Agricultural Mechanics Laboratory Safety Initiative Needs Assessment.

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Introduction

Teaching Agricultural Mechanics and Technology (AMT) has been considered a key component of the Agricultural Education program. Agricultural Mechanics Technology is identified as one of the five key content areas in Agricultural Education, and is one of the five career pathways (Illinois State Board of Education, 2006). For students to acquire the AMT skills and knowledge needed to be successful in the workforce, a well prepared teacher, a sound curriculum, and a safe working environment is needed. The AMT program should provide valuable education in working in this environment. In order for students to have a sound, safe experience, the teacher must be well prepared in safety as well, including the management of the laboratory itself, and the students within this environment. This area has always been of concern in teacher preparation (Hoerner and Bekkum, 1989; Hoerner and Bear, 1986; Johnson & Schumacher, 1989; Dryer and Andreasen, 1999)

Little has been done to assess the status of safety in the AMT laboratory, or in the preparation of the Agricultural Education Teacher to teach in the AMT laboratory since the late 1980's and early 1990's. To assess the current status of safety of Agricultural Education programs in Illinois, and to identify areas that need to be addressed a survey was administered. The objective of this survey was:

- To determine background information on the ag mechanics curriculum scope, sequence, resources and needs with particular emphasis on laboratory safety and management skills.

Methods

The list of Illinois Agricultural Education teachers was obtained from the Facilitating Coordination of Agricultural Education (FCAE) office. This consisted of 396 teachers. A sample of 300 was selected from this population. The use of a sample rather than the whole group was used so a pilot test group could be selected from the non-study group, to pilot the instrument and elicit feedback.

The survey was developed based on previous research in this area (Hoerner & Bekkum, 1990;). A randomly-selected pilot test group of 12 Illinois Teachers were selected from the non-study group and asked to complete the survey to provide feedback on face validity of the content, the organization and structure of the questions, and other general feedback. A total of 6 teachers agreed and provided feedback used to modify the questionnaire.

A website on a secure server was set up for the teachers to complete the survey. A mailing was sent to each individual in the sample during the spring semester of 2007, explaining the study, asking for their participation and directing them to the website. A postage-paid response card was provided on which the individual could indicate they did not teach Agricultural Mechanics and Technology (AMT) courses, they did not wish to participate, or that they requested a paper version of the questionnaire.

After two weeks, an email reminder was sent with a modified version of the letter, and a hot link to the questionnaire. A second and third follow-up followed at two week intervals.

Due to low response rates (15%), another round of follow-ups were conducted Fall of 2007, after summer break. This group (n=22) was used as a non or late responder group to look for differences and increase the total number of responses to the study to 68 (23%).

Results and Discussion

A t-test was used to determine if any differences existed in the opinions of the early and the late responders by testing for differences in years of experience and the questions eliciting opinions of the respondents. In only one case was a significant difference found, on the question of their perception on how well prepared they were to inspect the laboratory. In that case the late responders felt less prepared in that area.

Since there was no difference between the two groups for all other question, the researchers felt it appropriate to consider both groups in the data analysis, and to consider the responses to represent the population as a whole. Krathwhol (1993) suggested that late-responders could be used as to as a proxy for non-responders. However, the reader is cautioned that due to the low n, and the differences found in the one question, caution in applying the results should be exercised.

Since this study was exploratory in nature, descriptive statistics were considered to be the most appropriate.

The average years of experience of those that responded to this study was. 15.55, with the range being from one to thirty-four years of experience. This is slightly higher than the average years of teaching in the annual report *Illinois Agricultural Education High Schools; Professional Characteristics (FCAE 2007)* which places the average years of experience of Illinois teachers at 12 years. A t-test revealed a significant difference between the state average of 12 and the sample average of 15.55 years. The FCAE data is based on the total population of teachers in Illinois, indicating the sample that responded to this study is slightly more experienced than the average teacher. Once again, we must employ caution when interpreting the results.

