DOING TO LEARN WITH PROJECTS IN THE AGRICULTURAL MECHANICS LABORATORY

by

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of the requirements for the degree

of

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in

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Rodney Dale Braaten

August 2013

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ABSTRACT

The purpose of this study is to analyze the factors that affect the use of project based learning as part of the secondary agricultural education curriculum. Utilizing agricultural mechanics projects as a learning tool has been on the decline due to a variety of factors as schools and agricultural education has evolved. The results show space and equipment needs for an agricultural education laboratory, project implementation details, and teacher abilities. It also looked at curriculum design. A written survey instrument was used with the 70 secondary teachers of the Montana Association of Agricultural Educators was the sample population. 38 usable surveys were returned for a response rate of 54%. The results showed how common programs are equipped and how they implement project based learning in the agricultural education curriculum as well as strengths and weaknesses within the state that can be addressed through professional development.

CHAPTER 1

INTRODUCTION

Several factors have led to the decrease and almost extinction of self-directed projects performed by students in the agricultural mechanics laboratory. While no one would argue the value of education in projects, current teachers are faced with a challenge when it comes to giving the students the hands-on experience they need to master agricultural mechanics skills. One reason for the decline of projects is the cost of materials. As costs rise, the margin that makes final product economically worthwhile narrows. Many times similar items can be purchased prefabricated for near the same cost as the materials alone cost for students to build it themselves in the agricultural mechanics laboratory. This is certainly discouraging to any teacher or student.

The skill and effort of thinking through and planning an agricultural mechanics project is not common today. Unless students grow up in homes where the parents are do-it-yourselfers, they are never shown how to complete a project. The prevailing mentality is to just buy it and throw it away when you're done with it. There is less need to be inventive and creative in building your own equipment because of the ease of shopping with the internet where, with the click of a button, you can find it already finished and shipped to your door.

Building something for yourself takes time, and there are other interests that demand students time now. Project time is difficult to manage in a classroom setting because while some students are self-starters and will work well with the freedom, others

require more attention and will accomplish the minimum required with their time. Teacher directed projects take excessive time on the teachers part because of planning and procuring materials. Teachers are also faced with the economic challenge for the cost of the project. There are a number of questions that every teacher must ask when considering a student project in the agricultural mechanics laboratory. Is the school providing the materials cost free to the student? Does the student pay for the materials? Is the product sold to cover the costs or make a profit without competing with local business? Does the school facilities allow this? The situations described above may help explain the decline in size and scope of agricultural mechanics projects constructed by high school students.

The decrease in popularity of agricultural mechanics projects by students and teachers is somewhat of a “vocational education tragedy.” The value of agricultural mechanics projects is found in the combined application of cognitive and psychomotor processes. Agricultural Education’s approach to education is founded on Dewey’s pragmatic philosophy of education which advocates applied education and learning by doing. One way to return to these philosophical foundations is to rediscover the benefits of hands-on projects so that students, communities, and teachers can profit in the numerous ways provided through planning, design, construction, evaluation, and marketing of agricultural mechanics projects.

Problem Statement

As a product of Agricultural Education and as a current Agricultural Education teacher, I was fortunate to have both knowledge and skills in agricultural mechanics. A consistent challenge as a teacher was to manage the multiple resources in promoting, teaching and managing individual or class-based project builds. That challenge led me to the research question: What factors in Montana agricultural education programs affect the use of agricultural mechanics projects as a valuable learning tool.

Purpose and Objectives

The purpose of this study was to determine self-perceived programmatic, curricular, and professional development strengths and weaknesses in Agricultural Education programs across Montana for implementing project-based learning in agricultural mechanics. The following specific objectives were essential to accomplishing the purpose:

1. Determine how space and equipment availability affect the use of projects in agricultural education programs;
2. Identify knowledge and skill level and need of teachers in the agricultural education profession in Montana;
3. Determine the curricular structure strengths and limitations for implementing agricultural mechanics projects.

Definition of Terms

For the purpose of this study, certain terms needed defining to assist both the writer and the readers.

Metal working - is those processes involving metal as the primary resource.

Program - the agricultural education department at the school where the respondent is employed.

Projects - in agricultural mechanics involves building or constructing anything that is ultimately a useful product constructed with the tools made available and skills learned by the students through their high school agricultural education program.

Wood working - all projects involving wood as the primary resource.

Significance of Study

While constructing projects in the agricultural mechanics laboratory is nothing new, recent curricular changes and requirements have limited the amount of time available for such activities. Elective course teachers such as agricultural educators were adopting curriculum and courses with the intent to directly supplement the expectations in knowledge and skills required for high-stakes testing, school report cards and adequate yearly progress (AYP). There was little research conducted in this specific area of agricultural mechanics. The results of this study will provide valuable information to new and seasoned agricultural teachers in Montana. The results will be shared among agricultural educators, teacher educators in agriculture and other stakeholders.

CHAPTER 2

REVIEW OF LITERATURE

Teacher Preparation

Recent research has been limited in the area of agricultural mechanics. Teacher preparation has been a more popular topic of research but relates to agricultural mechanics. Teaching in and managing the agricultural mechanics laboratory is a struggle for many teachers, particularly those starting out that don't have a strong background. In one study respondents indicated that they felt "prepared" for only one out of ten areas in agricultural mechanics from a teacher education program (Burris, Robinson, & Terry, Jr., 2005). Teaching agricultural mechanics is not as enjoyable as other things for many teachers. The degree to which Missouri teachers like agricultural mechanics is lower than that of other subject areas (Walker, Garton, Kitchel 2004). The agricultural mechanics portion of the teacher certification curriculum needs to be updated and revised according to a Lawver, Barton, Akers, Smith, and Fraze (2004). Safety is a concern for many new teachers. Many teachers in Wyoming felt they needed more training in first aid, hazards, and safety (McKim & Saucier, 2011). Handling a class in the agricultural mechanics laboratory is a challenge. Many student teachers in Wyoming need professional development in laboratory management (Shinn, 1987). The ability to effectively manage, maintain, and improve laboratories is a characteristic of an effective agriculture teacher (Roberts & Dyer, 2004). Many agriculture teachers nationwide struggle because of their own inexperience in the field of agricultural mechanics and project planning. This does

not foster programs that are sound in producing educational projects out of the agricultural mechanics laboratory.

Ag Mechanics Curriculum

Agricultural mechanics curriculum is a very broad and complex subject that is difficult to master without a great deal of experience. Many agricultural mechanics competencies include safety and skill in metal fabrication and agricultural structures (Lawver, Barton, Akers, Smith and Fraze, 2004). Students working in the agricultural mechanics laboratory get an education that is interdisciplinary in nature. An Oklahoma study found that students in a math enhanced agriculture power and technology curriculum excelled better on math placement tests than those not enrolled (Parr & Edwards, 2009). Saucier, Terry and Schumacher found that there was a need for professional development programs for Missouri secondary agriculture teachers who are responsible for managing and instructing students in an agricultural mechanics laboratory at public schools to assure that teachers are able to safely and effectively teach in these conditions. (Saucier, P.R., Terry, Jr., R. and Schumacher, 2010) Ag mechanics curriculum is very diverse depending on the facilities, equipment, class size, instructor knowledge, skill and experience and grade level. Effective curriculum and instruction in agricultural mechanics is vital to having successful projects.

Safety

Safety is a major part of teaching agricultural mechanics. For some teachers of agricultural mechanics it is a big concern and for all teachers it is a big responsibility. Safety is another area where we find additional research related to agricultural mechanics education. 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. 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. 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. Additional research is needed concerning the prolonged exposure to teachers in laboratory settings. (Dyer and Andreasen, 1999) McKim and Saucier found that student teachers were in need of professional development in many areas of laboratory management, such as diagnosing malfunctioning laboratory equipment, repairing laboratory equipment, and administering first aid (2011). Hubert and Ullrich (2003) quoted on page 3, “If skill development is the focus of laboratory instruction, then thorough attention to all its components, including safety instruction, is essential." Safety is a key component of the agricultural mechanics laboratory. It must be taken seriously to be successful with projects. Safety includes complete instruction and

assessment, equipment maintenance and repair, classroom and laboratory management, and first aid.

