AGRICULTURAL MECHANICS CURRICULUM FOR AGRICULTURAL SCIENCE TEACHER CERTIFICATION: A DELPHI STUDY

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Abstract

This study identified topics and competencies in Agricultural Mechanics that should be included in the teacher certification curriculum for agricultural science teachers. Identification of the topics and competencies came from secondary agricultural science teachers. These teachers where nominated as experts by the State Director of Agricultural Education. A three-round Delphi technique was the procedure used to conduct the study with a total of 30 experts being asked to participate in round one. In the first round, the panel identified 4 topic areas that should be included in a teacher certification curriculum for secondary agricultural science teachers: (1) Metal Fabrication; (2) Agricultural Structures; (3) Agricultural Power and Machinery; and (4) Soil and Water Management. Subsequent rounds produced 99 competencies within the 4 topic areas that were identified for potential inclusion in the agricultural mechanics portion of the agricultural science teacher certification program. Of the 99 competencies, two were eliminated due to lack of agreement by the panel. The 97 competencies will be validated with future studies from industry and teacher educators to determine the agricultural mechanics curriculum for teacher certification.

Introduction

Agricultural mechanics is a very important part of the agricultural industry and agricultural education (McGregor, 1997). At one time, the production agriculture curriculum guide suggested that one-quarter of the school year be devoted to teaching agricultural mechanics. Local school districts have heavily invested in the Agricultural Mechanics portion of agricultural education. Facilities, tools, and equipment for agricultural mechanics instruction are quite costly. According to Baker (1977), these two facts implied an importance for instruction in agricultural mechanization. However, one must be concerned that the curriculum is up to date and appropriate.

Educating youth and adults have never been a simple process, and with ever increasing knowledge and technology, educators have a daunting task before them. As the agricultural industry grows and becomes broader based, teacher educators in agricultural education are faced with the challenge of deciding what topics are important and the depth to which each topic should be addressed when preparing individuals to become agricultural science teachers (Slocombe, 1984).

Identification of what is to be included in the curriculum is part of an effective curriculum design. Many times, the volume of potential topics for inclusion far exceeds available space within the curriculum. In order for realistic priorities for instructional developments to occur, the curriculum planning process should involve all affected by the program. Those involved include teachers, employers, and employees (Diamond, 1989). Finch and Crunkilton (1989) indicate it is vitally important to ensure that curriculum content reflect the needs of the work force. Only current agricultural science teachers who were identified by the state supervisor of agricultural education as agricultural mechanics experts were included in this study.

Purpose and Research Questions

The purpose of this study was to identify agricultural mechanics topics and competencies that should be addressed in the preparation of secondary agricultural science teachers.

As a means of accomplishing the purpose, answers to two questions were sought:

1. What specific topics should be included in a university curriculum for students preparing to teach agricultural science?

2. For each topic identified, what competencies should students preparing to teach agricultural science possess upon obtaining certification to teach?

Methodology

A three-round Delphi technique was the principle procedure used to conduct this study. A technique suggested by Anderson and Jones (1986) was used to select the panel of experts. The state supervisor of agricultural education was used as a third party to nominate agricultural science teachers with a strong interest in agricultural mechanization. The nomination process

yielded 30 individuals who served as the high school teaching experts for this study. Additionally, the researchers compared the nominees to state FFA records to determine the extent to which those nominated had participated in agricultural mechanics events and programs. It was determined that those nominated had a high degree of participation in events such as the State Agricultural Mechanics Career Development Event thus further validating the panel's qualification as experts.

From the reviewed literature, an open-ended questionnaire consisting of two questions was developed. These questions were validated for content regarding their appropriateness to the objectives of the study by a panel of faculty and graduate students.

In Round One, the panel of 30 experts was asked to list multiple responses to each open-ended question under investigation. Frequencies and percentages were used to summarize the responses to this round. Three independent readers completed this technique on round one responses. The independent readers then met to discuss and group similar responses. Dillman's Total Design Method (1978) was used for non-response follow-up. A total response of 80% (n=24) was achieved for this round.

