

# **Beginning SBAE Teachers' Metal Fabrication Knowledge Needs: Implications for Teacher Preparation**

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## **Abstract**

*While agricultural mechanics, which includes metal fabrication, continues to be popular among school-based agricultural education (SBAE) students (Hubert & Leising, 2000), the number of required courses in agricultural mechanics for teaching certification in agricultural education is relatively low (Blackburn, Robinson, & Field, 2015). Despite the minimal required coursework, Saucier and McKim (2010) argued that all SBAE teachers who instruct agricultural mechanics should be technically competent. To ensure preservice teachers are technically prepared to enter the profession, this study, guided by the model for teacher preparation (Whittington, 2005), sought to determine the essential metal fabrication knowledge and skills which beginning SBAE teachers should possess prior to beginning a career in agricultural education. Results from this study identified eight essential knowledge and skill areas categorized into four categories, metal fabrication equipment, metal fabrication production, student assessment, and laboratory management. Preservice teacher programs should be evaluated to determine if they are effectively preparing teachers in the curriculum area of metal fabrication. Teacher educators and professional development staff should plan professional education programs for in-service teachers in this agricultural mechanics area.*

**Keywords:** agricultural mechanics, metal fabrication, teacher needs

## **Introduction**

The importance of agricultural mechanics to school-based agricultural education (SBAE) programs has been documented (Burris, Robinson, & Terry, 2005) and continues to be popular among secondary agriculture students (Hubert & Leising, 2000; Oklahoma Department of Career and Technology Education (ODCTE), 2012). Approximately 59% of the United States' eleven thousand SBAE instructors teach agricultural mechanics (National FFA Organization, 2010). In Missouri, courses related to agricultural mechanics had the highest enrollment among SBAE courses (Burris et al., 2005). Likewise, in Texas, nearly 28,000 students were enrolled in agricultural mechanics-based courses at 925 secondary schools (Hubert & Leising, 2000). In 2012, the ODCTE reported approximately 5,000 secondary agriculture students were enrolled in courses related to agricultural mechanics. Most recently in New Mexico, approximately 15% of secondary agricultural education students were enrolled in agricultural mechanics-based courses (E. Lopez, personal communication, September 14, 2017).

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When not a standalone program, metal fabrication is an area which is included in agricultural mechanics curriculum. Metal fabrication can be defined as “the building of metal structures by cutting, bending, and assembling processes”, and includes welding, casing, machining, and metal finishing (Yakubu, 2014). A competent metal fabrication teacher must possess manipulative skills along with theoretical knowledge (Yakubu, 2014). Instruction in metal fabrication requires technical and administrative procedures, tools, equipment, laboratory arrangement, consumable materials, and quality assurance (Yakubu, 2014). To ensure SBAE teachers are technically competent, teacher preparation programs should engage preservice teachers in agricultural mechanics courses to prepare them to teach specific skills necessary for future employment (Blackburn et al., 2015).

Although agricultural mechanics has been integrated with or closely related to agricultural education for several years (Thoron, Myers, & Barrick, 2016) numerous agriculture teacher preparation programs require preservice teachers to complete relatively few credit hours of agricultural mechanics courses for graduation (Blackburn et al., 2015). As noted by Burris et al. (2005), a majority of teacher preparation programs required fewer than 12 hours in agricultural mechanics. Hubert and Leising (2000) reported the average number of credit hours in agricultural mechanics for preservice teachers to complete certification in agricultural education was 6.7, with most universities reporting three credit hours was the minimum requirement.

