SAFETY ISSUES IN AGRICULTURAL EDUCATION LABORATORIES: A SYNTHESIS OF RESEARCH

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Abstract

The objectives of this investigation were to synthesize research related to safety in agricultural education laboratories and to identify areas of deficiency in laboratory safety-related research. Findings showed that research in this area is primarily a mixture of descriptive, survey, and experimental research. Most laboratory research has been focused on agricultural mechanics laboratories. Studies revealed that agricultural education laboratories are potentially hazardous places for both work and study. Due to the nature of these laboratories, the potential for injury and subsequent litigation exists. Both teachers and administrators should assume a more active role in monitoring laboratory safety and in the procurement of necessary safety equipment and materials. Generally, teachers appear to be remiss both in their knowledge of local, state, and national safety laws, and in their performance in providing a safe environment for themselves and their students. Future research in this area should be directed toward determining the relationships between teacher attitudes and quality of instruction, identification of effective teaching strategies, determining ways to motivate students to practice safety techniques, identification of hazardous safety practices, determining inservice needs of teachers, identification of characteristics of students who are safety risks, and safety effects of laboratory instruction on teachers.

Introduction and Theoretical Framework

Of all of the jobs that a laboratory teacher performs, safety of students is the most important. According to Bruening, Hoover, and Radhakrishna (199 1), what and how students learn must be secondary to the physical safety of both students and teachers in agricultural education laboratories.

Parents demand that their children be educated in the proper and safe use of all tools, equipment, and materials. They also expect that their children will be properly supervised. However, even in instances where all precautions have been taken, the potential for serious injury still exists. Not only is safety an important consideration for educators, but a moral, professional, and legal obligation as well (Daniels, 1980; Gliem & Hard, 1988). The primary responsibility for providing safety instruction and a safe learning environment rests with the teacher (McMahon, 1975).

While programmatic research is expected across disciplines, it is imperative that study in this area of inquiry focus on the problems associated with agricultural education laboratory safety and address those problems in an orderly, systematic approach. In doing so, the need existed for a thorough review of research to critically examine its status and provide the profession with a basis from which to direct future research.

The theoretical framework for this study was furnished by Williams (199 1) in his "Dimensions of Agricultural Education" model. Williams noted that "we must fully understand the dimensions of agricultural education before we can successfully focus our research" (p. 8). Review and acknowledgment of past research, coupled with identification of voids in the current knowledge base is an effective method of fostering that

understanding and bringing focus.

Objectives

The primary objective was to synthesize research related to agricultural laboratory safety in the following areas: Occurrence of Accidents, Teacher Liability, Availability of Safety Equipment, Instructional Techniques of Laboratory Teachers, Teacher Preparation, Administrators' View of Safety, Student Attitudes Toward Safety, Instructor Attitudes Toward Safety, Noise levels, and Ventilation. A second objective was to identify areas of deficiency in research related to laboratory safety.

Procedures

Four sources were used to gather data: Journal of Agricultural Education, Dissertation Abstracts International, Proceedings from Regional and National Agricultural Education Research Meetings, and ERIC Documentation Reproduction Service. Studies appearing in these references were located through a library systems search completed at two Midwestern universities and consisted of articles published through May, 1997.

Findings

Occurrence of Accidents

Agricultural education laboratories are potentially hazardous learning environments. In studies involving high school agricultural education programs, Swan (1993) reported a mean of 1.3 major (requiring medical attention) student accidents and 13.3 minor accidents (requiring bandage but not medical attention) per year. Lawver (1992) reported a mean of 0.8 major student accidents per year, with a range of O-13 accidents per teacher. Nearly 42% of the respondents reported at least one accident. A second study by Lawver and Fraze (1995) reported a mean of 3.19 injuries that required medical attention.

Gliem and Miller (1993 b) conducted a study involving schools that had agriculture laboratories and had been engaged in litigation resulting from student injury. The researchers reported the range in number of injuries as O-14. Hard (1990) reported a majority of accidents occurring primarily in the woodworking or welding/metals area.