One demographic factor that was not asked in the questionnaire was the sex of the teacher. Analysis of the study group from public sources, suggests approximately 86 percent were male and 14 percent female. However, one major difference was in the subgroup that indicated they did not teach AMT. Of that group (n=11), 54.5% were female.

The teachers who responded to the survey indicated an average of 92 students in their programs with a range two to 350. The average number of classes taught each semester in the AMT area was about two with an average of 16 students per class.

Teachers were asked to estimate the percentage of their total agricultural education program devoted to AMT. Values ranged from 0 to 75%, with a mean of 25.7 and a standard deviation of 16.4%. A significant portion of Illinois Agricultural Education programs are occupied by the agricultural mechanics area. Likewise, the teachers were asked to estimate what percent of their

AMT instructional program was devoted to safety instruction. Teachers indicated a wide range of values, with the mean being 17.7% with a standard deviation of 20.4%.

Teachers were asked to indicate how many major and minor injuries had occurred in their laboratories. 15% indicated none. The average was 8.6 minor injuries per year (not requiring nurse or doctor attention) and 0.92 major injuries (requiring medical attention). Teachers were asked if they keep written reports on all accidents that occur in the laboratory. 62% indicated they did. This is also of concern and requires further investigation.

Protective eye-wear is another important issue in the AMT laboratory. Eighty-six percent of schools provided protective eye-wear to students at no cost. Another two percent of schools provided safety glasses for a rental fee. The remaining schools (12.5%) required students to provide their own safety glasses.

How the protective eye-wear were stored was more evenly split. Slightly less than twenty percent (18.8%) required students to store the glasses themselves and bring them to class. Nearly half (48.4%) stored them in the AMT laboratory in a shop made storage cabinet or box. The remainder (32.8%) stored them in a commercially manufactured storage cabinet. Proper storage and disinfection of eyewear is another area of concern revealed in this study, and warrants further investigation.

Teachers were asked the number of hours of Agricultural Mechanics and Technology courses they had in their undergraduate or graduate careers. They were also asked to estimate what percent of those classes focused on safety related instruction. Table 1 illustrates the credit hours of training, and the mean percent of these courses spent on safety instruction. The range of values for percent of time spent on safety instruction tended to have wide ranges, from zero to 100 percent and zero to 50 percent for undergraduate and graduate respectively.

Table 1: Credit hours of Ag Mechanics and Technology instruction and Percent of safety instruction in those courses.

	Number of Credit. Hours.		% spent on safety instruction	
level	Mean	SD	Mean	SD.
Undergraduate	8.40	5.94	15.13	17.38
Graduate	3.20	3.60	8.07	9.83

Teachers were also asked to indicate types of experiences they had related to Agricultural Mechanics and Technology. These experiences were(n=61): Reared/worked on a farm (94%); Worked as a farm operator (57%); Taken in-service workshops (79%); Completed shop-type classes in high school (82%); Worked in agriculture related industry (64%) and attended industry provided workshops (49%). Clearly, farm experiences, and high school classes play a huge role in preparation for teaching agricultural mechanics. This has significant implications as fewer and fewer students entering agricultural education programs have a farm background. In addition, in-service and industry provided workshops constitute a significant portion of Agricultural Mechanics and Technology experiences teachers gain outside the classroom. One of the comments provided by a respondent was “A great deal of my knowledge did not come from learning in college classes. A great deal came from on the job training. I have also been a

volunteer fire fighter for 15 years and received a lot of training concerning tools and equipment…" A second interesting comment came from a personal-injury lawyer who one of the researcher's contacted for background information. This individual, about to retire from a long career, commented on the importance of teaching students skills such as these, even if in the venue of life survival skills stated, "Most of what I learned on how to use tools properly and safely, came from my agriculture teacher".

