Are Teachers Ready to Integrate Science Concepts into Secondary Agriculture Programs?

Jason Scales, Assistant Professor
University of Central Missouri

Robert Terry, Jr., Professor
Robert M. Torres, Professor
University of Missouri

Abstract

For the past two decades, the idea of integrating more science concepts into the secondary agriculture curriculum has gained support. The purpose of this study was to assess the confidence and competence of agriculture instructors to teach concepts related to science. The sample was derived from the population of agriculture instructors teaching in secondary schools of a selected Missouri. For this descriptive research, an instrument was developed to assess the instructors' perceived level of competence to teach selected grade level expectations (GLE) for science in grades 9 to 11. A second instrument, obtained from the American Board for Certification in Teacher Excellence, was used to assess the general biological science knowledge of the teachers. Agriculture instructors perceive that they are competent to teach nearly all of the selected concepts associated with the selected GLE. On the other hand, less than 10% of the teachers scored high enough on the examination to indicate proficient knowledge of biological science, raising questions regarding their competence to teach this subject matter.

Introduction

During the past 150 years, the purpose of agricultural education has gone through several metamorphoses. In 1906, Chamber's Encyclopedia stated, "Agricultural education, as at present understood, is a comprehensive term, including instruction in chemistry, geology, botany, zoology, mechanics-embracing, in short the science as well as the practice of agriculture" (as cited in Hillison, 1996. p 10). With passage of the Smith Hughes Act in 1917, the focus of agricultural education in secondary schools changed to preparing farm boys to work on the farm (Smith-Hughes Act, p. 20). After decades during which the emphasis of these programs was upon vocational and career education, interest in the integration of science into the curriculum was rekindled in the 1980s (Phipps, Osborne, Dyer, & Ball, 2007). In 1988, the Committee on Agricultural Education in Secondary Schools of the Board on Agriculture of the National Research Council (NRC) released its report, *Understanding Agriculture: New Directions for Education*. In its report, the committee proposed numerous changes that have had a lasting effect on agricultural education, including their recommendation to update the agricultural education curriculum by "addressing the sciences basic to agriculture, food, and natural resources" (NRC, p. 35). Since that time, there has been an abundance of research examining the integration of science into the agricultural education curriculum, including questions of consequent benefits from doing so. In 1989, Norris and Briers found that agriculture instructors in Texas recognized the need for change in their programs. Further, in a study conducted in 1993, agriscience instructors in Mississippi supported pilot courses in agriscience (Newman & Johnson, 1993). This same study found that guidance counselors and science instructors supported this notion, as well as the granting of science credit for such courses in Mississippi.

The *2005–2006 Annual Report on Agricultural Education* proposed the goal to establish 10,000 quality agricultural education programs in the United States by 2015 (Team AgEd, 2007). To help meet this goal, commonly referred to as 10 × 15, several initiatives were launched including the national program standards program, national curriculum content standards, and a national research agenda for agricultural education. Incorporated within these initiatives were goals to align the secondary agriculture curriculum with science standards. Specifically, the curriculum of agricultural sciences education (CASE) model was created to fit within the science, technology, engineering, and mathematics (STEM) curriculum (Team AgEd). One of the desired outcomes for the National Curriculum Content Standards Committee was to have the secondary agriculture curriculum cross-walked with national and state standards in mathematics, science, and communication arts (Team AgEd).

Research investigating the perceptions of instructors, counselors, and administrators regarding the integration of these core concepts into the agriculture curriculum was prevalent in the *Journal of Agricultural Education* between the years 1998 and 2002. Ten papers were found on the topic in a review of volumes 39 to 43 (Balschweid, 2002; Balschweid & Thompson, 2002; Chaisson & Burnett 2001; Dyer & Osborne, 1999; Johnson & Newman, 1993; Newman & Johnson, 1993; Norris & Briers, 1989; Osborne & Dyer, 1998; Thompson, 2001; Thompson & Balschweid, 1999). Newman and Johnson found that agriculture instructors enjoyed teaching a more science-based agriscience curriculum and that they believed science credit should be awarded to students completing such courses. Thompson and Balschweid found that instructors believed they were prepared to teach integrated biological sciences within the agriculture curriculum. In a different study, these same researchers found that instructors in Indiana perceived that they were prepared to teach integrated biological and physical science concepts (Balschweid & Thompson).