Evolution in Agricultural Mechanics

Teaching agricultural education and agricultural mechanics specifically has changed drastically in the past few decades. The curriculum taught has become more broad and fewer of the students we work with have an agricultural background. Today's teachers are now teaching more students, in smaller laboratories with less money spent per student on agricultural mechanics laboratory consumables. These teachers have less experience and university credit hours in agricultural mechanics as well. (Saucier, P.R., Terry, Jr., R. and Schumacher, 2010). Schools and teachers used to put more emphasis on developing skills in agricultural mechanics than they do currently. With broadening the scope of agricultural education from the traditional vocational agriculture classes we have lost that focus.

Importance of Agricultural Mechanics Skills

The skills gained in the agricultural mechanics laboratory go beyond welding a bead or driving a nail. The planning, problem solving and critical thinking skills they gain are invaluable. This along with the ability to create or fix something with their hands are talents the workforce demands. Agriculture teachers use the agricultural mechanics laboratory to give students unique hands-on opportunities to develop valuable academic and vocational skills (Hubert 2003). Johnson, Schumacher, and Stewart (1990) found that

students learn important psychomotor skills in agricultural mechanics laboratory(Johnson, Schumacher, & Stewart, 1990)(Johnson, Schumacher, & Stewart, 1990). Up to two-thirds of the total instructional time in secondary agricultural education programs is devoted to laboratory instruction (Shinn, 1987). Business and industry still demands workers who can work with their hands, plan projects, and solve problems. The skills obtained in project based learning are a very valuable skill and deserve the attention of agricultural educators.

CHAPTER 3

METHODOLOGY

Population Description

The target population for this study was the Montana secondary agricultural education teachers who were members of the Montana Association of Agricultural Educators (MAAE) during the 2012-2013 school year.

Instrument Design

The survey instrument was created as a Microsoft Word Document and a PDF and divided by sections to include the following: metal working equipment, wood-working equipment, other agricultural mechanics equipment, equipment usage and sharing, lab spaces, courses offered, safety and equipment use instruction offered, mechanical skills taught, categories of projects built, and grading information. A demographic section included information about years' experience, self-perceived mechanical skills, and self-perceived in-service needs. The researcher completed the IRB training and has the completion certificate included as Appendix A.

Instrument Validity

A panel of experts was used to review the survey and check for validity. The panel included the agricultural education faculty and welding education faculty directly responsible for pre-service instruction in agricultural mechanics. A pilot study was

conducted using Idaho agricultural education teachers as the pilot respondents. The Idaho state FFA advisor provided names and contact information for ten teachers in Idaho of varied school sizes and years of experience who were proficient in agricultural mechanics. These teachers were contacted by email with a short cover letter explaining the survey and its purpose. The survey was attached as both a Microsoft Word document and PDF file with the option to either complete and submit the pilot survey electronically or through mail. Data from pilot surveys were compiled and analyzed and minor adjustments were made to several questions in attempts to increase reliability.

Data Collection Methods

Teachers were initially contacted at the MAAE winter meeting in Helena, MT on February 1st 2013. A brief introduction about this study was given followed by sufficient time to complete the survey. After the winter meeting, the survey was posted on Montana Office of Public Instruction METNET communication system for teachers to download and complete. Follow up with the target population was accomplished through METNET and phone calls were made to many individuals requesting them to complete and return the survey from February 18th through the 21st. The request to complete the survey was also conveyed through word of mouth at several FFA events where MAAE members were present. Through all methods, 38 completed and usable surveys were collected for a response rate of 54%. All surveys and survey information was kept confidential. No individual responses were reported.

Data Analysis

All surveys collected were manually entered into Microsoft Excel spreadsheets for tabulation. Two worksheets were used to include all the data. The first sheet included data regarding demographic information about the program. This included all of the quantitative information such as what equipment was available, laboratory size, classes offered and their size, instruction and assessment of equipment and skills, teacher experience and professional development needs, and grading criteria. Since most of the questions were yes/no, this was coded into the Microsoft Excel files as 0=no 1 =yes. This method of entry allowed the researcher to take an average of the row in order to find the percentage of respondents that answered yes. The second spread sheet included data for all of the student made projects reported by respondents.

CHAPTER 4

RESULTS OF THE STUDY

Purpose and Objectives

The purpose of this study was to determine self-perceived programmatic, curricular, and professional development strengths and weaknesses in Agricultural Education programs across Montana for implementing project-based learning in agricultural mechanics. The following specific objectives were essential to accomplishing the purpose:

1. Determine how space and equipment availability affect the use of projects in agricultural education programs;
2. Identify knowledge and skill level and need of teachers in the agricultural education profession in Montana;
3. Determine the curricular structure strengths and limitations for implementing agricultural mechanics projects.

Project Information

The teachers categorized common student projects into seven categories (Table 1): Production Ag, SAE, Home, Horticulture/Garden, Recreation, Community, and Other. A total of 234 projects were recorded. The information given on each project was: Project Name, who pays for materials, grade level, complexity (rated easy, medium, or hard), time in hours to complete the project, and finally who buys or gets the final project

(Table 1). All this information was then summarized and compiled and shown in Table 1. The data revealed that most projects were in the “Home” category. Over one third of the projects provided by respondents were listed in the “Home” category. Within this group, shelves were the most common type followed by chairs. The average grade level of these projects was 9.57, the lowest average grade level for all the categories. Almost one-third (32.53%) of the respondents ranked complexity of these projects as easy. This was second only to the SAE category where one third (33.33%) were rated as Easy by the teachers. The second most common type was production agriculture with 16.67% of the projects. The average grade level for the production agriculture category was eleventh grade and the complexity was primarily (64.1%) medium. The production agriculture category projects are constructed for people in the community 61.54% percent of the time and the students themselves 35.9%. Payment for the projects was made by the following groups: Community (35.9%), student (25.64%), school (28.21%) and FFA (7.69%).

Projects in the recreation section were also frequent (13.25%). Of the recreation projects, the largest percent were vehicle-related projects such as bumpers and headache racks. A larger number of medium to hard projects were found in this section. The majority (51.61%) of these projects were paid for by students and taken home by students (61.29%).

The mean time allotted for different projects was 21.54 hours for all projects. The shortest mean time for projects (14.96 hours) was found in the home category and the longest mean time (30.6 hours) was in the horticulture/garden category.

Table 1: Student Project Categories and Information.

Project Category	Production Ag		SAE		Home		Horticulture/Garden	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Number of projects	39	16.67%	18	7.69%	83	35.47%	21	8.97%
Most Common projects in the category	10 Feeders	25.64%	10 Tack Boxes	55.56%	16 Shelves	19.28%	14 planter	66.67%
	7 Panels	17.95%	4 Chutes	22.22%	11 Chairs	13.25%	4 structures	19.05%
	5 Gate Latches	12.82%			7 Stools	8.43%		
					5 Tool Boxes	6.02%		
Mode of Grade Level	11		9		9		11	
Average Grade Level	11.01		10.3		9.57		10.45	
Average Project Time in Hours	23.58		16.58		14.96		30.6	
Complexity Frequency								
Easy	5	12.82%	6	33.33%	27	32.53%	6	28.57%
Medium	25	64.10%	9	50.00%	49	59.04%	11	52.38%
Hard	9	23.08%	3	16.67%	7	8.43%	4	19.05%
Who Paid? Frequency								
School	11	28.21%	4	22.22%	43	51.81%	8	38.10%
Student	10	25.64%	13	72.22%	32	38.55%	3	14.29%
Outside/Community	14	35.90%	1	5.56%	2	2.41%	5	23.81%
FFA	3	7.69%		0.00%	4	4.82%	4	19.05%
Who Gets Project? Frequency								
Outside/Community	24	61.54%	2	11.11%	8	9.64%	7	33.33%
Student	14	35.90%	15	83.33%	75	90.36%	7	33.33%
School		0.00%	1	5.56%		0.00%	5	23.81%

Table 1: Student Project Categories and Information, continued.