In Round Two, the 24 experts who responded to Round One was presented with an instrument which asked them to indicate whether the individual agricultural mechanics topics and skills generated in Round One should be included in the teacher education curriculum. The panel was asked to rate each item using a four-point Likert-type scale with 1 = "Strongly Disagree," 2 = "Disagree," 3 = "Agree," and 4 = "Strongly Agree." The scale was used to determine each panel member's level of agreement as to the inclusion of the competency in a high school agricultural communications curriculum. The researchers determined *a priori* that only those competencies receiving an 85% or higher level of agreement would be used for inclusion in the curriculum. In addition to evaluating the 91 competencies, panel members were asked to list additional competencies missed in Round One. As a result, eight more competencies were identified. Dillman's (1978) non-response follow-up procedures were followed. Nineteen of the 24 individuals responded for a total response rate of 79%. Frequencies and percentages were used to evaluate the second round responses.

Round Three served as the final round for the study. Because consensus was found on 89 items in Round Two, only eight new competencies identified in Round Two plus two items that failed to reach consensus were submitted to the panel in Round Three. Because of time constraints and because there were only ten items to evaluate, the researchers elected to conduct the final round with a telephone survey. All 24 panel members who responded in round one were called and all 24 participated in the final round. Frequencies and percentages were used to evaluate the third round responses.

Findings

Research Question 1

The open-ended question regarding what agricultural mechanics topics should be included in a teacher certification curriculum yielded 686 responses from the panel. Analysis of the responses produced the following four topic areas: (1) Metal Fabrication; (2) Agricultural Structures; (3) Agricultural Power and Machinery; and (4) Soil and Water Management. All 19 Second Round participants "Strongly Agreed" that these topics should be included.

Research Question 2

In the Second Round, as can be seen in Table 1, 77 of the 91 skills and/or competencies received 100% agreement. Ten of the 91 skills and/or competencies received 94.7% agreement and two received 89.5% agreement. The panel identified these skills and/or competencies as those that should be possessed by students upon receiving their teacher certification.

The topic area "Metal Fabrication" had 20 skills and/or competencies identified at the 100% level, two at the 94.7% level, and one at the 89.5% level. One competency, "Discuss and explain robotics in metal fabrication" failed to receive consensus with 78.9% agreement. This competency was included in Round Three.

"Agricultural Structures" had 27 skills and/or competencies that reached consensus at the 100% level. Five skills and/or competencies reached consensus at the 94.7% level. No skill and/or competency included in the "Agricultural Structures" topic area failed to reach consensus in Round Two. However, three additional items were identified by individuals in the panel and included in Round Three.

Sixteen skills and/or competencies received 100% consensus in Round Two for the topic area "Agricultural Power and Machinery." Two skills and/or competencies achieved the 94.7% level of agreement and one received the 89.5% level. "Repair transmission systems" achieved the 78.9% level of agreement and thus failed to reach consensus. This skill was included for reconsideration in Round Three.

"Soil and Water Management" had 14 skills and/or competencies that reached consensus at the 100% level. Consensus at the 94.7% level was reached by one skill. Two additional skills and/or competencies surfaced as a result of Round Two and were included in Round Three.

Table 1
Agreement levels for each competency in Round Two.

Skill and/or Competency	Topic Area	% of Agreement[a]
1. Identify metal fabrication safety procedures	Metal Fabrication	100%
2. Perform metal fabrication laboratory management skills	Metal Fabrication	100%
3. Read metal fabrication measuring equipment	Metal Fabrication	100%
4. Identify oxyfuel cylinder safety procedures	Metal Fabrication	100%
5. Perform oxyfuel cutting and welding	Metal Fabrication	100%
6. Select oxyfuel cutting and welding equipment	Metal Fabrication	100%
7. Setup oxyfuel cutting and welding equipment	Metal Fabrication	100%
8. Perform plasma arc cutting	Metal Fabrication	100%
9. Identify shielded metal arc welding (SMAW) safety procedures	Metal Fabrication	100%
10. Perform SMAW skills	Metal Fabrication	100%
11. Select SMAW electrodes	Metal Fabrication	100%
12. Adjust amperage settings for SMAW	Metal Fabrication	100%
13. Identify gas metal arc welding (MIG) and tungsten arc welding (TIG) safety procedures	Metal Fabrication	100%
14. Identify types of metals	Metal Fabrication	100%
15. Drill, tap, and thread metal	Metal Fabrication	100%
16. Operate hydraulic bending and shaping equipment	Metal Fabrication	100%
17. Select metal fabrication fasteners	Metal Fabrication	100%
18. Layout metal projects	Metal Fabrication	100%
19. Draw metal project plans	Metal Fabrication	100%
20. Use computer aided drafting for metal fabrication	Metal Fabrication	100%
21. Identify agricultural structures safety procedures	Ag Structures	100%
22. Perform agricultural structures laboratory management skills	Ag Structures	100%
23. Use measuring devices	Ag Structures	100%
24. Utilize mathematics related to agricultural structures	Ag Structures	100%
25. Identify hand and power tools	Ag Structures	100%
26. Utilize hand and power tool safety	Ag Structures	100%
27. Use hand and power tools	Ag Structures	100%
28. Identify and select fasteners for agricultural structures	Ag Structures	100%
29. Identify types of lumber	Ag Structures	100%
30. Utilize framing and roofing skills	Ag Structures	100%
31. Identify electrical safety procedures	Ag Structures	100%
32. Discuss principles of electricity	Ag Structures	100%
33. Wire electrical circuits	Ag Structures	100%