The *American Association for Agricultural Education (AAAE)* endorsed standards for SBAE teacher preparation programs (AAAE, 2017) which include knowledge requirements of program graduates. *Standard 2: Technical Content Knowledge* indicates preservice teachers should exhibit knowledge of agricultural equipment found in facilities along with demonstrating awareness and ability to use technology in the agricultural industry (AAAE, 2017). Burris et al. (2005) recommended restructuring teacher education programs to better prepare preservice teachers in agricultural mechanics but, increasing credit hour requirements may not be an option (Blackburn et al., 2015). In 2001, Connors and Mundt reported the median number of credit hours to complete a degree in agricultural education was 128, with 45 hours devoted to technical agriculture. More recently, under pressure from state legislators, universities have decreased the number of credit hours required for graduation (Weldon, 2013), further complicating the issue for teacher educators as they prepare preservice teachers.

While well prepared SBAE teachers can aid secondary agricultural education students in developing practical, hands-on skills (McKim & Saucier, 2011), researchers have concluded recent agricultural education graduates were deficient in aspects of agricultural mechanics instruction (Dyer & Andreasen, 1999). Burris et al. (2005) reported that even though preservice teachers were receiving instruction in metal fabrication, the level of skill development was inconsistent with the allocation of resources devoted to this area of agricultural mechanics. In 1990, Johnson, Schumacher, and Stewart found agricultural education teachers in Missouri had earned, on average, over 17 college credit hours in agricultural mechanics education but, by 2009, that number had decreased to 11 credit hours (Saucier, Terry, & Schumacher, 2009). In Oklahoma, preservice teachers were only required to complete five credit hours in agricultural mechanics coursework, which can result in poor or failing scores in the agricultural mechanics sections on agricultural education certification exams (Leiby, Robinson, & Key, 2013; Leiby, Robinson, Key, & Leising, 2011).

Educators are typically considered beginning teachers until they have completed three years in the profession (Myers, Dyer, & Washburn, 2005). Although a variety of measures and data collection procedures have been employed, clearly identifying in-service needs of beginning teachers is difficult (Birkenholz & Harbstreit, 1987; Joerger, 2002; Myers et al., 2005). Differences

in program priorities has been purported as a possible cause in identifying beginning teacher needs (Birkenholz & Harbstreet, 1987; Myers et al., 2005). Although not specific to beginning teachers, Saucier, McKim, and Tummons (2012) identified 23 essential agricultural mechanics skills needed by SBAE teachers. Included in this comprehensive list, were basic metal fabrication skills.

### Conceptual Framework

A modified version of Whittington's (2005) model for teacher preparation in agricultural education served as the conceptual framework for this study. This framework is grounded in the philosophical tenets of agricultural education including experiential learning (Kolb, 1984), problem-based teaching (Lancelot, 1944), social cognition (Bandura, 1986), and reflective practice (Schön, 1983). Coursework in agricultural education teacher education programs are aligned with the Council for the Accreditation of Educator Preparation (CAEP) standards, Interstate New Teacher Assessment and Support Consortium (INTASC) principles, Praxis criteria for licensure, and AAAE Standards to guide preservice teacher preparation, including knowledge and skills needed for entry into the teaching profession.

As noted by Whittington (2005), the characteristics of experiential learning including hands-on, contextual, problem-solving, and project-based serve as one of the "philosophical foundations of agricultural education teacher preparation" (p.92). Without proper preservice preparation in metal fabrication, "it is unlikely that beginning teachers will be able to use the agricultural mechanics laboratory as a mode of experiential learning and a tool to provide rigorous and relevant instruction" (Saucier et al., 2012, p. 138) to their students. Because of the relatively few hours of agricultural mechanics coursework required for certification, it is important to establish the most appropriate and necessary metal fabrication knowledge and skills needed by beginning teachers. Thus, it is important to accurately identify the essential metal fabrication knowledge and skill areas needed by beginning SBAE teachers.