Project Category	**Recreation**		**Community**		**Other**		**Totals**	
	Number	Percent	Number	Percent	Number	Percent		Percent
Number of projects	31	13.25%	24	10.26%	18	7.69%	234	100%
Most Common projects in the category	13 Vehicle Related	41.94%	7 Benches	29.17%	4 Sheds	22.22%		
	4 Gambrels	12.90%	6 Picnic Tables	25.00%				
	3 Trailers	9.68%	2 Playground Equip	8.33%				
			2 Structures	8.33%				
Mode of Grade Level	11		11		11			
Average Grade Level	11.03		11.04		10.64			
Average Project Time in Hours	23.72		16.78		24.57			21.541%
Complexity Frequency								
Easy	2	6.45%	3	12.50%	1	5.56%	50	21.37%
Medium	16	51.61%	16	66.67%	7	38.89%	133	56.84%
Hard	13	41.94%	4	16.67%	10	55.56%	50	21.37%
Who Paid? Frequency								
School	3	9.68%	3	12.50%	6	33.33%	78	33.33%
Student	16	51.61%	0	0.00%	4	22.22%	78	33.33%
Outside/Community	3	9.68%	16	66.67%	6	33.33%	47	20.09%
FFA	0	0.00%	3	12.50%	1	5.56%	15	6.41%
Who Gets Project? Frequency								
Outside/Community	4	12.90%	23	95.83%	9	50.00%	77	32.91%
Student	19	61.29%	0	0.00%	7	38.89%	137	58.55%
School	3	9.68%	0	0.00%	2	11.11%	11	4.70%

Grading

Respondents were asked to list the classes under one of the four grading options. The options were numeric value, pass/fail, formula, and rubric. Two thirds of the responses were “numeric value”. Twenty-five percent responded to rubric and the remainder was divided evenly between pass/fail and formula.

Table 2: Grading Options.

Numeric Value	Pass/Fail	Formula	Rubric
66.00%	25.00%	4.00%	4.00%

Respondents were asked to indicate percentages among eleven grading criteria which included: Following instructions, neatness of job, free of defects, proper use of tools, attitude of student, safety, attendance, project plan, craftsmanship, use of time, and final product. Other was also an option and respondents added cleanup, teamwork, and finishing or painting. The most popular grading criteria were final product (20.2%), use of time (19.5%), and craftsmanship (16.9%). The other eight categories consistently ranged between 8.0% and 13.3%.

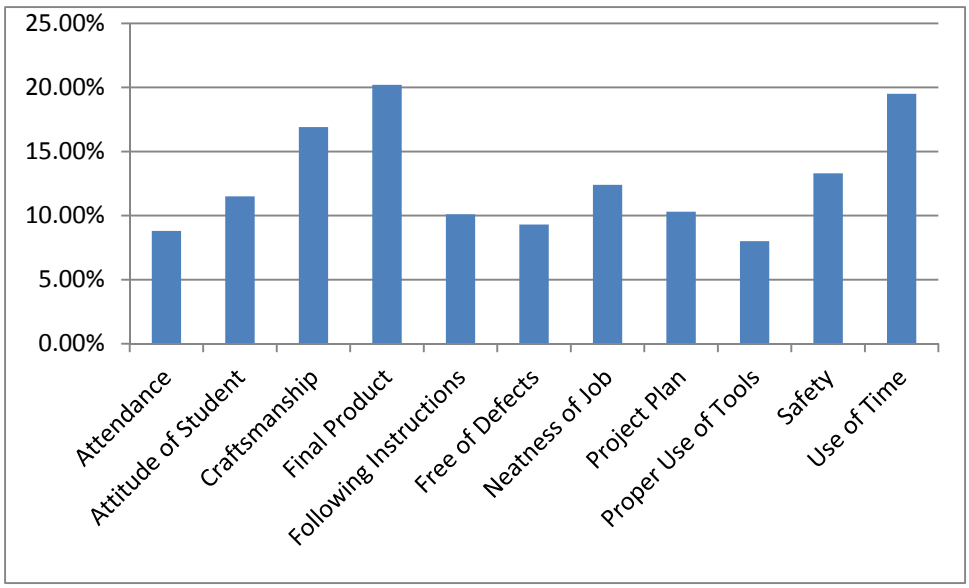


Figure 1: Grading Criteria.

Equipment

The agricultural mechanics equipment available governed what projects were undertaken in a particular program. The survey listed 17 common wood working tools and equipment and 17 common metal working tools and equipment. Figure 2 depicts the percentage of equipment and tools programs possessed. About 90% or more agricultural mechanics laboratories had a table saw, miter or compound miter saw, router, belt sander, circular saw, and drill press. The least common wood working equipment was spindle sanders, scroll saws, and power nailers. Overall programs had 79% of the wood working equipment listed.

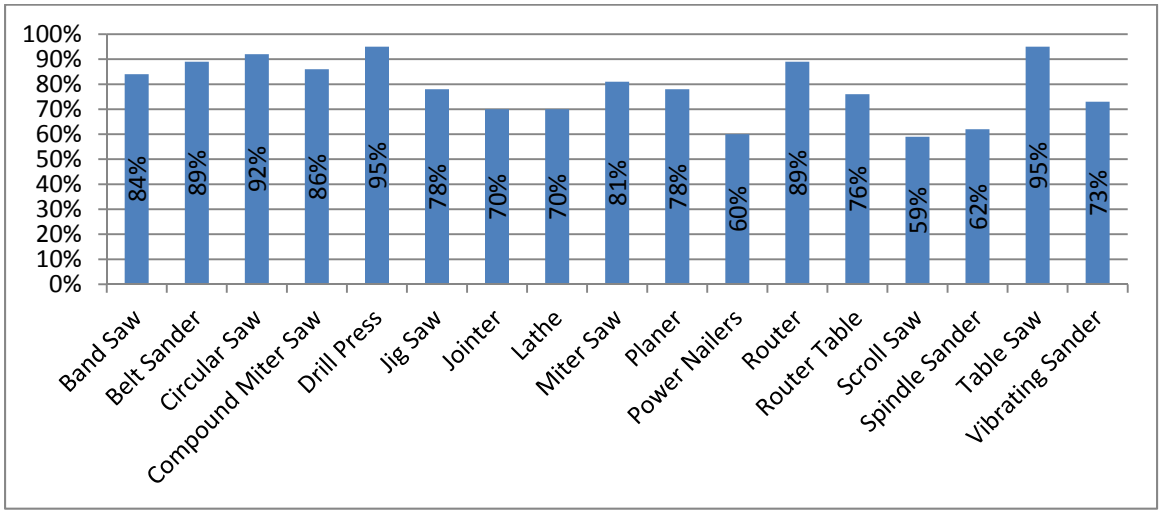


Figure 2: Programs and Wood Working Equipment Comparisons.

Figure 3 showed how programs were equipped with welding and other common metal equipment. Over 90% of programs had stick, MIG, and oxy fuel welders as well as a cutting torch, plasma cutter, anvil, and both hand and bench grinders. Sheet metal equipment and a forge were the least reported among the metal working equipment. Overall programs had 68% of the metal working equipment listed.