Teachers were also asked to indicate the amount of liability insurance they had through their school and professional organizations by selecting the appropriate category. The results are shown in table 2. An additional question asked them if they personally carried additional insurance protection. One-third of the teachers indicated they carried additional insurance. Even with that factored in the number of individuals with less than $500,000 in liability protection is of concern.

Table 2: Amount of Liability Insurance

Amount of Liability insurance	Percent
$0-49,999	6.6
$50,000 – 99,999	9.8
$100,000 – 199,000	26.2
$200,000 – 499,999	9.8
$500,000 to 999,999	16.4
$1,000,000 and over	31.1

In order to get an idea of the types and amounts of content as well as safety included in Illinois AMT programs, teachers were asked to estimate time (weeks) they spent in instruction in a number of AMT areas, and on safety instruction (hours). Table 3 provides an overview of the number of *weeks* teachers indicated they spent on AMT, and an estimate of the number of *hours* they spent on safety instruction in that area.

Table 3: Average weeks of instruction and hours of safety instruction for AMT content areas.

	Weeks of instruction			Hours of Safety Instruction		
Content area	N	Average	St. Dev.	N	Average	St. Dev.
Arc welding	60	8.00	6.67	57	5.19	4.22
Oxy-Acetylene Welding	58	5.22	6.41	56	4.25	4.22
Hot and cold metals	49	1.41	2.34	46	0.98	1.77
Small Gas engines	60	10.39	6.54	58	3.66	3.90
Ag Machinery	54	4.17	6.37	49	3.37	4.56
Tractor Service &Maintenance	52	2.60	6.10	51	2.14	3.58
Ag Electricity	59	6.85	5.92	57	3.81	3.69
Electric Motors	54	0.68	1.11	47	0.31	0.72
Electrical controls	51	0.69	1.52	48	0.38	0.73
Soil & water Engineering	52	1.88	2.64	48	0.43	0.98
Concrete construction	51	1.20	1.54	48	0.77	1.62
Ag Carpentry & Construction	57	7.79	8.44	54	3.98	5.76

Teachers were asked to indicate the teaching techniques they use for safety. The top 5 techniques were; Lectures (91%); Students pass safety exams (89.6%); Teacher conducts safety demonstrations (82.1%); Students watch safety videos (71.6%); and Students demonstrate safe use of tools (67.9%). It is interesting to note that while 89.6% have students pass safety exams, only 77.6% indicated they file the exams. Documentation of safety instruction is an important aspect of liability defense and exams should be maintained.

About 57% of teachers indicated they used a laboratory clean-up schedule. Only 45% indicate they designate a student clean-up foreman and only 16% designate a safety foreman. Also, only 45% of teachers indicated they conducted regular safety inspections.

Teachers were also asked to indicate what personal protective equipment (PPE) they require in the AMT laboratory. Only 91% indicated they required eye protection. Welding safety equipment used in the laboratory included gloves (85%) and aprons or jackets (73%). Other safety equipment included shop coats and coveralls (57%) and hearing protection (43%) and dust masks (39%).

The amount of reported safety equipment available in the AMT laboratory is a one area where questions arose. Follow-up is needed to determine if these items are indeed missing or if the teacher misinterpreted the question or was unsure if they were available. These items included, First Aid kits (82%); safety guards on equipment (82%); fire extinguishers (85%); marked exits (83.6%); fire blankets 68.7%; safety cabinet for flammables (33%); welding booths with screens/curtains (75%); and safety posters/rules near power tools (47%/41% respectively). The lack of these items in the lab, if indeed they are not present is of significant concern.

Teachers were asked how well prepared they felt they were to perform in three areas, teach safety, manage students in the lab, and maintain a safe lab. Table 4 provides an overview of the frequencies of the responses. By a large majority, teachers felt they were either very well or moderately prepared.

Table 4: Frequencies for teacher's perception of preparation.

