*Career and Technical Education Research, 42(2), p. 103*
*DOI: 10.5328/cter42.2.103*


# A Cross-sectional Analysis of the Importance of Agricultural Mechanics Skills Taught

**John R. Rasty**
*Sherrard High School*

**Ryan G. Anderson**
*Sauk Valley Community College*

## Abstract

*In 1994, Laird conducted a study using secondary agricultural education teachers across the United States to determine the depth agricultural mechanics skills were being taught at the time, and how important those skills would be in 2004. The researchers conducted a follow up study in 2016, using secondary agricultural education teachers in Iowa as the population. This research compares the findings from both Laird, and the researchers to form a cross-sectional comparison spanning 32 years between the depth skills that were taught in 1994 and the predicted importance of those skills in 2026. Findings from this study show that the overall depth of secondary agricultural mechanics instruction has decreased, but the importance to teach said skills is increasing. Teachers should use this information to prioritize the skills in their curriculum so that the skills with the most perceived importance are being taught in the greatest depth.*

*Keywords:* Agricultural Education, Agricultural Mechanics, Teacher Training

## Introduction

Today's employers are seeking employees with 21st Century skills (National Research Council, 2012), and agricultural education plays a crucial role in incorporating and developing these skills (National Research Council, 2009). Agricultural education has proven to be a powerful tool in helping students apply Science, Technology, Engineering, and Mathematics (STEM) skills into real-world situations (Ricketts, Duncan, & Peake, 2006; Shultz, Anderson, Shultz, & Paulsen, 2014). Contrary to the concern noted by Buriak (1992), Miller (1991) posited that agricultural mechanics "is a scientific based curriculum which provides the ideal setting to apply selected principles of physics, chemistry, and mathematics" (p. 4). Specifically, in agricultural mechanics, research has shown that secondary agricultural education instructors integrate mathematics content into 23% of their lessons (Anderson & Driskill, 2012).

Data collected from Connors and Mundt (2001) showed agricultural education teacher preparation program's credit requirements for technical agriculture to be 43.4 credits. Burris, Robinson, and Terry (2005) reported the credit requirement specifically related to agricultural mechanics was 9.13, which was slightly higher than the average of 7.3 agricultural mechanics credits required at teacher preparation institutions between 1992 and 1995 (Hubert & Leising, 2000). However, McKim and Saucier (2011) noted a reduction in required agricultural mechanics courses among universities. Byrd, Anderson, Paulsen and Shultz (2015) reported that approximately 29% of agricultural education teachers in Iowa had taken only one post-secondary course in agricultural mechanics and nearly 35% had not taken any post-secondary agricultural mechanics courses, yet active teachers maintained a sense of competence in their agricultural mechanics instruction. Contrary to the competence felt by current teachers, 83.3% of Iowa preservice teachers taught agricultural mechanics content during their student teaching experience, yet still felt unprepared to teach agricultural mechanics content (Stripling, Thoron, & Estepp, 2014). Burris, McLaughlin, McCulloch, Brashears, and Fraze (2010) identified agricultural mechanics as an area of concern among beginning teachers but deemed that over a five-year period agricultural mechanics often became a course that teachers felt confident teaching. In addition to feeling unprepared to teach, McCubbins, Wells, Anderson, & Paulsen (2017) also found many secondary agricultural mechanics facilities to be inadequately equipped with the tools necessary to teach effectively.

Despite a lack of post-secondary agricultural mechanics training received by teachers, and uncertainty regarding teachers' perceptions of their own competence to teach the subject, agricultural mechanics remains popular among secondary programs and their students (Herren, 2015). Rudolphi and Retallick (2011) found that nearly 90% of the agricultural education teachers in Iowa included some form of agricultural mechanics instruction into the curricula. In several states, secondary agricultural education teachers averaged two agricultural mechanics courses taught per semester (Hoerner & Bekkum, 1990). Byrd, Anderson, and Saucier (2016) found that, on average, agricultural education teachers dedicated 7.48 hours to agricultural mechanics laboratory instruction per week. Students enrolled in agricultural mechanics courses can explore a vast array of agricultural mechanic skills, which are needed in many careers related to agriculture which will prove valuable over a lifetime (Herren, 2015; Shultz, et al., 2014). Regardless of the variety of skills to which students are exposed to during their secondary education, if skills are not learned in preparation for a progressive and rapidly changing future, their learning may be for naught (Davis & Jayaratne, 2015). In order to effectively prepare students for college and career readiness, educational leaders must continue to look towards the future.

In 1994, Laird began to question the relevance of the skills taught in agricultural mechanics at the time. By examining the depth in which secondary agricultural education teachers across the United States taught individual agricultural mechanics skills, he was able to identify skills deemed most important to teach at the secondary level. Laird (1994) also asked the respondents to use their personal knowledge and connections with industry to predict the level of importance those same agricultural mechanics skills would hold in 2004, (ten years into the future). Utilizing the gathered insight into the future of agricultural mechanics allowed teacher education to design their instruction appropriately to meet the upcoming workforce needs.

More recently, we sought to follow up on the data collected by Laird (1994). We narrowed the scope to secondary agricultural programs in Iowa to generate results which could be more accurately utilized by educational programs in the area for agricultural mechanics curriculum design and professional development training purposes. McKim and Saucier (2011) recommended a longitudinal study of "in-service secondary agricultural education teachers' perceived importance of agricultural mechanics laboratory management competencies" (p. 84). By combining our data with that collected by Laird (1994), a broad, longitudinal view of the trends regarding the importance of secondary agricultural mechanics skills can be observed. This study analyzed the depth at which agricultural mechanics skills were taught in 1994 compared to 2016, the predicted importance of agricultural mechanics skills in 2004 compared to the predicted importance of skills in 2026, and compares the predicted importance of agricultural mechanics skills in 2004 with the depth those skills were taught in 2016.