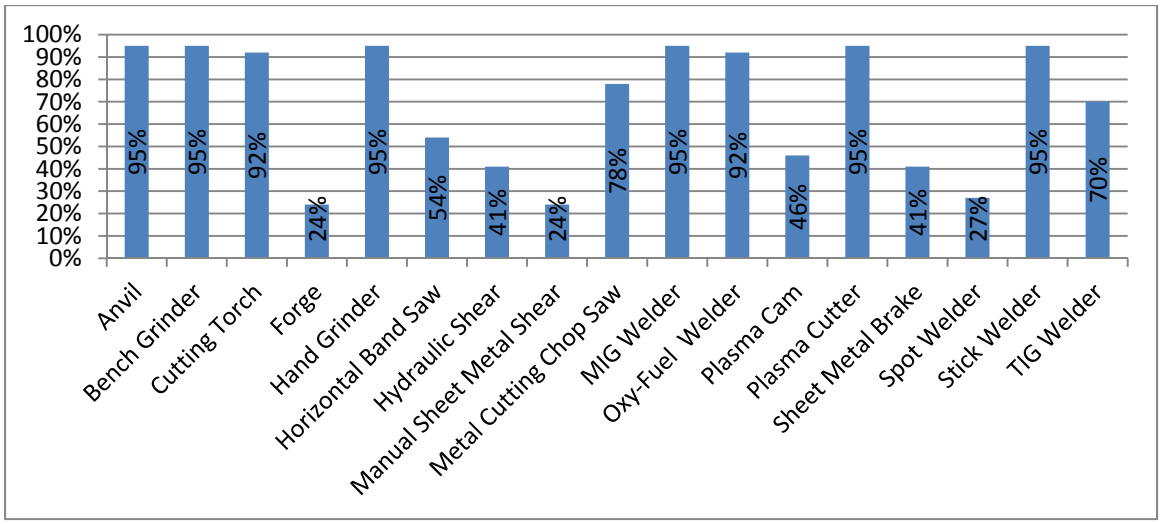


Figure 3: Programs and Metal Working Equipment Comparisons.

Correlations were conducted to see if a relationship existed between years of teaching experience and use of projects in the program. The first test was if teachers who had been teaching longer had built up a larger inventory of equipment available to them. A chart and Pearson product moment correlation coefficient were conducted for years of experience verses the equipment available. The equipment was divided into wood working equipment and metal working equipment. The equipment value was calculated by tallying the pieces of equipment of 17 typical laboratory tools in wood and metal categories indicated by surveys completed. The results showed that younger teachers actually had slightly more wood working equipment (Pearson r = -0.03157) than more experienced teachers but veteran teachers had a greater inventory of metal equipment (Pearson r = 0.300635) than new teachers. The results can be seen in Table 3.

Table 3: Years of Experience vs. Pieces* of Wood & Metal Working Equipment.

Years of Experience	**0-3**	**4-6**	**7-12**	**13-18**	**19+**
N	7	12	6	6	7
Average Pieces of Wood Working Equipment	12	14	15	14	13
Average Pieces of Metal Working Equipment	10	11	11	12	13

*Pieces of equipment are unduplicated

Skills

The skills surveyed for wood working were: Project planning, measuring, material identification and selection, wood joints, wood fasteners, sanding, painting, and staining. The skills surveyed for metal working were: Welding joints, metal separation, project

planning, material identification and selection, metal fasteners, heat treating, tool conditioning, and threading. Overall, wood working skills (81%) were taught more than metal working skills (64%). The most popular wood working skills taught were project planning and measuring while the least common was wood joints (Figure 4).

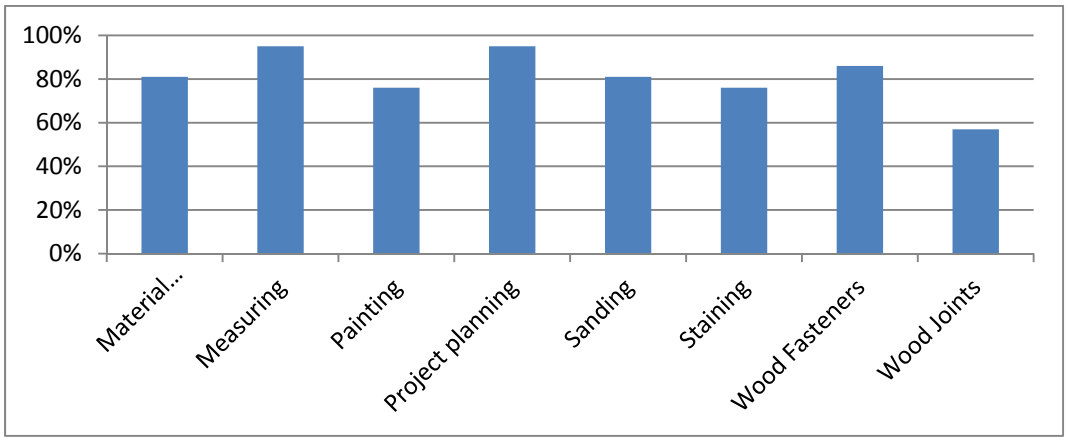


Figure 4: Percent of Programs That Teach Various Wood Working Skills.

The most common metal working skill taught was welding joints and the least common was heat treating (Figure 5).

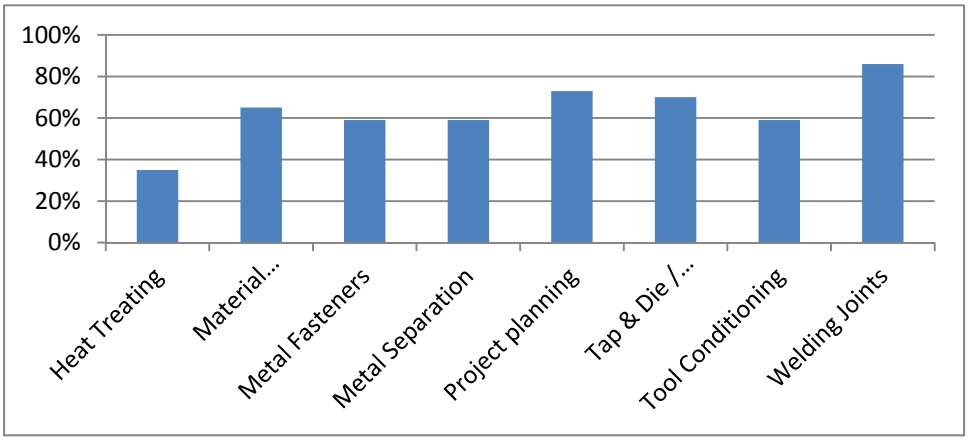


Figure 5: Percent of Programs That Teach Various Metal Working Skills.

Eight skills were assessed in each wood working and metal working category. The skills for the two categories were added up for a total of eight skills in each and compared to the years of experience of the teacher. A slightly negative correlation (Pearson r = -0.01947) was found between the number of wood working skills taught and the teachers' experience. Therefore, newer teachers were actually teaching a few more wood working skills than their more experienced counterparts. However, a stronger positive relationship (Pearson r = 0.231627) was found between experience and metal working skills. Neither correlation coefficient was statistically significant at the alpha 0.05 level. The results are shown in Table 4.

Table 4: Years of Experience vs. Wood & Metal Working Skills Taught.

Years of Experience	**.5-3**	**4-6**	**7-12**	**13-18**	**19+**
N	7	12	6	6	7
Average Number of Wood Working Skills Taught	5.3	7	6.6	7.1	6.4
Average Number of Metal Working Skills Taught	4	4.8	5.2	5.6	5.3

Professional Development Needs

The respondents were asked to rate their need for professional development for ten different agricultural mechanics areas. The areas were: Wood working tools, wood working safety, wood working skills, wood working structures, welding equipment, welding safety, welding skills, welding projects, agricultural power & machinery, and hydraulics. The respondents were asked to rate themselves on a scale of one to eight, with one meaning, "Need extensive training," and eight meaning, "Need no training." The

values for each section were averaged and represented in Figure 6. Overall, teachers felt they needed more training in metal working than wood working. The agricultural power and machinery and hydraulics categories were found to be needed more by respondents than the others.