Although there is strong support for integrating science concepts into the agriculture curriculum, studies have also shown that there are barriers preventing integration of science concepts into the curriculum (Balschweid & Thompson, 2002; Thompson, 2001; Thompson & Balschweid, 1999; Warnick, Thompson, & Gummer, 2004). Some of the perceived barriers described in these studies include a lack of appropriate equipment; a lack of funding from federal, state, and local sources; a lack of inservice workshops; a lack of integrated science curriculum; a lack of preparation (prior to enrolling in agricultural education); a lack of science competence; and a lack of close proximity to high tech firms. Balschweid and Thompson also found that agriculture instructors were unsure about how stakeholders within their school and community would respond to the integration of sciences in the agriscience curriculum. Such concerns were addressed by other researchers. Dyer and Osborne (1999) found that counselors in schools in which applied science in agricultural education courses were taught had positive perceptions of this practice, as did students and instructors. Thompson found that high school principals responded positively to the integration of science into agricultural education programs.

The idea of awarding science credit to students who complete certain agriculture courses was recommended by the Committee on Agricultural Education in Secondary Schools (NRC, 1988). Chiasson and Burnett (2001) stated that the state of Louisiana has offered science credit in exchange for students completing two agriscience courses. A review of admission requirements found that the University of Missouri accepts agriculture classes in exchange for entrance requirements for science and economics courses (University of Missouri, 2007). Johnson (1996) found that nearly 85% of the parents polled in Arkansas supported the notion of granting science credit for agriscience courses. Johnson also found that 76% of the administrators polled in Arkansas agreed that they would support granting science credit for agriscience courses. However, as noted by Belcher, McCaslin, and Headley (1996), for such an arrangement to be successful and beneficial to students, thought must be given to the breadth and depth of science to add to the agriculture curriculum. Thompson and Balschweid (1999) and Newman and Johnson (1993) called for further research in the area of science achievement among agriscience students.

Although curriculum, support of stakeholders, and policies are important considerations related to integrating science concepts into secondary agriculture curricula, the most important factor is the teachers' willingness and ability to teach the content. Goecker (1992) expressed concern that "the scientific and technical competence of today's agriculture education graduate does not compare to his or her counterpart of the 1970s" (p. 3).

Purpose and Objectives

The purpose of this study was to assess the confidence and competence of agriculture instructors to teach science concepts. The following objectives were formulated to accomplish this purpose:

1. Describe selected personal and professional characteristics of secondary agriculture instructors.
2. Describe agriculture instructors' self-perceived competence to teach science concepts related to agriculture.
3. Describe agriculture instructors' knowledge of principles of science related to agriculture.

Procedures

The target population for this study was secondary agriculture instructors in a selected Missouri. The 447 instructors of this population were identified from the 2006-2007 state agriculture teacher directory. Because the directory is a complete and unduplicated listing of all instructors in the state, it was determined to be the best resource to substantially reduce frame error. Simple random sampling was used following procedures recommended by Ary, Jacobs and Razavieh (2002). The sample size was determined by using Krejcie and Morgan's (1970) suggestion for a population of this size. This procedure, reflecting a precision of ± 5%, yielded a sample of 210.

