultural mechanics courses, and gender did not account for significant proportions ($p > 0.05$) of variance in student PPE comfort in the Agricultural Mechanics laboratory.

Table 8.

Stepwise Multiple Regression Analysis of Missouri High School Students' Perceived Level of PPE Comfort as predicted by age (n = 510).

Variable	*Adj. R^2*	□	*t*	*p*	*d*
Constant			7.467	0.01*	
Gender			-0.376	0.71	
Semesters of Ag Mech			1.136	0.26	
FFA District			-1.084	2.79	
Age	0.01	0.098	2.216	0.03*	0.20

Note. $F_{(1,509)}$=6.675; $p \leq 0.05$. Gender coded as 1=male, 2=female, *(p<.05)

Conclusions

Readers should use caution when interpreting the results of this study beyond the population of agriculture teachers and students represented as the teaching and learning class of [YEAR] in Missouri. Moreover, each school provided the number of unduplicated students eligible to participate in the study, and the author had no way to confirm or refute the numbers as reported by the teachers. The author also relied on self-administered questionnaires and made no observations to confirm teacher practices or student perceptions.

From Objective One, researchers conclude the demographics of secondary agricultural mechanics students are changing. Ulrich, Pavelock, Mueller, and Harrell (2005) reported 88% of the student participants in the 2003 Houston Livestock Show & Rodeo (*n* = 494) agricultural mechanics project show were male. However, this study indicated a 13% increase of females within a similar population. The conclusion can also be drawn that while students have the opportunity to enroll in as many as 10 semesters of agricultural mechanics courses, more than three-fourths of the students have enrolled in four or less semesters. Further, it can be concluded students appear to be enrolling in agricultural mechanics courses while in their sophomore and junior year rather than the freshman and senior years of high school based on the respondents' reported ages.

For Objective Two, researchers conclude secondary agricultural mechanics students who participated in the survey have, on average, at least a *moderate* level of PPE training. Students reported the highest levels of training in General PPE and Hot Metal Work PPE. This conclusion supports the findings of Chumbley et al. (2013) when they investigated teachers perceptions of safety importance.

Students reported the lowest levels of PPE training in Hearing PPE and Air Quality PPE. Over one-third of the students in this study do not use, do not have, or perceive there to be no training available for Hearing PPE and Air Quality PPE. Unfortunately, this conclusion substantiates previous research indicating safety deficiencies with in agricultural mechanics (Dyer & Andreasen, 1999), and specific concerns regarding hearing and air quality PPE set forth by Ulrich et al. (2005).

Objective three sought to describe the perceived comfort level of Missouri high school students while using PPE in the agricultural mechanics laboratory. It can be concluded that students perceive to be *mostly comfortable* when they are using safety equipment in the agricultural mechanics laboratory, with the highest levels of comfort in General PPE and Hot Metal Work PPE. Among the types of PPE listed, students scored the lowest comfort levels with Air Quality PPE and Hearing PPE, and the relatively high standard deviations among those constructs indicate a high proportion of students with little to no comfort with these types of protection, similar to the conclusions drawn for objective two. This conclusion is unfortunately echoed in the literature regarding student usage and teacher importance of certain types of PPE (Chumbley et al., 2013; Hubert, Ulrich, Lindner, & Murphy, 2003; Hubert, Ulrich, & Murphy, 2000; Ulrich et al., 2005).

Objectives Four and Five sought to determine if linear relationships exist between selected demographic variables and the perceived level of training and comfort reported by the respondents. Researchers failed to reject the null hypotheses for both variables, suggesting the demographic factors studied in this inquiry did not account for either statistical or practical proportions of variance in either PPE equipment training or PPE comfort. Among the demographic variables tested, only age was a significant predictor of PPE training or comfort; however, the *small* effect size (Cohen, 1992) suggests age as a predictor has limited practical significance. Dyer & Andreasen, (1999) suggested demographic variables could be influencing safety knowledge, attitudes, and practices. However, if demographic variables influence student safety outcomes, the firm conclusion from this population is there are other factors influencing the knowledge and attitudes of Missouri high school students beyond those operationalized by this study.