Comparing the data from the past with current results will help researchers determine the accuracy of the predictions made by secondary agricultural education teachers. This information could then lead to establishing a comprehensive list of the depth at which individual agricultural mechanics skills should be taught to educate students in the most efficient and purposeful manner possible. If secondary agricultural education teachers are currently not teaching skills as in depth as they feel are important, the barriers causing the lack of depth should be identified. In the context of factors influencing teachers' decisions to integrate technologies into their teaching, Buabeng-Andoh (2012), discussed many barriers, which may prevent a teacher from adopting new information or technology. Among the barriers discussed were the teachers' attitudes, knowledge, skill level, and support and funding from the school, all of which could have a similar impact on secondary agricultural mechanics programs.

## Conceptual Framework

The conceptual framework used in this study was derived from Roberts and Ball (2009) and can be seen in Figure 1. As described in this model, agricultural education programs deliver content through a combination of social and cognitive constructivism. Through this epistemology, curriculum can be delivered to meet the individual needs of students, whether they remain in the agricultural workforce or not. Roberts and Ball (2009) posited that agricultural education teachers reinforce learning through hands-on interactions resulting in two outcomes: a skilled agricultural workforce, and successful lifelong learners that are agriculturally literate citizens. The curriculum used by agricultural education teachers is crucial to generating the aforementioned outcomes. At the very root of this model is the idea that secondary agricultural education teachers use industry-validated curricula. In this study, secondary agricultural education teachers determined the depth agricultural mechanics skills are taught and to predict the future importance of agricultural mechanics skills based on the idea that they maintain connections with industry leaders to teach valid curricula.

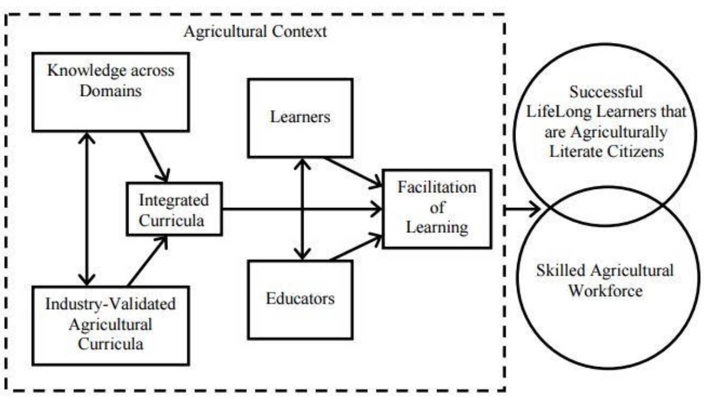


*Figure 1.* Conceptual model for agricultural subject matter as a content and context for teaching. (Roberts & Ball, 2009, p. 87). Reprinted with author permission.

## Purpose and Objectives

The purpose of this study was to describe trends regarding the importance of secondary agricultural mechanics skills. This research purpose aligns with the American Association for Agricultural Education National Research Agenda (Roberts, Harder, & Brashears, 2016) Research Priority 3, which calls to determine the competencies needed for a viable agriculture workforce. This study also aligns with Research Priority Areas 2: Curricula and Program Planning, specifically Research Objective 2.1: Curricula Designs, under Research Activity 2.2.1: Needs of Future Workforce (Lambeth, Elliot, & Joerger, 2008). The objectives for this study were as follows:

1. Determine the change in the depth of agricultural mechanics skills taught in the U.S. in 1994 and in Iowa in 2016.
2. Determine the change in perceived importance of agricultural mechanics skills in the U.S. in 2004 and in Iowa in 2026.
3. Analyze the difference in past U.S. secondary agricultural education teachers' predictions about the future importance of secondary agricultural mechanics skills and the depth agricultural mechanics skills are currently being taught in [STATE].

## Methods

This descriptive, non-experimental, quantitative study used a Cross-sectional approach to describe the perceptions of secondary agricultural education teachers regarding the importance of secondary agricultural mechanics skills. Our study and that of Laird (1994) were used to compare data collected over a 22-year span. Laird (1994) utilized a sample survey technique with secondary agricultural education teachers across the United States (*n* = 253). We used a census survey modified from the survey used by Laird (1994) to collect data from secondary agricultural education teachers in Iowa (*n* = 64).

Laird's (1994) instrument included 60 skills in nine constructs appropriate for inclusion in secondary agricultural mechanics curricula. One skill identified by Laird (1994), Oxy-Acetylene Welding and Cutting, could not be included in this study because when the instrument was modified Oxy-Acetylene Welding and Oxy-Acetylene Cutting were divided into two separate skills. The instruments designed by Laird (1994) consisted of nine constructs; *Carpentry and Woodworking, Metal Processes and Metalworking, Electrical Power, Farm Structures, Farm Power and Machinery, Soil and Water Management, Safety, Computer and Problem Solving,* and one construct (*Other*) consisted of skills that did not fit in any of the other constructs. To determine face validity, Laird (1994) had the instrument reviewed by his major professor and other graduate students in the Department of Agricultural Education and Studies at Iowa State University. The instrument was then pilot tested using a random sample of 20 secondary agricultural education teachers in [STATE]. Using Cronbach's alpha, the "overall reliability coefficient was 0. 97" (Laird, 1994, p. 42).