Two instruments were used to collect data for this study. One instrument was used to collect data associated with research objectives 1 and 2. Subjects were asked to provide their age and years of teaching experience. Other demographic data were gathered from existing sources. Twenty-seven items were used to assess the subjects' self-perceived competence to teach science concepts related to agriculture. These items were derived from three strands of the science grade level expectations (GLE) for grades 9 to 11. The GLE are state standards created to help local educators articulate precise learning outcomes for their students. GLE from Strand 3 – Living Organisms, Strand 4 – Ecology, and Strand 7 – Scientific Inquiry were selected for evaluation in this study because of their relevance to the existing agriculture courses and curriculum in the selected Missouri. The 27 concepts associated with the three strands were included in the data collection instrument. Each concept was preceded with the stem "I feel competent to teach…" The response choice for each item was a 5-point Likert-type scale for which 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. The instrument was reviewed for face and content validity by a panel of experts chosen for their mastery and experience in agricultural education curriculum and research design and statistics. Reliability was determined through the use of a pilot test. The pilot test was conducted with 36 instructors who were not included in the study group. Members of this group were purposefully selected to approximate the population. Cronbach's alpha was used to measure the homogeneity of items. The procedure yielded the following reliability coefficients for each section: Strand 3 = 0.91, Strand 4 = 0.84, and Strand 7 = 0.89. These reliability estimates were considered by the researchers to be acceptable.

A 20-question biology certification practice exam obtained from the American Board for Certification of Teacher Excellence (ABCTE) was used to assess the agriculture teachers' general knowledge of biological science. Multiple-choice responses with four alternatives were provided with each question. Content validity was determined by ABCTE through working with subject matter experts, classroom instructors, administrators, teacher educators, policymakers and business leaders to ensure that the instrument was valid (ABCTE, 2007). Reliability was determined by the ABCTE (2007) with the Kuder-Richardson formula 20.

Subjects were initially contacted by e-mail to solicit their participation in the study. Data were collected during July 2007. The instrument used to collect data associated with objectives 1 and 2 was made available to the subjects both online and following district meetings during the 2007 state agriculture teachers' conference. The instrument used to collect data associated with objective 3 was also administered following district meetings at the annual conference. After the conference, nonrespondents were identified and contacted by e-mail to encourage their participation in the study. After review, data from141 respondents were deemed to be usable, yielding a response rate of 67.14%. Early respondents were compared with late respondents to control for nonresponse error. No significant differences were detected.

Findings

Findings Related to Objective 1

Among the 141 respondents, there were 41 (29.08%) females and 100 (70.92 %) males. The mean age of the instructors was 35.34 (*SD* = 8.52) years with a range of 22 to 61 years. The average number of years of teaching experience was 10.25 (*SD* = 10.09), ranging from a low of 0 years to a high of 34 years. The average age of female respondents was 29.73 (*SD* = 7.69) with 5.89 (*SD* = 5.36) years of teaching experience. The average age of male respondents was 37.67 (*SD* = 10.09) with 12.76 (*SD* = 8.80) years of teaching experience.

Findings Related to Objective 2

Table 1 shows the instructors' level of confidence to teach science GLE related to Strand 3 – Living Organisms. The mode for all concepts was four. The concept with the highest mean was "Reproduction can occur asexually and sexually" (*M* = 4.49, *SD* = 0.58). Instructors also agreed that they feel competent to teach each of the eleven other concepts, including: "Photosynthesis and cellular respirations are complementary processes necessary to the survival of most organisms on Earth" (*M* = 4.31, *SD* = 0.64), "All living organisms have genetic material (DNA) that carries hereditary information" (*M* = 4.30, *SD* = 0.71), "Chromosomes are components of cells that occur in pairs and carry hereditary information from one cell to daughter cells and from parent to offspring during reproduction" (*M* = 4.13, *SD* = 0.79), "There is heritable variation within every species of organism" (*M* = 4.01, *SD* = 0.78), "Cells are the fundamental units of structure and function of all living things" (*M* = 3.97, *SD* = 0.79), "Cells carry out chemical transformations that use energy for the synthesis or breakdown of organic compounds" (*M* = 3.78, *SD* = 0.87), "Biological classifications are based on how organisms are related" (*M* = 3.77, *SD* = 0.84), "Organisms progress through life cycles unique to different types of organisms" (*M* = 3.74, *SD* = 0.85), "The pattern of inheritance for many traits can be predicted by using the principle of Mendelian genetics" (*M* = 3.70, *SD* = 1.05), "The cell contains a set of structures called organelles that interact to carry out life processes through physical and chemical means" (*M* = 3.70, *SD* = 0.85), and "Protein structure and function are coded by the DNA (deoxyribonucleic acid) molecule" (*M* = 3.61, *SD* = 0.91. Instructors were neutral about their competence to teach "Cellular activities and responses can maintain stability internally while external conditions are changing (homeostasis)" (*M* = 3.47, *SD* = 0.92). There was no concept that the teachers, as a group, felt incompetent to teach.