Teacher Liability

While many agricultural educators may be doing a good job of instructing students in safety, many others are vulnerable to legal action if an injury occurs, According to Reece (1980) and Laird and Kahler (1995), agriculture instructors agree that laboratory safety is important. Likewise, Gliem and Miller (1992a) reported that 100% of the administrators responding to their survey indicated that teachers instruct students in how to properly use equipment and demonstrate that usage, and 97.7% give students an equipment test. However, while instructors perceive written documentation to be important (Johnson & Schumacher, 1989), they generally fail to maintain written reports (Lawver, 1992; Swan, 1993). Of concern, Gliem and Miller reported that 15.6% of the administrators in their study reported that teachers leave the laboratory while students are using dangerous equipment or chemicals.

Teachers may be lax in their responsibility to know and conform to local, state, and national safety laws. Bruening, Hoover, and Radhakrishna (1991) reported the greatest deficiency of Pennsylvania agricultural mechanics teachers was knowledge of state safety laws. Reneau and Poor (1983) reported that teachers only scored 68.2% on a liability survey given to determine teachers knowledge of liability issues. Rudolph and Dillion (1984) noted that only 17 of the 37 safety standards were being met by more than 50% of the agricultural education departments in their study. Hard (1990) reported that nearly 50% of the teachers in his study did not know the recommended guidelines for noise, lighting, or ventilation requirements of their laboratories, 5 1% considered their tools unsafe to operate at times,

and nearly 90% believed themselves to be careless in the laboratory. According to Hard, whereas nearly all teachers (97%) considered knowledge of safety laws important, 24% indicated they did not know the laws.

Fletcher and Johnson (1990) concluded that teachers were not using recommended safety practices or providing student safety and emergency equipment to the extent warranted by the hazards present in the agricultural mechanics laboratory. These conclusions supported earlier findings by Lamb (1985) in a Missouri study.

It may be possible to identify students and/or teachers who are potential safety risks prior to their entering a laboratory setting. Indicators such as low emotional and behavioral control (Pulkkinen, 1995) and the identification of students with low self-esteem (Bettis & Crawford, 1972) may be used to identify students likely to be safety risks. The researchers recommended that students who were identified as "accident repeaters" be given additional attention or safety instruction. Plummert (1995) found that students overestimate their physical abilities and noted that this could be related to their accident proneness.

Availabilitv of Safety Equipment

Bennett (1984) concluded that providing a safe learning environment for public school agricultural education programs is a problem in most schools. Swan (1992) reported that instructors were not using recommended safety practices, and that school systems were not providing students with adequate safety equipment. Gliem and Miller (1993a) also reported the availability of safety equipment to be lacking in some schools.

Concerning availability of safety equipment, researchers have provided similar lists of safety equipment found in agricultural mechanics laboratories. The most frequently available equipment/materials are fire extinguishers, welding gloves, screens, booths, exhaust systems, fire alarms, safety glasses, safety guards, first aid kits, exit signs, posted eye safety regulations, safety posters at power tools, safety zones, and safety cans for flammable liquids (Bruening, Hoover, & Radhakrishna, 199 1; Fletcher & Johnson, 1990; Lawver, 1992; Swan, 1993). Panic buttons were the least frequently reported safety item by Swan (1993). Bennett (1984) listed the most common safety hazards found in Mississippi high schools to be: lack of exit signs, equipment without guards, ungrounded extension cords, absent or uninspected fire extinguishers, and inadequate paint storage.

Instructional Techniques

Instructors use a variety of materials while teaching safety, but limit their instructional repertoire to demonstration. Instructors used safety exams, manuals, safety-related subject matter, clean-up schedules, inspections, booklets, videotapes, and worksheets most often as instructional materials/practices (Bruening, Hoover, & Radhakrishna, 1991; Lawver, 1992; Swan, 1993). Teachers listed the operation of power tools, eye protection, use of hand tools, and electrical safety as the most important safety instructional topics (Lawver).