Laird's instrument was then revalidated in 2015 by a panel of eight experts who were agricultural education faculty members with backgrounds in agricultural mechanics at different institutions across the United States. Fink (1995) indicated that 10 people are typically needed to field test an instrument. To confirm the reliability of the instrument, another pilot study was conducted in 2016 using ten secondary agricultural education teachers from an adjoining state (*n = 10*). Following the pilot study, reliability was calculated using Cronbach's alpha ($\alpha = 0.92$) which was determined to be highly reliable (Ary, Jacobs, Razevieh, & Sorensen, 2006). It should be noted that the researchers did not have access to the raw data from the 1994 study. Therefore, a limitation exists on the statistical analysis that could be conducted in this study.

The researchers asked respondents to evaluate a set of agricultural mechanics skills using a nine-point summated double-matrix rating scale. The double-matrix allowed respondents to answer twice; first rating the depth at which they currently teach each skill (1 = *no depth*, 3 = *little depth*, 5 = *some depth*, 7 = *much depth*, 9 = *utmost depth*), and secondly rating the importance they perceive each skill to have in secondary agricultural education in 2026 (1 = *not important*, 3 = *of little importance*, 5 = *somewhat important*, 7 = *important*, 9 = *very* important). As a result, data collected showed the depth secondary agricultural mechanics skills were taught in 1994, the importance teachers believed those skills would have in 2004 (Laird, 1994), and the depth those skills were taught in 2016 as well as the importance of those skills in 2026.

To analyze trends relating to the importance of the agricultural mechanics skills included in this study, three major comparisons were analyzed. First, we looked at the change in mean score ratings each skill received for the depth they were taught in 1994 and the depth those same skills were taught in 2016. This comparison shows what changes have occurred in the level of depth agricultural mechanics skills were taught over a 22-year period. Next, we compared teachers' future perceptions of the importance of each skill by looking at what teachers in 1994 thought each skill's importance would be in 2004, and what teachers thought importance would be in 2026. Comparing these two categories gives insight into the changes in future perceptions of the importance of agricultural mechanics. Lastly, we compared the mean score for each of the skills from what the 1994 teachers thought would be important in 2004 with the depth teachers were teaching those skills in 2016. This comparison shows us, within a 12-year period, how teachers' perceptions of the importance of agricultural mechanics skills differs from the depth teachers are actually teaching those skills. Two tables were utilized for each of the three major comparisons. The first table shows the grand mean scores for each construct during the two time periods in question, as well as the change in grand mean scores. The second table shows the mean scores for each skill during the two time periods in question, as well as the change in mean scores.

## Results

The first objective of this study was to determine the change in the depth of agricultural mechanics skills taught from 1994 to 2016. Table 1 shows each construct's grand mean scores from Laird (1994) and from this study. Constructs are arranged in order of greatest positive change in mean score to least positive change in mean score. Table 1 indicates that all constructs are taught in less depth than what they were taught in 1994. Computers and Problem Solving ($\Delta M$ = -0.52) showed the least change in mean scores while Others ($\Delta M$ = -2.46) showed the greatest change in mean scores.

Table 2 compares the data collected from Laird (1994) with the data collected by the researchers. This comparison shows the depth secondary agricultural education teachers from across the United States taught each skill in 1994 in relation to the depth secondary agricultural education teachers taught each skill in 2016. In this comparison, four skills (Metric System, Robotics, Problem Solving Strategies, and Farmstead Layout) resulted in positive changes in mean scores between 1994 and 2016, while 55 skills resulted in a negative change in mean scores. The four skills with the greatest negative change in mean scores were

Brazing, Painting and Preserving, Careers, and Cooperation and Teamwork. The top ten and bottom ten average change in mean scores were reported in Table 2.

Table 1

*Construct Grand Mean Scores for the Current Depth Agricultural Mechanics Skills were Taught in the U.S. in 1994* (*n ranges from 224 to 240*), *and in Iowa in 2016 (n = 64)*

| Construct | 1994 *M* | 1994 *SD* | *n* | 2016 *M* | 2016 *SD* | *Δ M* |
|---|---|---|---|---|---|---|
| Computers and Problem Solving | 3.73 | 1.90 | 62 | 3.21 | 1.48 | -0.52 |
| Metal Processing and Metalworking | 4.46 | 1.69 | 63 | 3.57 | 1.72 | -0.89 |
| Carpentry and Woodworking | 5.81 | 2.16 | 63 | 4.90 | 2.21 | -0.91 |
| Safety | 6.62 | 1.73 | 62 | 5.70 | 2.03 | -0.92 |
| Farm Structures | 3.95 | 1.87 | 63 | 2.99 | 1.73 | -0.96 |
| Soil and Water Management | 3.44 | 2.09 | 60 | 2.38 | 1.37 | -1.06 |
| Electrical Power | 4.42 | 2.22 | 63 | 3.32 | 2.05 | -1.10 |
| Farm Power and Machinery | 3.87 | 1.90 | 62 | 2.59 | 1.64 | -1.28 |
| Others | 5.36 | 1.85 | 62 | 2.90 | 0.74 | -2.46 |

(1 = *no depth*, 3 = *little depth*, 5 = *some depth*, 7 = *much depth*, 9 = *utmost depth*)