Implications

In a study of PPE, Lombardi et al. (2009) found focus group participants unanimously identified comfort and fit issues as barriers to wearing eye protection. Further, the demographics of this study indicate the agricultural mechanics classroom could be seeing a changing in regards to gender. From this conclusion, it can be implied that agricultural mechanics teachers may need to consider changes in how PPE is provided and purchased better reflect the needs of a changing demographic.

Providing a safe learning environment for students is the most important job of any agriculture mechanics instructor (Swan, 1992), and students in this study perceive to have moderate training and were at least mostly comfortable across five categories of PPE used in the agriculture mechanics laboratory. Since most PPE usage is based on knowledge, attitudes, and beliefs rather than policy (Carpenter et al., 2002), the findings regarding most PPE categories are encouraging for agriculture teachers and practitioners. Furthermore, the high usage of most PPE categories could imply students are helping to reduce the risk of injury in the agricultural mechanics laboratory as well as outside the laboratory. For example, Carpenter et al. (2002) reported farm workers wearing general PPE often, just as students responded having an advanced perception of training and a perception of being extremely comfortable with General PPE.

While the majority of students in this study indicated to have moderate training and be at least mostly comfortable while using various forms of PPE, the researchers express concern regarding the usage and availability of hearing and air quality PPE. This is particularly troublesome when you consider 29% of farmers surveyed in 2002 reported definite hearing loss (Carpenter et al., 2002). Furthermore, research specifically in the agricultural mechanics laboratory has indicated noise exceeding the Occupational Safety and Health Administrations (OSHA) maximum exposure level of 110 decibels for 30 minutes (Miller, 1989). These findings could imply the lack of PPE being used in the agricultural mechanics laboratory is providing precedence for work outside the school. Thus, an overarching implication can be made that students' perceptions in the laboratory setting are a possible reflection of perceptions at locations beyond the school doors.

Researchers noted the nonsignificant (p > 0.05) difference between semesters of agricultural mechanics instruction and receipt of safety training. This finding suggests agricultural mechanics students perceive teachers are, on average, doing an adequate job of providing continuous training commensurate with the level of hazard exposure in the shop.

Recommendations for Practice

Most students in this study indicated they perceive to be have at least moderate levels of training and feel mostly comfortable while using PPE. Given that teachers face curricular pressure of limited instructional time, instructors are, on average, providing an adequate level of safety instruction to allow a majority of students to feel mostly comfortable. Based on these conclusions teachers should continue with the educational practices in place being used to achieve this perception. However, teachers may need to focus more attention on the areas of hearing and air quality PPE as students indicate those are areas of minimal use. Specifically, it is recommended teachers identify areas where PPE such as respirators and hearing protection are to be used, especially when multiple students are in the laboratory. Further, teachers should consider the demographics of their classroom/laboratory and subjectively evaluate PPE purchased and on hand. This could be a way to improve the usage and comfort of specific PPE.

The data indicate there is a group of students who do not feel comfortable with their PPE comfort and training. What level of discomfort with PPE or safety training are teachers comfortable with? What about administrators? Will some students remain uncomfortable regardless of the time spent on training and money spent on equipment?

Recommendations for Research

For Air Quality PPE, researchers noted only a one percent difference between the number of students reporting training (75.55%) and equipment in laboratory (74.27%). These numbers indicate a relative alignment between training and practice. However, there is almost a ten percent difference between hearing protection training (75.55%) and equipment in laboratory (66.97%). These differences between training and implementation could indicate belief differences among teachers, availability of equipment, or student knowledge of availability. Researchers recommend further investigation on the agriculture teachers' beliefs on hearing PPE and availability of PPE within laboratories.

Further research should be conducted to determine what specific PPE materials and training is available and to what extent PPE is provided, managed, and maintained by the school. Further, observational research should be conducted to determine to what extent PPE provided is used by the students. What inventory, assignment, and storage procedures are being used in high school agricultural mechanics laboratories? What is the condition of the PPE supplies? Does storage, maintenance, and upkeep of PPE influence use and comfort?