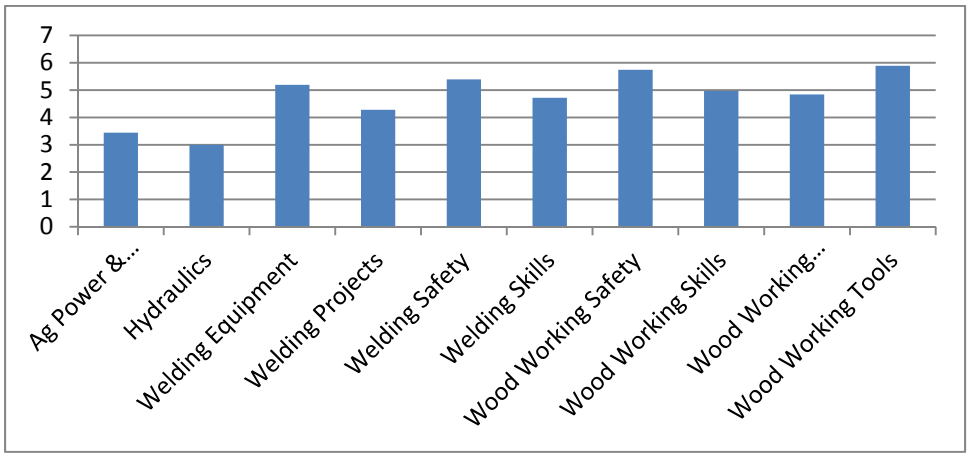


Figure 6: Professional Development Needs* by Category.
*Lower the value equals higher need

The values given by each respondent were then totaled to calculate their individual professional development need. This was then compared against years of experience (Table 5). There was a slightly positive correlation coefficient (Pearson r = 0.025831) between the two variables: therefore, the more experienced teachers need less training than the less experienced.

Table 5: Years of Experience vs. Professional Development Need.

Years of Experience	**.5-3**	**4-6**	**7-12**	**13-18**	**19+**
N	7	12	6	6	7
Average Individual Professional Development Need	42	48	43	53	45

Professional development needs were also calculated for female (1) and male (2) teachers. The result was a positive correlation (Pearson r = 0.291418) between males and no need for training (Figure 7).

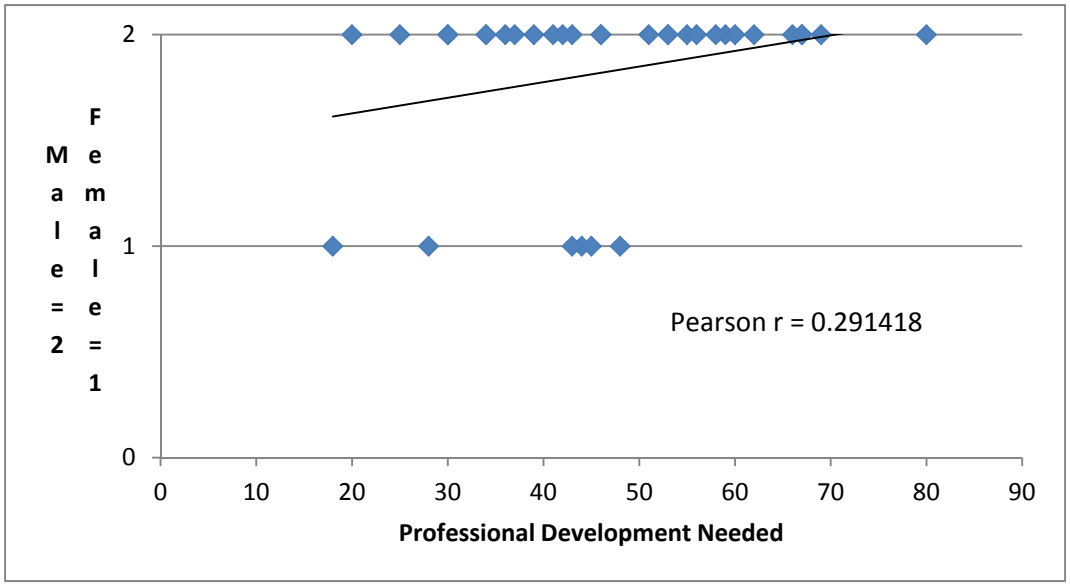


Figure 7: Male/Female vs. Professional Development Need.

Several correlations were conducted to see if there were any relationships between a male or female instructors and implementing agricultural mechanics projects in the curriculum. Respondents were surveyed on the skills they teach in both wood working and metal working. The skills surveyed for wood working were: Project planning, measuring, material identification and selection, wood joints, wood fasteners, sanding, painting, and staining. The skills surveyed for metal working were: Welding joints, metal separation, project planning, material identification and selection, metal fasteners, heat treating, tool conditioning, and threading. Eight skills were assessed in each wood working and metal working. The eight skills were summed for each and

compared to the gender of the instructor. To quantify gender a one was put in for females, and a two for males. Figures 8 and 9 denote the correlation between teacher gender and skills. A slight positive correlation resulted between male teachers and the number of skills they teach. The correlation is stronger for metal skills (Pearson r = 0.280976) than wood working skills (Pearson r = 0.216083).

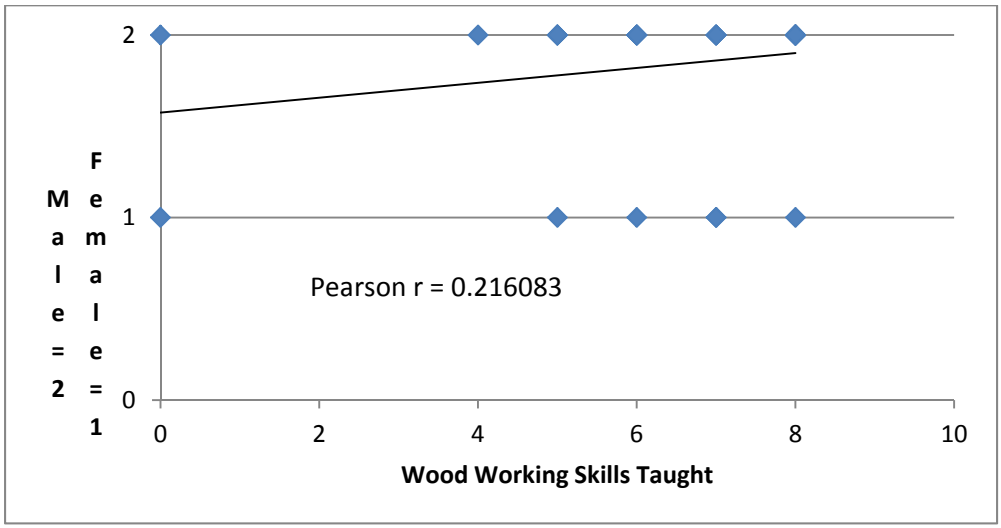


Figure 8: Male/Female vs. Wood Working Skills Taught.

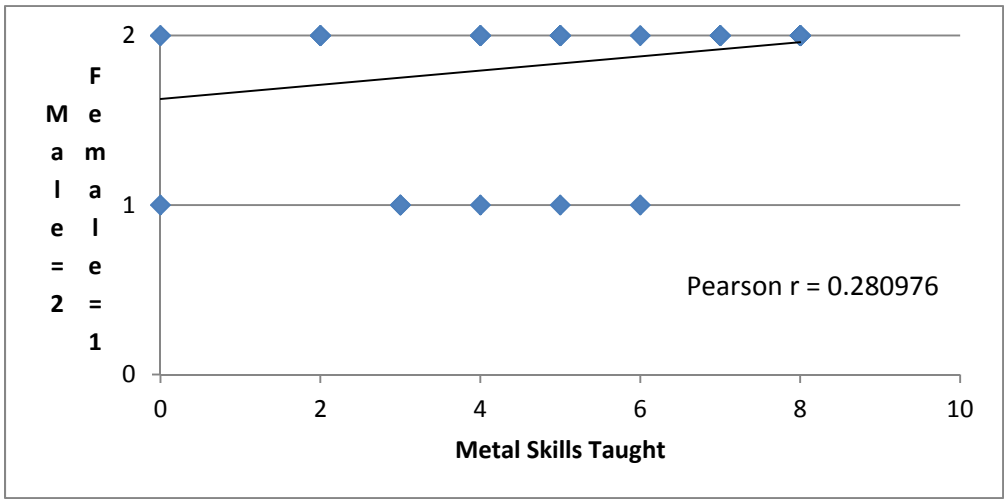


Figure 9: Male/Female vs. Metal Working Skills Taught.

Laboratory Size

Respondents indicated the laboratory size of their program in square feet area in of their wood working area, metal working area and the sum of the two for a combined laboratory space. The open project space that can be created was also requested. Teachers were also asked if space was a limiting factor for the projects that can be built in their facility. The largest reported laboratory (16,000 square feet) and the smallest (672 square feet) were omitted from the averages. Figure 10 showed the average wood working area was 1682 square feet while the average metal working area was slightly larger at 2001 square feet. Open project space which could be created averaged 2460 square feet. The second graph (Figure 11) showed the respondents actual wood working area and metal working area for each school as well as their combined laboratory space in square feet.