Table 2

*The Depth Secondary Agricultural Mechanics Skills Taught Across the United States in 1994* (*n ranges from 224 to 240*), *and Currently Taught in Iowa (n = 64)*

| Instructional Topic | 1994 *M* | 1994 *SD* | *n* | 2016 *M* | 2016 *SD* | *Δ M* |
|---|---|---|---|---|---|---|
| Metric System | 2.91 | 2.32 | 61 | 3.43 | 2.12 | 0.52 |
| Robotics | 2.01 | 2.07 | 60 | 2.12 | 1.91 | 0.11 |
| Problem Solving Strategies | 5.27 | 2.73 | 61 | 5.33 | 2.34 | 0.06 |
| Farmstead Layout | 3.02 | 2.12 | 62 | 3.05 | 2.37 | 0.03 |
| GMAW Welding (MIG) | 5.45 | 2.92 | 62 | 5.44 | 2.98 | -0.01 |
| TIG Welding | 3.17 | 2.71 | 62 | 3.13 | 2.57 | -0.04 |
| Plastic Welding | 1.73 | 1.75 | 62 | 1.61 | 1.45 | -0.12 |
| CPR and First Aid | 4.40 | 2.99 | 62 | 4.21 | 2.44 | -0.19 |
| Computer Usage in Ag Mechanics | 3.81 | 2.65 | 62 | 3.60 | 2.32 | -0.21 |
| Metal Machining | 2.73 | 2.23 | 63 | 2.48 | 2.05 | -0.25 |
| Small Gasoline Engines | 5.85 | 2.57 | 62 | 4.13 | 2.88 | -1.72 |
| SMAW Welding (Stick/Arc) | 6.84 | 2.35 | 62 | 5.10 | 2.91 | -1.74 |
| Preventive Maintenance | 5.46 | 2.61 | 60 | 3.72 | 2.68 | -1.74 |
| Surveying | 4.49 | 2.68 | 60 | 2.73 | 2.08 | -1.76 |
| Plumbing | 4.24 | 2.51 | 61 | 2.48 | 1.87 | -1.76 |
| Brazing | 5.20 | 2.47 | 61 | 3.08 | 2.67 | -2.12 |
| Painting and Preserving | 4.26 | 2.52 | 61 | 2.10 | 1.01 | -2.16 |
| Careers | 6.26 | 2.31 | 62 | 3.53 | 1.00 | -2.73 |
| Cooperation and Teamwork | 6.90 | 2.27 | 62 | 3.84 | 0.93 | -3.06 |

(1 = *no depth*, 3 = *little depth*, 5 = *some depth*, 7 = *much depth*, 9 = *utmost depth*)

The second objective of this study was to determine the change in perceived importance of agricultural mechanics skills in the U.S. in 2004 and in Iowa in 2026. Table 3 shows each construct's grand mean scores from Laird (1994) and from this study. Constructs within Table 3 are arranged in order of greatest positive change in mean scores to least positive change in mean scores. Table 3 indicates that the Farm Structures, and Soil and Water Management constructs saw the greatest positive change in mean scores (*ΔM* = 0.40*)*, while the construct consisting of remaining skills, Others, saw the most negative change in mean scores *(ΔM* = -2.33).

Table 3

*Construct Grand Mean Scores for the Perceptions of the Importance of Secondary Agricultural Mechanics Skills Ten Years into the Future from Teachers Across the United States in 2004* (*n ranges from 224 to 240*) *and in Iowa in 2026(n = 64)*

| Construct | 2004 | | 2026 | | | |
|---|---|---|---|---|---|---|
| | *M* | *SD* | *n* | *M* | *SD* | *Δ M* |
| Farm Structures | 5.29 | 1.90 | 61 | 5.69 | 1.81 | 0.40 |
| Soil and Water Management | 4.72 | 2.20 | 58 | 5.12 | 2.01 | 0.40 |
| Farm Power and Machinery | 5.31 | 1.94 | 60 | 5.57 | 1.99 | 0.26 |
| Computers and Problem Solving | 5.85 | 2.06 | 60 | 6.07 | 1.79 | 0.22 |
| Electrical Power | 5.90 | 2.15 | 61 | 6.05 | 2.04 | 0.15 |
| Carpentry and Woodworking | 6.44 | 1.95 | 61 | 6.44 | 1.83 | 0.00 |
| Metal Processing and Metalworking | 5.59 | 1.72 | 61 | 5.59 | 1.85 | 0.00 |
| Safety | 7.78 | 1.40 | 61 | 7.75 | 1.38 | -0.03 |
| Others | 6.16 | 1.75 | 60 | 3.83 | 0.72 | -2.33 |

(1 = *not important*, 3 = *of little importance*, 5 = *somewhat important*, 7 = *important*, 9 = *very* important)

Table 4 compared Laird's data from 1994, which asked secondary agricultural education teachers from across the United States to rate the level of importance they perceived each skill would hold in 2004 with current data that asked secondary agricultural education teachers in Iowa in 2016 to rate the level of importance they perceived each skill would hold in 2026. Table 4 shows that all but 20 skills yielded a positive change in mean scores between the 2004 predictions and predictions for 2026. The skills with the greatest positive changes in mean scores were Fencing, Robotics, Transmissions, and Farmstead Layout, while the skills with the greatest negative changes in mean scores were Shop Layout, Painting and Preserving, Careers, and Cooperation and Teamwork. The top ten and bottom ten average change in mean scores were reported in Table 4.