Teacher Preparation

The role of teacher educators is important in developing the safety proficiency of pre-service and current teachers (Gliem & Miller, 1993a). However, studies have indicated several voids exist in teacher preparation in laboratory safety (Forsythe, 1983; Jarrett, 1967;Rosencrans, 1996). In national studies of teacher educators, Forsythe concluded that teacher educators provide minimal experiences and instruction designed to develop teacher competency in safety.

Another void exists in the amount of continuing instruction provided to experienced teachers. According to Bennett (1984) and Lamb (1985), teachers with less experience place more emphasis on laboratory safety than do experienced teachers. Likewise, Schumacher and Johnson (1990) reported the average agriculture teacher in

Missouri placed less perceptual importance on safety-related competencies than did student teachers. Additional training in the form of inservice workshops, training seminars, or additional course work has been recommended by Everett (1982); Fletcher and Johnson (1990); Johnson, Schumacher, and Stewart (1990); and Umbaugh (1989).

Administrators' View of Safetv

Safety is important to administrators (Gliem & Miller, 1992a, 1992b, 1993b). They overwhelmingly agree that safety instruction should be included as part of the curriculum (1992b, 1993b). However, most administrators depend on the knowledge and expertise of teachers in providing a safe environment and believe that teachers are responsible for the repair and maintenance of laboratory equipment (1992b, 1993b).

There is an apparent connection to administrators' attitudes toward laboratory safety and teacher actions. Gliem and Miller (1992a) reported significant positive correlations between administrator's safety attitude and the teacher's preparedness to provide safety instruction, the number of safety materials/equipment available, and the number of teacher safety practices used.

Student Attitudes Toward Safetv

Students' safety attitudes are significantly and positively related to their perceptions of instructor and parental safety attitude (Hard, 1990; Harper, 1984); their agricultural mechanics safety knowledge; employer's safety attitudes; teacher's, parent's, and employer's safety knowledge; and school, home, and workplace safety environment (Harper, 1984).

Instructor Attitudes Toward Safety

Laird and Kahler (1995) reported that instructors considered safety to be the most important unit of instruction in agricultural mechanics laboratories. Maines (1989) reported the antecedent variables explaining instructor safety attitudes were instructor age, years of teaching experience, the instructor's having had a serious accident, and/or having had a close friend or relative killed in a work-related accident. Furthermore, Maines identified the best predictors of instructor safety attitude as the instructor's perception of his/her health hazard knowledge base, the instructor having had a serious accident in the past, and the instructor having had horticulture as a specialty area. Lawver and Fraze (1995) reported inconsistencies between teachers' attitudes toward safety and the teaching of those practices.

Noise levels

Some studies have reported that while noise is a concern, it is not a problem (Madou-Bangurah, 1978; Shell, 1972). Others have examined effects of noise on students and warn of the dangers of noise created in these learning environments (Miller, 1986, 1989; Miller, Jacobs, & Schimpp, 1992; Reynolds, 1990; Weston & Stewart, 1980; Woodford, Lawrence, & Bartrug, 1993).

Miller (1989), Reynolds (1990), and Miller, Jacobs, and Schimpp (1992) all concluded that both students and teachers are routinely experiencing significant and potentially damaging noise exposure during welding in school laboratories. Jewell (1979) noted that as noise intensities increased in the learning environment, the amount of time necessary to complete a task also increased. Miller (1986) concluded that performance loss in cognitive and motor domains may be reduced by providing effective hearing protection devices in noisy environments. However, Miller and Schimpp (1993) noted that the intensity of noise is not the primary factor in reduction in performance, but rather the interaction from the nature of the noise. They recommended teachers determine the nature of noise, rather then try to eliminate all of it.

Teachers are also susceptible to hearing

problems. Burke (1987) reported hearing loss greater in agricultural education teachers than that observed in other people of the same age group. Woodford, Lawrence, and Bartrug (1993) noted that all of the instructors in their study had high frequency loss of hearing greater than 25dBHL.