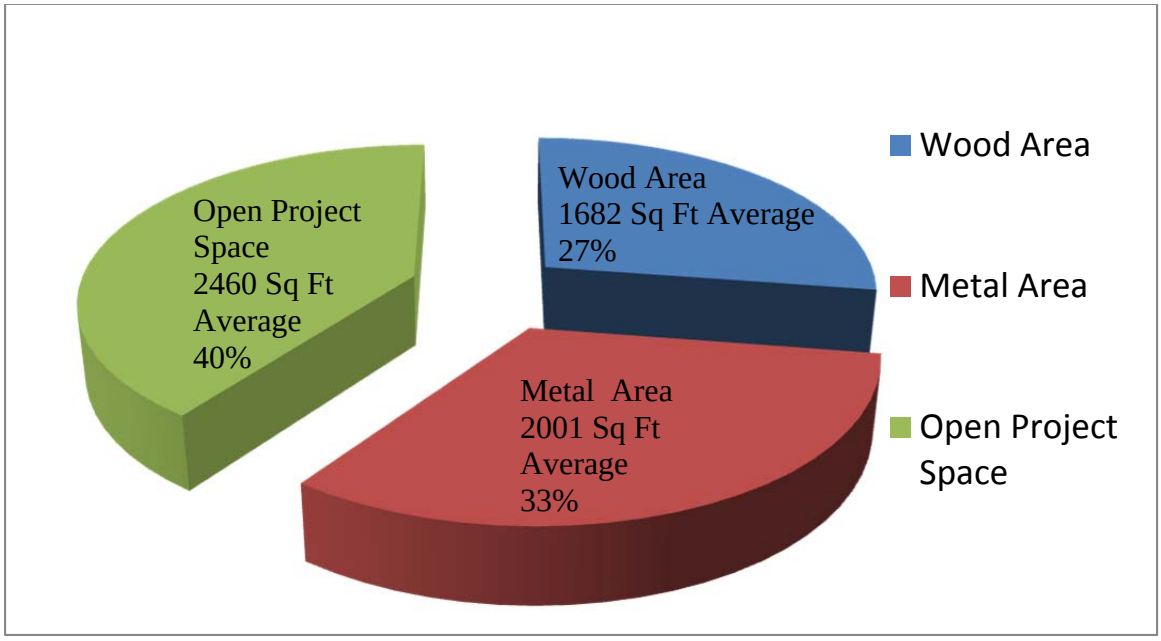


Figure 10: Average Laboratory Space Split between Wood and Metal Area and Open Project Space.

Figure 11 shows respondent results for the question, "Does the size of your laboratory limit projects?" corresponding to laboratory size. The “no” answers are represented by a one on the graph and the “yes” answers by a two. The majority (53%) of respondents reported that size was a limiting factor in implementing projects in their program. The negative trend-line shows that the larger the laboratory space, there is a less chance size was a limiting factor for constructing projects.

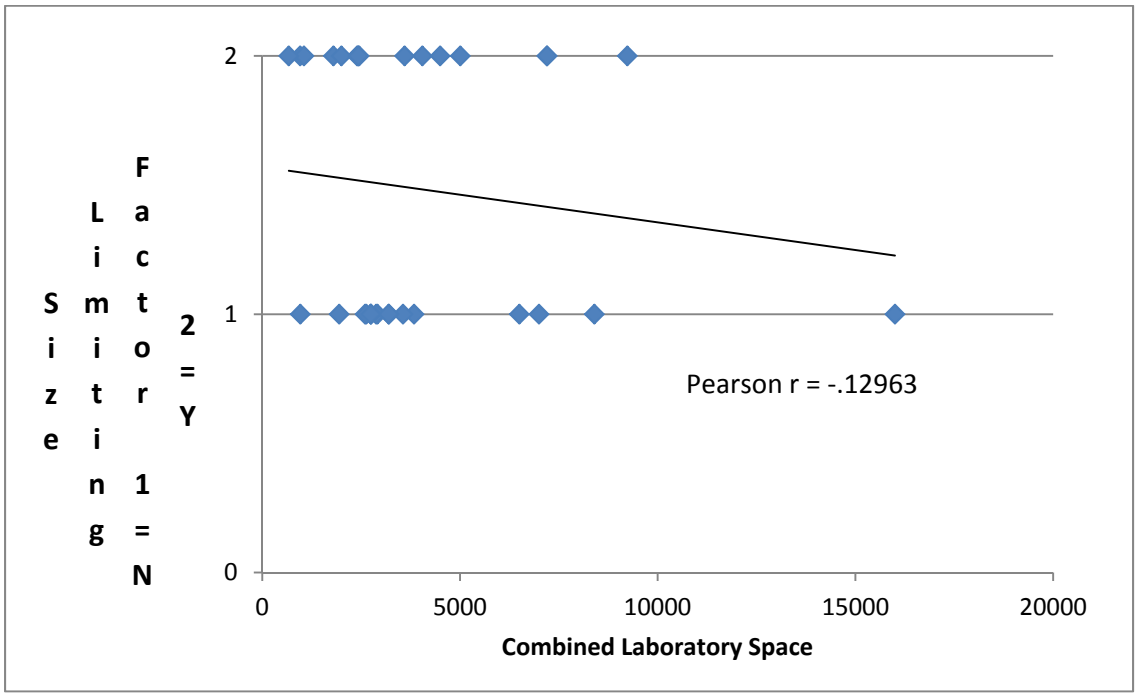


Figure 11: Laboratory Space as a Limiting Factor

Community Organizations

Community projects accounted for 10.26% (Table 1) of projects given by respondents. The most common community organizations to do projects for were listed

along with the percentage of respondents who did projects for the listed entities: School Board 66%, Fair Board 63%, Town Council 57%, and Alumni 34%. Other organizations that were listed by respondents were: Weed department, library, United States Forest Service, Natural Resources Conservation Service, city parks, cemetery, scales association, trails group, extension office, chamber of commerce, nursing home, school farm, and museum.

Showcasing Projects

Respondents were answered the open ended question, “Are you using county or state fairs to showcase agricultural mechanics projects? If so which ones?” Many programs are presenting their projects to the public (67%). 61% are using their county fair. Other venues for showcasing projects were: State fair, open house, and FFA banquet.

Student Enrollment

Respondents were asked to list the classes they teach and enrollment in two sections. The first being those that spend 25% or more time devoted to agricultural mechanics and the second with classes that devote 75% or more time to agricultural mechanics. The average student enrollment was 13.2 students and 10.6 students respectively. Those classes that had more laboratory time tend to be smaller classes.

A correlation was performed between student enrollment of those classes that devote 75% or more of class time on agricultural mechanics curriculum and laboratory

and combined laboratory space. A moderate positive correlation was found (Pearson r = 0.517528) between the two. The equation for the resulting trend line was y=0.0011x + 5.9089. The smaller the student enrollment, the smaller the size of the laboratory in general.