Table 1 (continued)

Skill and/or Competency	Topic Area	% of Agreement[a]
34. Operate multimeters	Ag Structures	100%
35. Discuss ventilation systems	Ag Structures	100%
36. Prepare site for concrete	Ag Structures	100%
37. Construct forms, reinforce, finish, and cure concrete	Ag Structures	100%
38. Estimate materials needed for concrete	Ag Structures	100%
39. Select and apply paints	Ag Structures	100%
40. Demonstrate painting techniques	Ag Structures	100%
41. Prepare surfaces to be painted	Ag Structures	100%
42. Install PVC plumbing	Ag Structures	100%
43. Identify plumbing tools	Ag Structures	100%
44. Plan and construct agricultural structures	Ag Structures	100%
45. Prepare bill of materials	Ag Structures	100%
46. Construct agricultural fences	Ag Structures	100%
47. Draw building plans	Ag Structures	100%
48. Identify agricultural power & machinery safety procedures	Ag Power & Machinery	100%
49. Perform agricultural power & machinery laboratory management skills	Ag Power & Machinery	100%
50. Discuss principles of engine operation	Ag Power & Machinery	100%
51. Describe safety procedures associated with small engines	Ag Power & Machinery	100%
52. Perform engine diagnostic procedures	Ag Power & Machinery	100%
53. Use engine test equipment	Ag Power & Machinery	100%
54. Describe safe operation of tractors and equipment	Ag Power & Machinery	100%
55. Identify tractor components and implements	Ag Power & Machinery	100%
56. Select power and equipment fasteners	Ag Power & Machinery	100%
57. Identify and repair bearings, seals, gaskets, tubing, and hoses	Ag Power & Machinery	100%
58. Operate, calibrate, and adjust tractors and implements	Ag Power & Machinery	100%
59. Operate computers found on tractors	Ag Power & Machinery	100%
60. Discuss pneumatic systems	Ag Power & Machinery	100%
61. Repair fuel and air intake systems	Ag Power & Machinery	100%
62. Describe ignition, charging, starting, and other electrical components	Ag Power & Machinery	100%
63. Explain heating and cooling systems	Ag Power & Machinery	100%
64. Identify soil & water management safety procedures	Soil & Water Management	100%
65. Perform soil & water management laboratory management skills	Soil & Water Management	100%

Table 1 (continued)