Table 4

*Perceptions of the Importance of Secondary Agricultural Mechanics Skills Ten Years into the Future from Teachers Across the United States in 1994* (*n ranges from 224 to 240*) *and in Iowa in 2016 (n = 64)*

| Instructional Topic | 2004 | | | 2026 | | |
|---|---|---|---|---|---|---|
| | *M* | *SD* | *n* | *M* | *SD* | *Δ M* |
| Fencing | 3.44 | 4.15 | 59 | 4.93 | 2.47 | 1.49 |
| Robotics | 4.52 | 2.94 | 58 | 5.91 | 2.47 | 1.39 |
| Transmissions | 3.99 | 2.54 | 59 | 5.17 | 2.37 | 1.18 |
| Farmstead Layout | 4.14 | 2.49 | 59 | 5.29 | 2.40 | 1.15 |
| Metric System | 4.72 | 2.91 | 59 | 5.75 | 2.28 | 1.03 |
| Drive Trains | 4.06 | 2.54 | 58 | 5.07 | 2.38 | 1.01 |
| Metalworking Project Design | 5.54 | 2.29 | 60 | 6.48 | 2.02 | 0.94 |
| Metal Machining | 4.03 | 2.58 | 60 | 4.87 | 2.49 | 0.84 |
| Sheet Metalworking | 3.88 | 2.39 | 61 | 4.64 | 2.59 | 0.76 |
| Irrigation Structures | 4.21 | 2.80 | 58 | 4.90 | 2.25 | 0.69 |
| Safety Clothing, Protective Devices | 8.25 | 1.42 | 60 | 7.90 | 1.61 | -0.35 |
| Computer Usage in Ag Mechanics | 6.72 | 2.38 | 59 | 6.36 | 2.04 | -0.36 |
| Shop and Tool Safety | 8.36 | 1.35 | 59 | 7.85 | 1.51 | -0.51 |
| Small Gasoline Engines | 6.43 | 2.30 | 59 | 5.92 | 2.03 | -0.51 |
| Brazing | 5.70 | 2.22 | 59 | 5.17 | 2.51 | -0.53 |
| SMAW Welding (Stick/Arc) | 6.98 | 2.13 | 60 | 6.33 | 2.23 | -0.65 |
| Shop Layout | 4.49 | 2.66 | 58 | 3.29 | 1.11 | -1.20 |
| Painting and Preserving | 5.32 | 2.50 | 59 | 3.19 | 1.11 | -2.13 |
| Careers | 7.33 | 1.93 | 59 | 4.32 | 0.80 | -3.01 |
| Cooperation and Teamwork | 7.63 | 2.01 | 60 | 4.48 | 0.65 | -3.15 |

(1 = *not important*, 3 = *of little importance*, 5 = *somewhat important*, 7 = *important*, 9 = *very* important)

The third objective of this study was to compare perceptions regarding the future importance of secondary agricultural mechanics skills from teachers in 1994 with the current depth those skills are currently being taught. Table 5 shows each construct's grand mean scores from Laird (1994) and from this study. Constructs within Table 5 are arranged in order of greatest positive change in mean scores to least positive change in mean scores. All constructs in Table 5 have seen a negative change in mean scores. The least negative change in mean scores was seen in Carpentry and Woodworking (*ΔM* = -1.54), and the most negative change in mean scores was in the construct made up of remaining skills, Others (*ΔM* = -3.26).

Table 5

*Construct Grand Mean Scores for the Perceptions of the Importance of Secondary Agricultural Mechanics Skills Ten Years into the Future from Teachers Across the United States in 1994 (n ranges from 224 to 240) and the Current Depth Those Skills were Taught in Iowa in 2016 ( n = 64)*

| | 2004 | | 2016 | | | |
|---|---|---|---|---|---|---|
| Construct | *M* | *SD* | *n* | *M* | *SD* | *Δ M* |
| Carpentry and Woodworking | 6.44 | 1.95 | 63 | 4.90 | 2.21 | -1.54 |
| Metal Processing and Metalworking | 5.59 | 1.72 | 63 | 3.57 | 1.72 | -2.02 |
| Safety | 7.78 | 1.40 | 62 | 5.70 | 2.03 | -2.08 |
| Farm Structures | 5.29 | 1.90 | 63 | 2.99 | 1.73 | -2.30 |
| Soil and Water Management | 4.72 | 2.20 | 60 | 2.38 | 1.37 | -2.34 |
| Electrical Power | 5.90 | 2.15 | 63 | 3.32 | 2.05 | -2.58 |
| Computers and Problem Solving | 5.85 | 2.06 | 62 | 3.21 | 1.48 | -2.64 |
| Farm Power and Machinery | 5.31 | 1.94 | 62 | 2.59 | 1.64 | -2.72 |
| Others | 6.16 | 1.75 | 62 | 2.90 | 0.74 | -3.26 |

(1 = *no depth*, 3 = *little depth*, 5 = *some depth*, 7 = *much depth*, 9 = *utmost depth*)
(1 = *not important*, 3 = *of little importance*, 5 = *somewhat important*, 7 = *important*, 9 = *very* important)

Table 6 utilizes the predictions made by secondary agricultural education teachers in 1994 about the future importance of each agricultural mechanics skill in 2004 (Laird, 1994) and compares those predictions with the depth secondary agricultural education teachers in Iowa taught those same skills in 2016. The skills with the greatest positive change in mean scores were Safety Clothing and Protective Devices, Shop and Tool Safety, Metalworking Project Design, and Carpentry Project Construction, while the skills with the greatest negative change in mean scores were Irrigation Structures, Plastic Welding, Surveying, and Electrical Systems and Monitoring Devices. The top ten and bottom ten average change in mean scores were reported in Table 6.