Table 1
Agriculture Instructors' Perceived Level of Competence to Teach Science Grade Level Expectations Strand 3 – Living Organisms (n = 141)

Science grade level expectations for Strand 3 – Living Organisms	Mode	*M*	*SD*
Reproduction can occur asexually or sexually.	4	4.49	0.58
Photosynthesis and cellular respirations are complementary processes necessary to the survival of most organisms on Earth.	4	4.31	0.64
All living organisms have genetic material (DNA) that carries hereditary information.	4	4.30	0.71
Chromosomes are components of cells that occur in pairs and carry hereditary information from one cell to daughter cells and from parent to offspring during reproduction.	4	4.13	0.79
There is heritable variation within every species of organism.	4	4.01	0.78
Cells are the fundamental units of structure and function of all living things.	4	3.97	0.79
Cells carry out chemical transformations that use energy for the synthesis or breakdown of organic compounds.	4	3.78	0.87
Biological classifications are based on how organisms are related.	4	3.77	0.84
Organisms progress through life cycles unique to different types of organisms.	4	3.74	0.85
The pattern of inheritance for many traits can be predicted by using the principle of Mendelian genetics.	4	3.70	1.05
The cell contains a set of structures called organelles that interact to carry out life processes through physical and chemical means.	4	3.70	0.85
Protein structure and function are coded by the DNA (Deoxyribonucleic acid) molecule.	4	3.61	0.91
Cellular activities and responses can maintain stability internally while external conditions are changing (homeostasis).	4	3.47	0.92
Grand mean		3.92	0.60

Note. Scale: 1.00–1.49 = strongly disagree, 1.50–2.49 = disagree, 2.50–3.49 = neutral, 3.50–4.49 = agree, 4.50–5.00 = strongly agree.

Instructors agreed that they are confident to teach eight of the nine concepts (88.89%) related to ecology (Strand 4). The modal response for each concept was four, except for "Evidence for the nature and rates of evolution can be found in anatomical and molecular characteristics of organisms and in the fossil record," which had a mode of three. The concept with the highest level of agreement was "Reproduction is essential to the continuation of every species" (M = 4.21, SD = 0.69), followed by "Natural selection is the process of sorting individuals based on their ability to survive and reproduce within their ecosystem" (M = 4.06, SD = 0.70), "All populations living together within a community interact with one another and with their environment in order to survive and maintain a balanced ecosystem" (M = 4.04, SD = 0.81), "All organisms, including humans, and their activities cause changes in their environment that affect the ecosystem" (M = 4.01, SD = 0.81), "The diversity of species within an ecosystem is affected by changes in the environment, which can be caused by other organisms or outside processes" (M = 4.01, SD = 0.87), "Living organisms have the capacity to produce populations of infinite size, but environments and resources are finite" (M = 3.90, SD = .94), "Matter is recycled through an ecosystem" (M = 3.74, SD = 0.93), "All organisms capture a portion of that energy and transform it to a form that they can use" had the lowest level of agreement (M = 3.73, SD = 0.93), and "As energy flows through an ecosystem, all organisms capture a portion of that energy and transform it to a form that they can use" (M = 3.73, SD = 0.93). Instructors were neutral (M = 3.02, SD = 0.95) regarding their competence to teach the concept of "Evidence for the nature and rates of evolution can be found in anatomical and molecular characteristics of organisms and in the fossil record" (M = 3.02 SD = 0.95). There were no concepts for which the instructors indicated they were incompetent to teach. These data are displayed in Table 2.