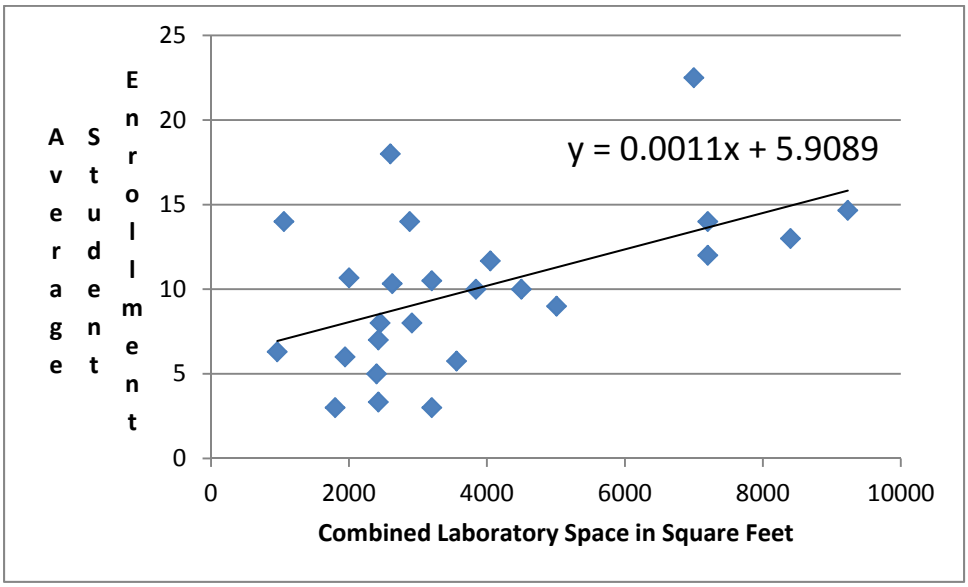


Figure 122: Average Student Enrollment vs. Laboratory Size.

CHAPTER 5

CONCLUSIONS, IMPLECATIONS, AND RECOMMENDATIONS

The purpose of this study was to determine self-perceived programmatic, curricular, and professional development strengths and weaknesses in Agricultural Education programs across Montana for implementing project-based learning in agricultural mechanics. The following specific objectives were essential to accomplishing the purpose:

1. Determine how space and equipment availability affect the use of projects in agricultural education programs;
2. Identify knowledge and skill level and need of teachers in the agricultural education profession in Montana;
3. Determine the curricular structure strengths and limitations for implementing agricultural mechanics projects.

Conclusions

From the objectives and results of the study conclusions can be drawn. Equipment availability has an effect on the skills taught and projects that could be completed in a particular program (objective 1). Programs on average possessed 79% of the wood working equipment and 68% of the metal working equipment. The average program taught 81% of the wood working skills and 64% of the metal working skills. Overall more wood projects are completed than metal projects. Therefore we can see that the

equipment effects the skills and projects that are taught in a program to answer to objective one

Space also had an effect on the project based learning (objective 1). Figure 12: "Average Student Enrollment vs. Laboratory Size" showed a moderate correlation coefficient (.5175). The equation of the trend line in Figure 12 is: y =0.0011x + 5.9089 where y=class size and x=square feet. This provides a good guide that teachers can use to compare laboratory size with the average of the respondents of this survey. Teachers can calculate the needed laboratory size for a class size if they were building new or adding onto a facility. One can also determine a recommended class size to use in a laboratory. For example, if a teacher had a 2400 square foot laboratory the teacher can input that in for x and the result is 8.55 students. Likewise the average class size is 10, plug that in for y and find out that your new facility should be at least 3,719 square feet. Space impacts the use of project-based learning and these figures should be considered a minimum because many of the teachers in these programs (53%) indicated that size was a limiting factor.

The knowledge and skill level of Montana agricultural educators (objective 2) was revealed through the respondents self perceived professional development need. Teachers rated wood working skills higher than metal working skills. Teachers lack knowledge and skill in hydraulics, agricultural power and machinery, welding projects, welding skills, and wood working structures. Teachers tend to teach what they know best. The less need for most wood working in-service training and higher number of wood

working skills taught was reflected by students completing more wood working projects than metal working projects.

No significant difference was found between male and female teachers. A weak relationship existed (Pearson r = 0.291418) between male teachers and respondents rating of their need for professional development. In general male teachers have at least slightly more confidence in teaching agricultural mechanics concepts and projects than female teachers. Male respondents taught more wood working and metal working skills than female respondents. Male instructors placed slightly more emphasis on agricultural mechanics skills than female instructors. Some of the variation in this could be due to sharing curriculum among other teachers or programs so the respondent may not be responsible for some areas where in other schools, teachers are responsible for all mechanics courses at the school.

The curricular strengths and limitations for implementing agricultural mechanics projects (objective 3) were found throughout the study. The most common type of project completed in the agricultural mechanics laboratory is a home project primarily completed by younger (9^{th} grade) students enrolled in agricultural education. The most common projects coming from the agricultural mechanics laboratory were not related to agriculture but were projects for students to use at home. They are primarily freshman level projects that are easy to medium in complexity paid for by the school and taken home by the student. There are several explanations for this. While the survey didn't go into this detail, many programs simply have more underclassmen (9-10^{th} grade) than upperclassmen (11-12^{th} grade). Therefore, one can conclude that the home projects that

tend to be of a simpler introductory style are the most common. Many of these projects were probably introductory projects that help develop laboratory skills for more in-depth projects later on. Trends in American agriculture showed, fewer students were from families involved in production agriculture. Home projects can be used by anyone in the community unlike having a whole class build feeders when only one student might have a use for one at home. Home projects also require less knowledge and skill and are easier for both the teacher and student to complete. Many of the introductory type projects are in the wood working area and the metal working projects tend to be from the higher grade levels.

Overall, schools pay for projects one-third of the time. One-third of the projects are paid for by students while the remainder of the projects are paid for by a group or individual outside of the school which represents another third of the projects. Most of the time small simple projects are paid for by the school as part of taking the class. Some schools charge a "lab fee" and then pay for the materials needed for the projects constructed in that class. More complex projects that cost more or are individually constructed rather than the entire class making the same project lends themselves to having students pay for it. The SAE category had the largest percent of projects paid for by the students (72.22%) and that of projects taken home by students (83.33%) in all categories.

The majority of agricultural mechanics projects took about 10-25 hours to complete according to respondents. This is a considerable amount of time when planning curriculum for a class; Often it took one half of a quarter to complete one project. Some

projects took much longer. Most of these include an entire class working on a structure or community project. The horticulture/garden category had the longest project time because 19.05% of these projects were creating structures such as greenhouses. As the grade level increased the projects became more difficult and took more time generally, as one would expect. Wood projects were more frequently reported by respondents. This is likely due to the cost of materials.

Nearly all classes that included projects were graded on a numeric value. Teachers were moving toward using rubrics for individual projects. This became a part of the numeric value final grade. The project type, grade level, complexity, time, grading, and cost responsibility are all curricular structure strengths and limitations for implementing agricultural mechanics projects (objective 3).

Implications

Professional development in the near future should look to incorporate the subject of hydraulics and agriculture power and machinery. These categories ranked lower (most needed) than the rest. This would be a good focus for future conferences of the Montana Association of Agricultural Educators. While it doesn't link as close to the direct construction of many projects as some of the other subjects, they are applied in many projects. The next lowest two areas were wood working structures and welding projects. These should also be considered for future professional development. While more experienced teachers indicated they needed slightly less training in these areas overall, all teachers needed about the same amount of professional development in agricultural

mechanics areas. Teacher educators should cover more in depth the managing of the agricultural mechanics laboratory and how to plan and execute projects. Objective and subjective grading and utilizing rubrics is another area to implement in professional development. The office of public instruction (OPI) should also train administrators and trustees on the budgeting and spending of money on equipment for the agricultural mechanics laboratory and provide more state or federal funding to do so.

Recommendations for Future Research

More research is needed in the area of agricultural mechanics projects. Research regarding the specific type of projects that could be built and sold to community members is recommended. In addition, research related to project developments as an in-service need is warranted. To survey grading types and criteria, more explanation for the respondent is needed to receive accurate information. Concerning direct applications to future research on agricultural mechanics projects, the researcher suggests the following be implemented:

1. Split "projects" into three sections. The first section with those where the entire class completes the same individual project. Second, split the projects into those which are individual and self-led. Third, those projects which are not individual, but a team or class works on collectively. As the research of this study progressed it was apparent that these are drastically different types of projects and should be treated separately so data could be compiled on each.

2. The researcher felt that he would have attained a higher response rate and therefore better data if the survey would have only been administered electronically.

3. Examine Occupational Safety and Health Administration (OSHA) standards that impact an agricultural mechanics facility in relation to space and safety.

4. Examine student demographics such as rural, urban and agriculture background.

5. Examine injuries in the agricultural mechanics laboratory by demographic, project type, laboratory space, and teacher expertise and experience.