## Conclusions, Implications, and Recommendations

The purpose of this study was to describe trends regarding the importance of secondary agricultural mechanics skills. The first objective of this study was to identify trends in the depth agricultural mechanics skills were taught at the secondary level. The two skills with the highest mean change between the Depths taught in the U.S. in 1994 and in Iowa in 2016 were Metric System and Robotics. With the mathematic and technology principals required for Metric System and Robotics instruction, both of these skills can be easily integrated in a STEM-based curricula, which could be a cause for the increase in the depth taught. Furthermore, Computers and Problem Solving was the construct, which remained most constant from the Depth taught in 1994 to 2016. Based on these findings, secondary agricultural education teachers are making efforts to change the skills included in their curriculum based on technological advancements and opportunities for STEM integration. This finding is similar to that of Stubbs and Myers (2015) who reported secondary agricultural education teachers are making an effort to integrate STEM-based content into their curricula.

Table 6

*Perceptions of the Importance of Secondary Agricultural Mechanics Skills in 2004 from Teachers Across the United States in 1994 (N ranges from 224 to 240) compared to the depth Those Skills were Taught in Iowa in 2016 ( n = 64)*

| Instructional Topic | 2004 | | 2016 | | | |
|---|---|---|---|---|---|---|
| | *M* | *SD* | *n* | *M* | *SD* | *Δ M* |
| Safety Clothing and Protective Devices | 4.43 | 1.42 | 62 | 6.63 | 2.34 | 2.20 |
| Shop and Tool Safety | 4.26 | 1.35 | 62 | 6.45 | 2.65 | 2.19 |
| Metalworking Project Design | 3.44 | 2.29 | 62 | 4.74 | 2.44 | 1.30 |
| Carpentry Project Construction | 4.06 | 2.27 | 63 | 5.08 | 2.39 | 1.02 |
| Power Tools | 4.21 | 2.07 | 63 | 5.22 | 2.64 | 1.01 |
| SMAW Welding (Stick/Arc) | 4.11 | 2.13 | 62 | 5.10 | 2.91 | 0.99 |
| Carpentry Project Design | 4.14 | 2.34 | 63 | 4.78 | 2.23 | 0.64 |
| Hand Tools | 3.88 | 2.24 | 63 | 4.52 | 2.42 | 0.64 |
| Problem Solving Strategies | 5.00 | 2.49 | 61 | 5.33 | 2.34 | 0.33 |
| Metal Grinding | 4.52 | 2.31 | 63 | 4.17 | 2.26 | -0.35 |
| Manual and Catalog Usage | 6.72 | 2.54 | 61 | 2.77 | 2.36 | -3.95 |
| Robotics | 6.15 | 2.94 | 60 | 2.12 | 1.91 | -4.03 |
| Machinery Management | 6.43 | 2.56 | 61 | 2.36 | 2.05 | -4.07 |
| Careers | 7.63 | 1.93 | 62 | 3.53 | 1.00 | -4.10 |
| Drive Trains | 5.78 | 2.54 | 60 | 1.63 | 1.29 | -4.15 |
| Applied Physics | 7.80 | 2.86 | 59 | 3.34 | 2.24 | -4.46 |
| Irrigation Structures | 6.98 | 2.80 | 60 | 2.02 | 1.72 | -4.69 |
| Plastic Welding | 6.62 | 2.85 | 62 | 1.61 | 1.45 | -5.01 |
| Surveying | 8.25 | 2.50 | 60 | 2.73 | 2.08 | -5.52 |
| Electrical Systems and Monitoring Devices | 8.36 | 2.67 | 61 | 1.87 | 1.70 | -6.49 |

(1 = *no depth*, 3 = *little depth*, 5 = *some depth*, 7 = *much depth*, 9 = *utmost depth*)
(1 = *not important*, 3 = *of little importance*, 5 = *somewhat important*, 7 = *important*, 9 = *very* important)

The remaining 55 skills in Table 2 saw a negative change in depths taught in the U.S. in 1994 and in Iowa in 2016, meaning they are taught in less depth in Iowa than what they were taught 22 years ago in the U.S. Even so, according to our data current teachers believe all 59 skills will be more important in the future. Additionally, each construct in Table 1 saw a negative change in mean scores. It is possible that due to the reduced post-secondary training requirements in the early-to-mid 1990s (Burris, et al., 2005; Byrd et al., 2015; Connors & Mundt, 2001), the current depth at which these skills are being taught at the secondary level has diminished. The current lack of instructional depth could be a result of the educators responsible for delivering the content not receiving proper agricultural mechanics training during their post-secondary training. Skills may also be currently taught in less depth due to programs having inadequate tools (McCubbins et al., 2017). Having inadequate equipment makes it very difficult to teach agricultural mechanics skills at the depth secondary teachers deem necessary.