Research should also be conducted to explore what PPE is needed in the agricultural mechanics laboratory based on curriculum and learning outcomes.

Moreover, research should be conducted to determine what, if any, additional factors explain differences in PPE behaviors. For students, what home or SAE experience factors might impact students' decision to use/not use specific PPE in the agricultural mechanics laboratory? Are there personality differences which influence students' safety knowledge, attitudes, and practices? Which brands and/or styles of PPE are perceived as most comfortable among students?

What teacher characteristics or personal experiences might explain to what extent PPE is prioritized in the agricultural mechanics laboratory? What factors do agriculture teachers use when selecting and purchasing PPE? What are teachers' sources of knowledge and curriculum for safety instruction? What are the perceived challenges of creating a safe climate among students?

For the school district and program, what additional PPE training do students receive from science or industrial technology teachers within the district? To what extent does frequency of mechanics instruction in the laboratory affect perceived PPE importance? What type of budgets do schools provide for PPE? What type of storage or sterilization equipment is provided for PPE? To what extent do principals or CTE directors monitor and/or support the PPE use of students?

References

Akbar-Khanzadeh, F., Bisesi, M. S., & Rivas, R. D. (1995). Comfort of personal protective equipment. *Applied Ergonomics, 26*(3), 195-198. doi:http://dx.doi.org/10.1016/0003-6870(95)00017-7

Carpenter, W. S., Lee, B. C., Gunderson, P. D., & Stueland, D. T. (2002). Assessment of personal protective equipment use among Midwestern farmers. *American Journal of Industrial Medicine, 42*(3), 236-247. doi:10.1002/ajim.10103

Chumbley, S. B., Gill, B. E., & Chesher, L. (2013). *Laboratory safety practices of New Mexico agricultural science teachers.* Paper presented at the 2013 Western Region AAAE Research Conference, Lubbock, Texas.

Cohen, J. (1992). A power primer. *Psychological Bulletin, 112*(1), 155.

Dillman, D. A. (2007). *Mail and internet surveys : The tailored design method* (2nd ed.). Hoboken, N.J.: Wiley.

Dyer, J. E., & Andreasen, R. J. (1999). Safety issues in agricultural education laboratories: A synthesis of research. *Journal of Agricultural Education, 40*(2), 9.

Field, A. P. (2009). *Discovering statistics using SPSS : (and sex, drugs and rock 'n' roll)* (3rd ed.). Los Angeles: SAGE Publications.

Fink, A. (2003). *The survey kit*. Thousand Oaks, Calif: Sage Publications.

Gall, J. P., Gall, M. D., & Borg, W. R. (2003). *Educational research: an introduction*. Boston: Allyn and Bacon.

Gliem, J. A., & Miller, G. (1993). Laboratory safety in vocationaleEducation: An administrator's perspective. *Journal of Agricultural Education, 34*(4).

Herren, R. V. (2010). *Agricultural mechanics : Fundamentals & applications* (6th ed.). Clifton Park, NY: Delmar Cengage Learning.

Hubert, D., Ulrich, D., Lindner, J. r., & Murphy, T. H. (2003). An examination of Texas agriculture teacher safety attitudes based on a personal blief scale from common safety and health practices. *Journal of Agricultural Systems Managment, 17,* 13.

Hubert, D., Ulrich, D., & Murphy, T. (2000). *Safety and health education analysis of Texas' first year agriculture teachers.* Paper presented at the 27th Annual National Agricultural Education Research Conference, San Diego, CA.

Ingersoll, R., & Kralik, J. (2004). *The impact of mentoring on teacher retention: What the research says.* Retrieved from http://repository.upenn.edu/gse_pubs/127

Johnson, D., & Schumacher, L. G. (1989). Agricultural mechanics specialists identification and evaluation of agricultural mechanics laboratory management competencies: A modified delphi approach. *Journal of Agricultural Education, 30*(3), 54. doi:10.5032/jae.1989.03023

Langley, G. C., & Kitchel, T. (2013). *Agricultural mechanics instructors' perception of the health beliefs in their laboratory*. Paper presented at the Western Region American Association for Agricultural Education Research Conference, Lubbock, Texas.