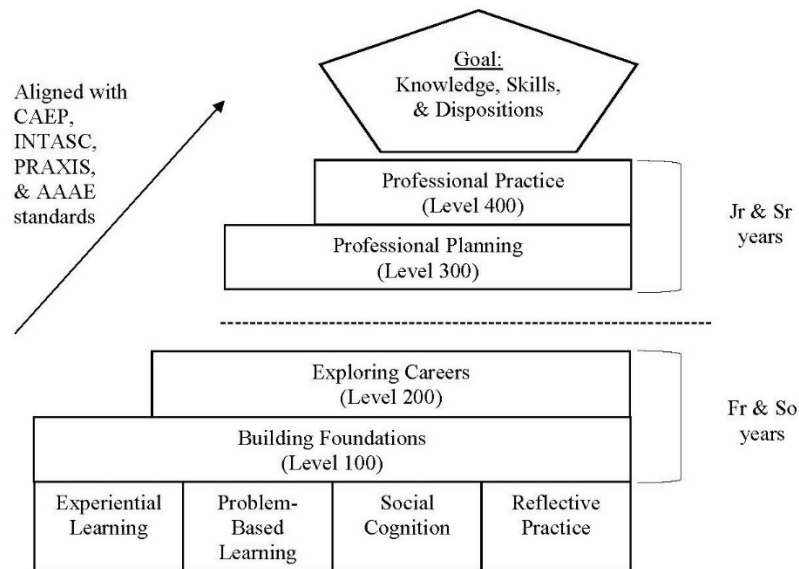


Figure 1. Modified model for teacher preparation in agricultural education. Adapted from Whittington (2005, p. 94).

Note. Years in College: Fr=Freshman year, So=Sophomore year, Jr= Junior year, Sr= Senior year

### **Purpose and Objective**

The *2017-2020 Standards for School-Based Agricultural Education Teacher Preparation Programs* (AAAE, 2017) indicated students completing an agricultural education teacher preparation program and who will be licensed to teach should demonstrate awareness of contemporary technology and its use in agriculture and be able to teach students how to use technology present in the modern agricultural industry. Therefore, the purpose of this study was to identify the metal fabrication knowledge needed by beginning SBAE teachers. The specific objective of this study was to:

1. Identify the perceived metal fabrication knowledge and skills needed by beginning school-based agricultural education teachers.

### **Methods**

The Delphi method was used to determine the perceived metal fabrication knowledge and skills areas needed by beginning SBAE teachers as determined by identified experts. The Delphi method is a process by which a panel of experts is convened to provide informed judgment toward consensus on a specific topic (Delp, Thesen, Motiwalla, & Seshadri, 1977). The purpose of a Delphi panel is to collect responses from a group of experts and combine the responses into a useful statement (Stitt-Gohdes & Crews, 2004). In agricultural education, Martin and Frick (1998) noted that this method is effective when planning curriculum. Delphi studies reduce the negative impacts of the bandwagon effect of majority opinion, persuasiveness of opinionated individuals, the vulnerability of group dynamics to group manipulation, and the unwillingness of individuals to abandon publicly stated opinions (Isaac & Michael, 1987).

Delphi studies employ a series of questionnaires to collect data from the expert panel (Isaac & Michael, 1987). Prior to data collection, experts are identified and selected due to their knowledge in the subject matter being explored. For this study, purposeful sampling was used to select members for the panel of experts. Purposeful sampling can be defined as “a qualitative sampling procedure which researchers intentionally select individuals and sites to learn or understand the central phenomenon” (p. 359). Dalkey (1969) noted, for a Delphi instrument to be reliable (.70 or greater), a panel of experts must consist of 11 or more members. However, a panel size of 13 is needed for an instrument to be reliable with a correlation coefficient of .90 (Dalkey, Rourke, Lewis, & Snyder, 1972). To ensure the reliability of this instrument, 24 panelists were selected and solicited to serve on the panel for this study.

The participants for this study included those college and university faculty members who taught metal fabrication courses as part of an agricultural education department or program. Teacher educators were selected as the experts in this study based upon their knowledge of the methods used to teach metal fabrication along with the technology currently located in preservice teacher programs and their alignment with the curriculum taught at the secondary level. To ensure a representative sample across the AAAE membership, eight faculty members were selected from each region (North Central, Southern, & Western). All panelists were deemed proficient with the entry level metal fabrication knowledge required of beginning SBAE teachers. Of the 24 faculty invited, 16 accepted and returned the initial instrument. Thirteen completed the second and third round questionnaires.