The second objective of this study was to determine future trends in secondary agricultural mechanics skill's levels of importance in ten years. Table 4 shows that 39 of the 59 skills and seven of the nine constructs were rated as having a higher future importance by Iowa teachers active in 2016 than the ratings received by U.S. teachers in 1994. This aligns well with the researcher's initial findings, which showed that teachers perceived each of the 59 skills to be more important in the future. In general, it would seem that current agricultural education teachers in Iowa are optimistic about the important role agricultural mechanics will play in their programs. This also corresponds with the suggestion made by Davis and Jayaratne (2015) that it is important for students to be prepared with new century skills to "be competitive in the globalizing work place" (p. 54). Table 1 through Table 4 shows that teachers' perceptions of the future importance of agricultural mechanics skills has increased overall, yet the depth they are teaching these skills has decreased. Alarmingly, this shows that the gap between what the teachers think should be taught and what is truly being taught is widening. For this reason, it is important for teachers to continue evaluating the purpose behind what they are teaching. Is their current curriculum based on teaching skills they are comfortable with, skills for which they have adequate equipment, or is their curriculum based on what is most important for their students to know?

Objective 3 sought to compare perceptions regarding the future importance of secondary agricultural mechanics skills from teachers in 1994 compared to the current depth those same skills are taught. Interestingly, 50 skills in Table 6 and all nine constructs in Table 5 saw a negative change in mean scores between the predicted importance to teach the skills in 2004 and the depth those skills were taught in 2016. Results from Table 5 and Table 6 show that the teachers' optimistic views in 1994 have not been realized in 2016. This leads researchers to conclude that secondary agricultural mechanics taught in Iowa is taught in less depth overall in 2016 than what was predicted by teachers in 1994. In both this study and the study conducted by Laird (1994), all agricultural mechanics skills were predicted to be more important in the future than the depth they were currently being taught. Therefore, we need to determine why the depth agricultural mechanics skills are being taught does not meet the expectations from teachers in the past.

There are several possibilities as to why agricultural mechanics skills are not currently taught at the predicted depth. One key reason is that it is seemingly impossible to teach all 59 skills at more depth. Common sense would tell us that in order to teach one skill at more depth, another skill as a result will be taught in less depth due to having a limited amount of instructional time.

Based on these results, we can conclude that teachers are struggling to teach industry-validated agricultural mechanics content because the depth at which agricultural mechanics content is being taught has diminished over the past 22 years. According to the conceptual framework for this study, teachers should be working with industry to prepare a curriculum, which prepares students to be lifelong learners who are successful in the workforce (Roberts & Ball, 2009). While teachers are not able to teach all agricultural mechanics skills in a depth that fully prepares students for college or careers, at a minimum, students are being exposed to those career pathways which can lead to a student driven search for deeper content learning. Due to the decline in the depth of secondary agricultural mechanics instruction, secondary agricultural education teachers, post-secondary teacher educators, and professional development organizers need to work together with industry to ensure the curriculum being taught will be useful to students as they enter the workforce.

For future research, we recommend looking at their realistic expectations regarding the depth they will actually teach those skills by asking teachers what depth they believe they will teach agricultural mechanics skill in ten years. It is also important to continue to research why teachers believe they might not be able to teach agricultural mechanics content in the depth they believe it should be taught. By better identifying the obstacles preventing educators from teaching relevant content, teacher preparation programs will be able to better train preservice teachers with methods for overcoming the restrictive barriers whether it is ways to find funding, stretch tight budgets, or to effectively communicate with administrators.

Findings from this study imply that secondary agricultural mechanics education in Iowa is not at the level teachers from 1994 had hoped that it would be in the U.S. Despite the shortcomings in the depth agricultural mechanics skills are being taught, secondary agricultural education teachers were optimistic 22 years ago, and their optimism is even greater today that agricultural mechanics is important. Teacher preparation programs, active teachers, and industry leaders are going to have to work together and communicate effectively to prioritize the many skills included in agricultural mechanics. For future research, we recommend studying the perceptions of industry leaders and post-secondary professionals regarding what depths they believe agricultural mechanics skills should be taught, and what level of importance they believe agricultural mechanics will have in ten years. Current agricultural education teachers should utilize this data to begin preparing themselves to teach the skills, which are becoming increasingly important. Through diligent collaboration, secondary agricultural education students can experience tremendous learning opportunities that benefit themselves as well as the industries and communities in which they work.

## References


Anderson, R. G., & Driskill, C. D. (2012) Mathematics integration in agricultural mechanics courses by outstanding agricultural educators. *Journal of Agricultural Systems Technology, and Management*, *23,* 56-68.

Ary, D., Jacobs, L., Razavieh, A., & Sorensen, C. (2006). *Introduction to Research in Education.* (7th ed.). Belmont, CA: Wadsworth Publishing

Buabeng-Andoh, C. (2012). Factors influencing teachers' adoption and integration of information and communication technology into teaching: A review of the literature. *International Journal of Education and Development using Information and Communication Technology*, *8*(1), 136-155.

Buriak, P. (1992). Filling the gap in agriculture. *The Agricultural Education Magazine, (64)*, 9, 23.