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APPENDICES

APPENDIX A

CERTIFICATE OF COMPLETION

Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that **Rodney Braaten** successfully completed the NIH Web-based training course "Protecting Human Research Participants".

Date of completion: 10/18/2009

Certification Number: 323081

APPENDIX B

PILOT TEST COVER LETTER

Hello I'm Rodney Braaten. I am a high school agricultural education teacher in the small town of Sheridan in southwest Montana. I am also a master’s degree student at Montana State University. I am beginning a study on the use of projects in high school agricultural mechanics laboratories. We are planning to survey all Montana Agriculture programs this spring, but would like to conduct a small pilot test of our survey instrument first. Ben Meyer gave me your contact information as a good candidate to give some useful feedback to me. If you would be willing to participate by taking my survey please respond. I'd also like to know if you would prefer to take the survey on a hard paper copy mailed to you, a word document emailed to you. When you respond I will send you the survey in the method you prefer.

Thanks for your consideration.

Rodney Braaten

APPENDIX C

SURVEY INSTRUMENT

2/1/2013

Thank you for agreeing to take part in this completely voluntary survey. Your participation is strictly voluntary and you may refuse to participate at any time. This survey is being collected by MSU Agricultural Education graduate student Rodney Braaten. The purpose of this survey is to assess the different factors that contribute to the undertaking of student agricultural mechanics projects in Montana Agricultural Education programs.

Student agricultural mechanics projects have long been a mainstay for experiential learning in Agricultural Education. However, research has not been conducted to consider which programmatic factors support student engagement and success with agricultural mechanics projects. Almost every agricultural education program has an agricultural mechanics laboratory and all agricultural education programs espouse experiential learning.

Please return the survey to:

Rodney Braaten
Sheridan High School
107 Madison Street
Sheridan, MT 59749
==========

Survey--Doing to Learn with projects in the Ag Mechanics Laboratory

Survey's purpose: To assess the different factors that contributes to the successful completion of student agricultural mechanics projects in Montana Agricultural Education programs.

What agricultural mechanics equipment is available to you and your students?

Please circle all that apply.

Wood Working Equipment

Table Saw
Miter Saw
Compound Miter Saw
Planer
Jointer
Router
Router Table
Belt Sander
Spindle Sander
Vibrating Sander
Band Saw
Circular Saw
Drill Press
Lathe
Scroll Saw
Jig Saw
Power Nailers

Metal Working Equipment

Stick Welder
MIG Welder
TIG Welder
Oxy-Fuel Welder
Cutting Torch
Plasma Cutter
Plasma Cam
Forge
Anvil
Horizontal Band Saw
Hydraulic Shear
Metal Cutting Chop Saw
Spot Welder
Sheet Metal Brake
Manual Sheet Metal Shear
Bench Grinder
Hand Grinder

Other Equipment

Surveying Equipment
Concrete Tools
Electrical Tools
Plumbing Tools
Small Engine Tools
Automotive Tools
Other_____
Other_____
Other_____

Is this equipment shared with another school program (i.e., Technology Education, school maintenance facility?)

Wood Working Equipment Yes____ No____

Metal Working Equipment Yes____ No____

Other Equipment_____ Yes____ No____

Please indicate how many square feet encompass the following work areas

a. Wood Area Length_____ x Width_____ = Square Feet_____
b. Metal Area Length_____ x Width_____ = Square Feet_____

Combined Laboratory Space (a + b)_____square feet

Open project space that can be created by moving benches or equipment to allow for a large project. _____ Square feet.

Does the size of your laboratory limit projects? Yes___ No___

Classes offered with 25% or more of the time devoted to agricultural mechanics

1. _____ Class Size: _____students
2. _____ Class Size: _____students
3. _____ Class Size: _____students
4. _____ Class Size: _____students
5. _____ Class Size: _____students
6. _____ Class Size: _____students

Classes offered with 75% or more of the time devoted to agricultural mechanics

1. _____ Class Size: _____students
2. _____ Class Size: _____students
3. _____ Class Size: _____students

Does your ventilation system limit the projects that can be built? Yes____
No____

Does your school policy or liability limit the projects that can be built? Yes____
No____

If yes what is limited?

_____
_____
_____

Instruction:

For which of the following equipment do you provide complete <u>SAFETY</u> instruction <u>AND</u> assessment?

Please circle all that apply

<u>Wood Working Equipment</u>

Table Saw

Miter Saw

Compound Miter Saw

Planer

Jointer

Router

Router Table

Belt Sander

Spindle Sander

Vibrating Sander

Band Saw

Circular Saw

Drill Press

Hand Drill

Lathe

Scroll Saw

Jig Saw

Power Nailer

Biscuit Jointer

<u>Metal Working Equipment</u>

Stick Welder

MIG Welder

TIG Welder

Gas Welder

Cutting Torch

Plasma Cutter

Plasma Cam

Forge

Anvil

Horizontal Band Saw

Hydraulic Shear

Metal Cutting Chop Saw

Spot Welder

Sheet Metal Brake

Manual Sheet Metal Shear

Bench Grinder

Hand Grinder

Metal Lathe

Milling Machine

What Agricultural Mechanics skills do your students learn?

Wood Working

Project planning

Measuring

Material Identification & Selection

Wood Joints

Wood Fasteners

Sanding

Painting

Staining

Metal Working

Welding Joints

Metal Separation

Project planning

Material Identification & Selection

Metal Fasteners

Heat Treating

Tool Conditioning

Tap & Die / Threading

Other (please describe) _____

_____

_____

_____

Teacher Information

How many years of experience do you have in teaching agricultural mechanics?

_____

Please rate the following categories for what you could use for in-service training to make you a better teacher of agricultural mechanics.

	Need Extensive Training							Need No Training
Wood Working Tools	1	2	3	4	5	6	7	8
Wood Working Safety	1	2	3	4	5	6	7	8
Wood Working Skills	1	2	3	4	5	6	7	8
Wood Working Structures	1	2	3	4	5	6	7	8
Welding Equipment	1	2	3	4	5	6	7	8
Welding Safety	1	2	3	4	5	6	7	8
Welding Skills	1	2	3	4	5	6	7	8
Welding Projects	1	2	3	4	5	6	7	8
Ag Power & Machinery	1	2	3	4	5	6	7	8
Hydraulics	1	2	3	4	5	6	7	8

Agricultural Mechanics Project Categories

List the Agricultural Mechanics Projects your students complete in the following areas

	List Common Projects and information in the table below					
	Project Name	Who Pays for Materials	Grade Level	Complexity E=Easy M=Medium H=Hard	Time in Hours	Who Buys or Gets Final Project
Production Ag- i.e. Gates, Feeders,						
S.A.E.- i.e. Steer Blocking Chute, Tack Box,						
Home- i.e. Adirondack Chair, Shelf						
Horticulture/Garden- i.e. Planters						
Recreation- i.e. Game Gambrel, Bumper						
Community- i.e. Park Benches,						
Other Projects						

Grading Ag Projects

List the classes that you use the following grading scale for.

NUMERIC VALUE- Grade users by assigning a value out of a specified total number of points.

_____

PASS/FAIL- Grade users using a simple pass/fail grade scheme.

_____

FORMULA- Grade students using a custom formula based on achievement on other grade items.

_____

RUBRIC- Grade using a breakdown of a variety of categories

_____

For a typical junior/senior level project, what percent of their agricultural mechanics grade would you give from the following criteria? The sum of your %s must total 100%. Don't apply a percent to the sections you would not grade on.

Following Instructions _____

Neatness of Job _____

Free of Defects _____

Proper Use of Tools _____

Attitude of Student _____

Safety _____

Attendance _____

Project Plan _____

Craftsmanship _____

Use of Time _____

Final Product _____

Other _____

Other _____

Total **___100%___**

Are you using county or state fairs to showcase agricultural mechanics projects? If so which ones?

_____

_____

_____

Which community organizations request your program or students to construct agricultural mechanics projects for them? (i.e. Town Council, Fair Board, Alumni, School Board etc.) Circle the one who asks the most.

_____

_____

_____

THANK YOU FOR COMPLETING THIS SURVEY!!!