Item How well prepared do you feel to…	Very well prepared %	Moderately prepared %	Somewhat prepared %	Poorly prepared %
teach safety in Ag Mechanics	59.0	34.4	6.6	0.0
maintain a safe laboratory	57.4	34.4	4.9	3.3
manage students in the laboratory	57.4	39.3	1.6	1.6

Teachers were also asked how instruction related to Agricultural Mechanics and Technology safety should be presented. Eighty-one percent felt is should be in undergraduate AMT courses, 73% felt an in-service workshop was appropriate, 69% felt it should be incorporated into agricultural mechanics workshops, and 46% felt a graduate level course on teaching safety in AMT was appropriate.

Lastly, teachers were asked to rate the importance, and their perceived level of preparation for teaching 16 safety related topics on a three point interval scale. They were to rate these topics thinking in terms of the importance in the preparation of an Agricultural Education teacher. They were also asked to rate their perception of their own preparation in terms of these same topics on a four-point interval scale. The means, standard deviations and n for both questions on all 16 elements can be found in table 5.

Table 5 presents the results of the responses to those questions.

Item	**Importance of the topic**[1]			**How well prepared**[2]		
	n	Mean	SD	n	Mean	SD
Administering safety exams	61	2.6	0.56	61	3.6	0.49
Fire extinguisher types	60	2.6	0.53	60	3.5	0.65
Laws related to safety in the AMT lab	61	2.5	0.59	60	2.6	0.69
Clean up schedules	60	2.3	0.63	60	3.4	0.70
Eye protection	61	2.8	0.37	61	3.7	0.50
Safely operating power tools	61	2.9	0.25	60	3.6	0.61
Color coding shop tools	61	2.1	0.66	61	2.7	0.77
Safety using hand tools	61	2.8	0.47	61	3.7	0.57
Power tool safety posters	61	2.2	0.56	61	3.0	0.89
Electrical safety	60	2.8	0.45	61	3.5	0.65
Power tool operation posters	59	2.2	0.56	60	3.0	0.85
Welding exhaust systems	61	2.8	0.42	61	3.5	0.62
Lab safety inspections	61	2.6	0.56	61	3.1	0.75
Engine exhaust systems	61	2.4	0.59	60	2.8	0.79
First aid materials	61	2.8	0.43	61	3.5	0.57
Keeping accident reports	61	2.7	0.45	60	3.3	0.73

[1]Scale 3= Very important, 2=somewhat important, 1=not important
[2]Scale: 4= very prepared, 3=somewhat prepared, 3=poorly prepared, 1= not prepared.

In general, teachers felt most of the topics were very or somewhat important. With safely operating tools rated most important, followed by eye protection, welding exhaust systems, and first aid. Rated as least important was the color coding of the shop and power tool safety posters.

In terms of the teachers' perceptions of their preparation, they felt least prepared in the laws that pertain to the AMT laboratory, color coding of the shop, and engine exhaust systems. They felt most prepared in the topics of eye protection, safety using hand tools, and safely operating power tools.

Conclusions and Recommendations.

Based on the findings of this study, current and past literature, the following conclusions and recommendations are offered.

- A significant portion (about 25%) of the Agricultural Education programs are dedicated to AMT topics, with an average of about 2 Agricultural Mechanics and Technology courses taught each semester.
- Welding (Arc and Oxy-Acetylene), Small Engines, Carpentry and Electricity are the AMT content areas most taught, and also represent the largest areas for safety instruction.
- While protective equipment is available and used in most schools, the evidence suggests that the use of PPE varies among programs.
- Most teachers feel they are moderately to very well prepared to teach safety, maintain a safe laboratory and manage students in the laboratory.

Recommendations

Given our findings, we recommend the following;

- An assessment of the current status of AMT laboratories in relation to safety is needed, to explore the correlation of teacher's perceptions to laboratory conditions.
- Further study through case-study and focus group methodologies of highly successful AMT teachers (as recognized by their peers) should be conducted to identify key skills and knowledge needed in the teacher-preparation programs to ensure beginning teachers are ready for the laboratory.

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