Burris, S., McLaughlin, E. K., McCulloch, A., Brashears, T., & Fraze, S. (2010). A comparison of first and fifth year agriculture teachers on personal teaching efficacy, general teaching efficacy and content efficacy. *Journal of Agricultural Education*, *51*(1), 22-31. doi: 10.5032/jae.2010.01022

Burris, S., Robinson, J. S., & Terry, R. (2005). Preparation of pre-service teachers in agricultural mechanics. *Journal of Agricultural Education*, *46*(3), 23-34. doi: 10.5032/jae.2005.03023

Byrd, A. P., Anderson, R. G., & Paulsen, T. H. (2015). Does agricultural mechanics laboratory size affect agricultural education teachers' job satisfaction? *Journal of Agricultural Education, 56*(1), 6-19. doi: 10.5032/jae.2015.01006

Byrd, A.P., Anderson, R. G., Paulsen, T. H., & Shultz, M. J. (2015). Does the number of post-secondary agricultural mechanics courses completed affect teacher competence? *Journal of Agricultural Education, 56*(1), 20-31. doi: 10.5032/jae.2015.01020

Byrd, P. A., Anderson, R. G., & Saucier, R. P. (2016). Secondary agricultural education student injuries and other accidents sustained in an agricultural mechanics laboratory [Abstract]. *NACTA Journal*, *60*, 103.

Davis, R. J., & Jayaratne, K. S. U. (2015). In-service training needs of agriculture teachers for preparing them to be effective in the 21st Century. *Journal of Agricultural Education*, *56*(4), 47-58. doi: 10.5032/jae.2015.04047

Connors, J. J. & Mundt, J. P. (2001). *Characteristics of preservice teacher education programs in agricultural education in the United States*. Proceedings for the 28th Annual National Agricultural Education Research Conference, 109-118.

Fink, A. (1995). *How to sample in surveys* (Vol. 6, The survey kit). London: Sage.

Herren, R. (2015). *Agricultural mechanics: Fundamentals & applications.* (7th ed.). Cengage Learning.

Hoerner, T., & Bekkum, V. (1990). *Factors related to safety instruction in secondary mechanics programs in seven selected states.* Paper presented to the Agricultural Mechanics Special Interest Group during the 44th Annual Central States Seminar in Agricultural Education/Agribusiness. Chicago, IL.

Hubert, D. J., & Leising, J. (2000). An assessment of agricultural mechanics course requirements in agriculture teacher education programs in the United States. *Journal of Southern Agricultural Education Research*, *50*(1), 24-31.

Iowa Department of Education (2015). *FY15 Iowa high school agricultural education contract summary.* Retrieved from https://docs.google.com/viewer?a=v&pid=sites&srcid=dGVhbWFnZWQuY29tfHd3d3xneDoxNDM2ZGFhMzYzZjI1YzRm

Laird, S. C. (1994). *Present and future emphasis of secondary school agricultural mechanics programs in the United States* (Master's thesis). Iowa State University.

Lambeth, J. M., Elliot, J., & Joerger, R. M. (2008). The National Career and Technical Education Research Agenda. *Techniques*, *83*(7), 52-55.

McCubbins, O.P., Wells, T., Anderson, R. G., & Paulsen, T. H. (2017). Examining the relationship between the perceived adequacy of tools and equipment and perceived competency to teach agricultural mechanics. *Journal of Agricultural Education, 58*(2), 268-283. https://doi.org/10.5032/jae.2017.02268

McKim, B. R., & Saucier, P. R. (2011). Agricultural mechanics laboratory management professional development needs of Wyoming secondary agriculture teachers. *Journal of Agricultural Education, 52*(3), 75-86. doi: 10.5032/jae.2011.03075

Miller, G. (1991). Agricultural mechanics: A vanishing curriculum. *The Agricultural Education Magazine, (64)*, 4, 23.

National Research Council. (2009). Transforming Agricultural Education for a Changing World. Washington, DC: The National Academies Press.

National Research Council. (2012). *Education for life and work: Developing transferable knowledge and skills in the 21st Century*. Washington, DC: The National Academy Press.

Ricketts, J. C., Duncan, D. W., & Peake, J. B. (2006). Science achievement of high school students in complete programs of agriscience education. *Journal of Agricultural Education, 47*(2), 48-55. doi: 10.5032/jae.2006.02048

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

Roberts, T. G., Harder, A., & Brashears, M. T. (Eds). (2016). *American Association for Agricultural Education national research agenda: 2016-2020*. Gainesville, FL: Department of Agricultural Education and Communication.

Rudolphi, J. M., & Retallick, M. S. (2011). *Integration and needs of Iowa high school agricultural educators regarding agricultural safety and health education*. Proceeding of the 2011 American Association for Agricultural Education Research Conference *38,* 303-316.

Shultz, M. J., Anderson, R. G., Shultz, A. M., & Paulsen, T. H. (2014). Importance and capability of teaching agricultural mechanics as perceived by secondary agricultural educators. *Journal of Agricultural Education, 55*(2), 48-65. doi: 10.5032/jae.2014.02048

Stripling, C. T., Thoron, A. C., & Estepp, C. M. (2014). Learning activities utilized and readiness for the student teaching internship. *Journal of Agricultural Education, 55*(4), 148-161. doi: 10.5032/jae.2014.04148

Stubbs, E. A., & Myers, B. E. (2015). Multiple case study of STEM in school-based agricultural education. *Journal of Agricultural Education, 56*(2), 188-203. doi: 10.5032/jae.2015.02188

**Authors**

**John R. Rasty** is a Secondary Agricultural Education Teacher, Sherrard High School, 4701-176th Ave. Sherrard, IL. 61281, (309-593-2175) email: rastyj@sherrard.us

**Ryan G. Anderson** is a Professor and Chair of the Agriculture Department, Sauk Valley Community College, 173 IL. RT 2. Dixon, IL. 61021, (815-835-6279) email: ryan.g.anderson@svcc.edu

Manuscript originally submitted 07.27.2015, accepted for publication 01.05.2017, published 12.15.2017