This Delphi study employed three rounds and was initiated through an email detailing the process and anticipated timeline. The entire study was conducted electronically, using a web-based data collection service, as the panelists were located throughout the United States. Each round was

closed after 21 days, and data collection was closed after 63 days. IBM SPSS Statistics Version 22 was used to create frequency tables. Upon collecting data from round one, variables were recoded to combine *Strongly Agree*, and *Very Strongly Agree* to examine the percentage of overall agreement among the panelists. Consensus was defined *a priori* as two-thirds strong agreement or very strong agreement on a seven-point Likert-type scale. Validity of the content analysis was conducted by experts including a teacher educator, two secondary SBAE teachers, and an agricultural systems management faculty member.

The first round consisted of one open-ended question that asked the panel members to list the metal fabrication knowledge and skill areas that a beginning SBAE teacher should possess prior to starting a career in secondary agricultural education. Upon closing data collection for round one, the research team identified an initial list of 68 statements. Similar concepts were combined and resulted in 44 knowledge and skill areas. These areas were then used to develop the second questionnaire and can be found in Table 1.

In round two, the consolidated needs identified in round one were provided alongside a Likert-type scale and the panelists were prompted to indicate their level of agreement or disagreement to each identified need. The Likert-type scale was constructed with seven-points ranging from 1 (*Very Strongly Disagree*) to 7 (*Very Strongly Agree*). The panel was also asked to revisit the complete list of consolidated needs from round one and provide additional needs that were missing from the list. The same data analysis process used in round one was repeated to analyze the additional suggestions. Consensus was defined *a priori* as items that achieved two-thirds consensus of *Strongly Agree*, or *Very Strongly Agree*.

The 19 items which met the two-thirds threshold from round two were retained for round three to finalize consensus among the panelists. Results from round three revealed eight items received two-thirds consensus, while eleven areas were dropped. Based upon the panel's level of agreement with the areas in round three, the researchers determined to cease data collection and no future rounds were conducted.

## Results

In round one, 16 panelists (66% response rate) identified 68 statements of metal fabrication knowledge and skills a beginning teacher should possess prior to teaching SBAE. Similar or duplicated statements were combined or eliminated while compound statements were separated (Shinn, Wingenbach, Briers, Lindner, and Baker, 2009). The statements were validated by the research team, grouped into 44 knowledge and skill areas, and were used to develop the round two questionnaire. The knowledge and skill areas from round one can be found in Table 1.

Table 1

*Results of Round 1 Metal Fabrication Knowledge and Skills Needed by Beginning SBAE Teachers*

Metal Fabrication Knowledge and Skill Areas		
Parts/components of metal fabrication equipment including, PAC, SMAW, GMAW, GTAW, FCAW, & Oxy-Fuel	Operation of metal fabrication equipment including, PAC, SMAW, GMAW, GTAW, FCAW, & Oxy-Fuel	Scientific processes of metal fabrication equipment including, PAC, SMAW, GMAW, GTAW, FCAW, & Oxy-Fuel
Evaluation rubrics	Performance assessments	Safety
Distinguishing weld joints	Welding positions	Laboratory management
Electricity principles	Fabrication techniques	Basic engineering principles
Ordering materials	Reading blueprints	Cut lists
Designing projects	Heat and distortion	Metal identification
CAD/CAM software	Reading welding schematics	Metallurgy
First Aid	Bill of materials	Sheet metal work
Cold metal work	Hot metal work	Equipment maintenance
Power and hand tools used in metal fabrication	Specialized metal work to include aluminum, cast iron and stainless steel	

The data from round one were re-distributed to the panel to seek consensus in round two. Twenty-five areas were removed from the list. The response rate for this round was 54% (n=13). The knowledge and skills in round two reaching two-thirds consensus can be found in Table 2.