Skill and/or Competency	Topic Area	% of Agreement[a]
66. Describe soil & water management principles	Soil & Water Management	100%
67. Read land measurement equipment	Soil & Water Management	100%
68. Classify land	Soil & Water Management	100%
69. Perform differential leveling	Soil & Water Management	100%
70. Calculate acreage	Soil & Water Management	100%
71. Explain soil erosion principles	Soil & Water Management	100%
72. Explain irrigation principles	Soil & Water Management	100%
73. Manage water systems	Soil & Water Management	100%
74. Repair and maintain irrigation systems	Soil & Water Management	100%
75. Install waster water plumbing	Soil & Water Management	100%
76. Draw soil & water management plans	Soil & Water Management	100%
77. Utilize computer aided drafting for soil & water management	Soil & Water Management	100%
78. Perform soldering skills	Metal Fabrication	94.7%
79. Perform MIG & TIG skills	Metal Fabrication	94.7%
80. Select insulation	Ag Structures	94.7%
81. Service and repair electric motors and controllers	Ag Structures	94.7%
82. Proportion and mix concrete	Ag Structures	94.7%
83. Discuss effects of temperature on paint	Ag Structures	94.7%
84. Use computer aided drafting to design agricultural structures	Ag Structures	94.7%
85. Explain small engine theory	Ag Power & Machinery	94.7%
86. Explain hydraulic systems	Ag Power & Machinery	94.7%
87. Install irrigation systems and timers	Soil & Water Management	94.7%
88. Cut, shape, and file metal	Metal Fabrication	89.5%
89. Repair hydraulic cylinders, pumps, and motors	Ag Power & Machinery	89.5%
90. Discuss and explain robotics in metal fabrication	Metal Fabrication	78.9%
91. Repair transmission systems	Ag Power & Machinery	78.9%

[a]The percentage of individuals who gave a rating of either 3 ("Agree") or 4 ("Strongly Agree")

Table 2 shows the results of Round Three. Because only ten skills and/or competencies were included in Round Three and because the end of the school year was fast approaching, the researchers elected to collect the Round Three data by utilizing a telephone survey. Additionally, the researchers decided to attempt to collect data from all 24 experts who participated in Round One. All 24 participated in Round Three.

Round Three included the two items from Round Two that failed to achieve consensus plus eight additional items as identified by the Round Two participants. The two skills and/or competencies that failed consensus in Round Two achieved the 79.2% level of agreement and again failed to reach consensus. Of the eight additional items, six reached consensus at the 100% level and two reached consensus at the 91.7% level.

Table 2
Agreement levels for each competency in Round Three.

Skill and/or Competency	Topic Area	% of Agreement[a]
1. Weld in multiple positions	Metal Fabrication	100%
2. Layout batter boards	Ag Structures	100%
3. Demonstrate safety when using chemicals for painting	Ag Structures	100%
4. Demonstrate procedure for layout and cutting of angles	Ag Structures	100%
5. Replace bearings	Ag Power & Machinery	100%
6. Repair universal joints	Ag Power & Machinery	100%
7. Identify soil textures	Soil & Water Management	91.7%
8. Conduct subsoil percolation test	Soil & Water Management	91.7%
9. Discuss and explain robotics in metal fabrication	Metal Fabrication	79.2%
10. Repair transmissions	Ag Power & Machinery	79.2%

[a]The percentage of individuals who gave a rating of either 3 ("Agree") or 4 ("Strongly Agree")

Conclusions

The conclusions for the study are based on interpretations of data presented in the study and are restricted to the populations surveyed. Based on this information, the researchers make the following conclusions:

1. The following topic areas are appropriate for use in revising a curriculum in agricultural mechanics for university students who are preparing for teacher certification:
   - Metal Fabrication
   - Agricultural Structures
   - Agricultural Power and Machinery
   - Soil and Water Management

2. Specific skills and/or competencies where identified for each of the topic areas listed above. A total of 97 skills and/or competencies achieved a level of agreement above the 80% level. Following is a summary:
   - Metal Fabrication – 24 skills and/or competencies were identified.
   - Agricultural Structures – 35 skills and/or competencies were identified.
   - Agricultural Power and Machinery – 21 skills and/or competencies were identified
   - Soil and Water Management – 17 skills and/or competencies were identified

Recommendations

The following recommendations are based on the findings and conclusions of the study:

1. The researchers who conducted this study surveyed one of three audiences that should be considered in designing an agricultural mechanics curriculum for teacher certification. It is

recommended that representatives of industry and university agricultural mechanics experts be included in further studies to validate the results of this study. Findings from the three groups should be considered as efforts are made to update and revise what is being taught.

2. The agricultural mechanics portion of the teacher certification curriculum needs to be updated and revised. The researchers have noted some discrepancy between what is currently being taught and the results of this study. Results from this study, along with information gathered from the two additional audiences mention in the previous recommendation, can be used to insure that the curriculum is meeting the needs of communities, students, and secondary agricultural science teachers.

3. The newly updated and revised curriculum should be pilot tested to determine if changes/additions are needed.

References

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