Ventilation

Only one study was found which mentioned the safety problems associated with ventilation/dust/smoke. Madou-Bangurah (1978) noted that where smoke and/or dust were problems, either no ventilation or improperly installed ventilation was the cause.

Conclusions and Recommendations

Overall, research addressing the problem of safety in agricultural mechanics laboratories can best be characterized as a mixture of descriptive, survey, and experimental studies. To a greater extent than most other areas of agricultural education, research in the area of agricultural mechanics has also been relatively programmatic. In areas examining instructional methods and the effects of noise, a sound empirical base of knowledge has been established from which future research efforts may be directed.

Agricultural education laboratories are potentially hazardous places for both work and study. Due to the nature of these laboratories, the inexperience of students who participate, and the proximity to dangerous equipment and chemicals, the potential for injury exists. Teachers should make every effort to minimize these risks by preparing themselves to effectively and safely manage these laboratories and to provide first aid assistance if needed. Likewise, administrators should assume a more active role in monitoring laboratory safety and in the procurement of necessary safety equipment and/or materials.

While teachers claim to support the concept of laboratory safety, many fail to fully implement safety guidelines and practices to the extent warranted by the hazards present. This failure results in increased danger to both students and teachers, and increased liability to teachers. Strategies to involve all partners (students, teachers, parents, and administration) in laboratory safety programs should de developed and tested.

Generally, teachers appear to be remiss both in their knowledge of local, state, and national safety laws and in their performance in providing a safe environment for themselves and their students. In nearly all studies reviewed, safety violations were noted. Likewise, a serious void exists in teacher safety preparation. Pre-service teachers are leaving colleges without being adequately trained in first aid measures or prepared to safely manage agricultural laboratories. Experienced teachers are even less safety conscious. Furthermore, no research showed that local school systems are addressing the safety-related deficiencies of their employees. A safety education course, complete with first aid certification, should be a requirement by all teacher education programs. Pre-service and inservice workshops/seminars should be incorporated into teacher education programs to more adequately prepare teachers to address safety-related concerns.

The possibility may exist to identify students and teachers who are possible safety risks prior to their entering a laboratory setting. Research in this area should be further explored in pursuit of the development of an instrument that could be used throughout the teaching profession.

Noise levels typically found in agricultural mechanics laboratories constitute a nuisance, affect performance, and may be dangerous to students and teachers. Because of student and teacher exposure of high levels of noise outside the laboratory setting, every effort should be made to limit exposure during laboratory classes. All students and teachers should wear hearing protection devices during laboratory classes in which noise levels approach OSHA limits.

Most of the research conducted to date focuses on the hazards of the laboratory

environment to students. Additional research is needed concerning the prolonged exposure to teachers in laboratory settings.

Research Deficiencies

In analyzing the findings from the synthesis of research pertaining to safety in agricultural laboratories, several areas of deficiency were found. Future research should seek to answer the following questions:

1. What factors influence teachers' attitudes toward safety?

2. How do teachers and students acquire safety knowledge and develop positive safety attitudes?

3. How should safety training differ for the varying types of agricultural laboratories?

4. Which teaching methods are most effective in generating student motivation towards safety?

5. Which laboratory activities constitute the greatest hazards to students and teachers?

7. What demographic factors influence student and teacher safety knowledge, attitudes, and practices? (i.e., geographic background, ethnicity, age, grade level, gender)

8. Is there a relationship between level of achievement and safety attitude?

9. How does safety instruction and teacher record keeping practices affect the propensity for litigation?

10. What are the safety inservice needs of teachers?

11. What are the major causes of serious and/or minor accidents in the laboratory?

12. Are there curricula that are not appropriate for high school agricultural laboratory instruction because of the danger involved?

13. What are the characteristics of individuals most likely to be safety risks in the laboratory setting?

14. What are the dangers of prolonged exposure in a laboratory environment to agriculture teachers?

15. What is the effect of cumulative noise (home, school, work) on students' hearing and/or performance?

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