Table 2

*Results of Round 2 Metal Fabrication Knowledge and Skills Needed by Beginning SBAE Teachers*

Metal Fabrication Knowledge Areas		
Parts/components of metal fabrication equipment including, SMAW, GMAW, & Oxy-fuel	Operation of metal fabrication including, SMAW, GMAW, & Oxy-fuel	Power and hand tools used in metal fabrication
Distinguishing weld joints	Welding positions	Laboratory Management
First Aid	Bill of materials	Distinguishing weld joints
Performance assessments	Evaluation rubrics	Electricity principles
Fabrication techniques	Equipment Maintenance	Ordering materials

A 54% response rate (n=13) was achieved for round three. The areas from round two, meeting the two-thirds consensus threshold, were re-distributed to the panelists in round three. The areas including *Laboratory Management, Safety, First Aid, Maintaining Equipment, and Ordering Materials*, were combined into one knowledge area for round three. The new area was labeled as *Laboratory Management – to include safety, first aid, maintaining equipment, and ordering materials*. Data collection ceased after round three and the resulting eight areas were consolidated

into four categories, *metal fabrication equipment*, *metal fabrication production*, *teaching*, and *management*. Table 3 provides a visual representation of the final list of categories including the knowledge and skill areas.

Table 3

*Categories and Areas of Metal Fabrication Knowledge and Skills Needed by Beginning SBAE Teachers*

Metal Fabrication Knowledge & Skill Categories
<i>Metal Fabrication Equipment</i>
1. Identify parts/components of welding and cutting equipment including: SMAW, GMAW, Oxy-Fuel
2. Understand the operating procedures of welding and cutting equipment including: SMAW, GMAW, Oxy-Fuel
3. Understand the proper use of power and hand tools used in metal fabrication
<i>Metal Fabrication Production</i>
4. Distinguish weld joints
<i>Table 3 Continued</i>
5. Welding positions
6. Create project bill of materials
<i>Student Assessment</i>
7. Create authentic performance assessments
<i>Laboratory Management</i>
8. Implement laboratory management plans to include: Safety First-aid Ordering materials Equipment maintenance

### Conclusions/Implications/Recommendations

A panel of experts identified eight essential metal fabrication knowledge and skill areas that beginning agricultural education teachers should possess prior to starting a career as an SBAE teacher. These knowledge skill areas ranged from metal fabrication equipment and production to student assessment and laboratory management.

After analyzing the responses from this study four main questions arose: Are preservice teacher preparation programs providing preservice teachers with the opportunities to increase and improve their metal fabrication knowledge and skills to successfully gain employment upon graduation? If the answer is yes, what strategies have teacher educators implemented to mitigate the reduction in laboratory time resulting from the decrease in credit hour requirements? If the question is no, what are the compounding issues existing in teacher education programs which prevent adequate preparation of preservice teachers? Furthermore, what professional development

opportunities exist for in-service teachers to enhance and improve their knowledge and skills in metal fabrication techniques and instruction?

As this study only took into consideration the needs of beginning SBAE teachers from the perspectives of faculty involved in teacher education, are the knowledge and skills identified by these experts relevant to the needs of secondary students who enter the workforce upon graduation? Are the graduates of SBAE programs prepared for a modern metal fabrication workforce emphasizing STEM concepts and advanced technology-related skills? How should industry-based advisory groups be implemented to aid teacher preparation programs to help modernize metal fabrication instruction to ensure employability skills of high school graduates?

Based upon the results of this study, several actions are recommended. Teacher preparation programs should use this list of knowledge and skill areas as a guide to determine if preservice teachers are being adequately educated in metal fabrication. Teacher educators should continuously monitor metal fabrication knowledge and skill needs of in-service teachers and use the resulting data to provide educational opportunities to improve teaching and learning in this area. Researchers should assess the metal fabrication technology currently located in preservice SBAE programs and ensure it aligns with the curriculum taught at the secondary level.

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