Lawver, D. E. (1992). *An analysis of agricultural mechanics safety practices in Texas agricultural science programs*. Paper presented at the 19th annual NAAAE Research Meeting.

Lombardi, D. A., Verma, S. K., Brennan, M. J., & Perry, M. J. (2009). Factors influencing worker use of personal protective eyewear. *Accident Analysis & Prevention, 41*(4), 755-762. doi:http://dx.doi.org/10.1016/j.aap.2009.03.017

McKim, B. R., & Saucier, P. R. (2011). Agricultural mechanics laboratory management professional development needs of Wyoming secondary agriculture teachers. *Journal of Agricultural Education, 52*(3), 12.

Miller, G. M. (1989). Student arc welding noise exposures in agricultural mechanics. *Journal of Agricultural Education, 30*(2), 6. doi:10.5032/jae.1989.02062

Mukhopadhyay, P. (2009). Ergonomic design of head gear for use by rural youths in summer. *Work, 34*(4), 431-438. doi:10.3233/WOR-2009-0943

Oliver, J. D., & Hinkle, D. E. (1982). Occupational education research: Selecting statistical procedures. *Journal of Studies in Technical Careers, 4*(3), 199-209.

Phipps, L. J., & Reynolds, C. L. (1992). *Mechanics in agriculture* (4th ed.). Danville, Ill.: Interstate Publishers.

Rasty, J., Anderson, R. G., & Paulsen, T. H. (2017). How the quantity of agricultural mechanics training received at the secondary level impact teacher perceived importance of agricultural mechanics skills. *Journal of Agricultural Education, 58*(1). *https://doi.org/10.5032/jae.2017.01036*

Roberts, G., & Ball, A. (2009). Secondary agricultural science as content and context for teaching. *Journal of Agricultural Education, 50*(1), 81-91. doi:10.5032/jae.2009.01081

Roberts, G., Harder, A., & Brashears, M. T. (2016). *American Association for Agricultural Education national research agenda: 2016-2020*. Retrieved from Gainesville, FL:

Rubin, A., & Babbie, E. (2009). *Essential research methods for social work*. Independence Kentucky: Cengage Learning

Safety and Health in Agriculture: ILO Code of Practice. (2011). Geneva: International Labour Office.

Stripling, C. T., & Ricketts, J. C. (2016). Research Priority 3: Sufficient scientific and professional workforce that addresses the challenges of the 21st century. In T. G. Roberts, A. Harder, & M. T. Brashears (Eds.), *American Association for Agricultural Education national research agenda: 2016-2020*. Gainesville, FL: Department of Agricultural Education and Communication.

Swan, M. K. (1992). *An analysis of agricultural mechanics safety practices in agricultural science laboratories*. Paper presented at the American Vocational Association, St. Louis, MO.

Tracey, J. B., Hinkin, R. T., Tannenbaum, S., & Mathuey, E. J. (2001). The influence of individual characteristics and the work environment on varying levels of training outcomes. *Human Resource Development Quarterly, 12*(1), 5-23. doi:http://onlinelibrary.wiley.com/journal/10.1002/%28ISSN%291532-1096/issues

Ulrich, D., Pavelock, D., Mueller, J., & Harrell, B. (2005). Student demographics, extracurricular participation and safety education of students participating in the 2003 Houston Livestock Show and Rodeo agricultural mechanics project show. *Journal of Southern Agricultural Education Research, 55*(1), 11.

Vidal-Salazar, M. D., Hurtado-Torres, N. E., & Matías-Reche, F. (2012). Training as a generator of employee capabilities. *International Journal of Human Resource Management, 23*(13), 2680-2697. doi:10.1080/09585192.2011.610971