Table 2
Agriculture Instructors' Perceived Level of Competence to Teach Science Grade Level Expectations Strand 4 – Ecology (n = 141)

Science grade level expectations for Strand 4 – Ecology	Mode	*M*	*SD*
Reproduction is essential to the continuation of every species.	4	4.21	0.69
Natural selection is the process of sorting individuals based on their ability to survive and reproduce within their ecosystem.	4	4.06	0.70
All populations living together within a community interact with one another and with their environment in order to survive and maintain a balanced ecosystem.	4	4.04	0.81
All organisms, including humans, and their activities cause changes in their environment that affect the ecosystem.	4	4.01	0.81
The diversity of species within an ecosystem is affected by changes in the environment, which can be caused by other organisms or outside processes.	4	4.01	0.87
Living organisms have the capacity to produce populations of infinite size, but environments and resources are finite.	4	3.90	0.94
Matter is recycled through an ecosystem.	4	3.74	0.93
As energy flows through the ecosystem, all organisms capture a portion of that energy and transform it to a form that they can use.	4	3.73	0.93
Evidence for the nature and rates of evolution can be found in anatomical and molecular characteristics of organisms and in the fossil record.	3	3.02	0.95
Grand mean		3.86	0.68

Note. Scale: 1.00–1.49 = strongly disagree, 1.50–2.49 = disagree, 2.50–3.49 = neutral, 3.50–4.49 = agree, 4.50–5.00 = strongly agree.

Instructors agreed that they are confident to teach the concepts related to Strand 7 – Scientific Inquiry. The mode for each concept was four. The concept with the highest mean level of agreement was "Evidence is used to formulate explanations" (M = 3.68, SD = 0.86), followed by "Scientific inquiry includes the ability of students to formulate a testable question and explanation, and to select appropriate investigative methods in order to obtain evidence relevant to the explanation" (M = 3.60, SD = 0.79), "Scientific inquiry includes evaluation of explanations (hypotheses, laws, theories) in light of scientific principles (understandings)" (M = 3.60, SD = 0.83), "Scientific inquiry relies upon gathering evidence from qualitative and quantitative observations" (M = 3.59, SD = 0.82), and "The nature of science relies upon communication of results and justification of explanations" (M = 3.59 SD = 0.68 These data are displayed in Table 3.

Table 3
Agriculture Instructors' Perceived Level of Competence to Teach Science Grade Level Expectations Strand 7 – Scientific Inquiry (n = 141)

Science grade level expectations Strand 7 – Scientific Inquiry	Mode	*M*	*SD*
Evidence is used to formulate explanations.	4	3.68	0.86
Scientific inquiry includes the ability of students to formulate a testable question and explanation, and to select appropriate investigative methods in order to obtain evidence relevant to the explanation.	4	3.60	0.79
Scientific inquiry includes evaluation of explanations (hypotheses, laws, theories) in light of scientific principles (understandings).	4	3.60	0.83
Scientific inquiry relies upon gathering evidence from qualitative and quantitative observations.	4	3.59	0.82
The nature of science relies upon communication of results and justification of explanations.	4	3.59	0.82
Grand mean		3.61	0.68

Note. Scale: 1.00–1.49 = strongly disagree, 1.50–2.49 = disagree, 2.50–3.49 = neutral, 3.50–4.49 = agree, 4.50–5.00 = strongly agree.

Findings Related to Objective 3

Objective 3 sought to determine agriculture instructors' knowledge of principles of science associated with selected GLE related to science for students in grades 9 to 11. A biological science practice certification exam from the ABCTE was used to assess this objective. The maximum score for this examination was 20. The mean score for the agriculture instructors was 8.40 (*SD* = 3.19), which is 41.25% of the maximum score. Scores ranged from 0 (0.00%) to 16 (80.00%). The mean score for female teachers was a 9.44 (*SD* = 3.24), and the mean score for males was 7.97 (*SD* = 3.08). Further analysis showed novice instructors, defined as those teachers with fewer than 5 years of experience, scored the highest (*M* = 9.24, *SD* = 3.23) followed by experienced instructors (*M* = 7.95, *SD* = 3.10) and seasoned instructors (*M* = 7.92, *SD* = 3.15). These data are displayed in Table 4.

Table 4
Agriculture Instructors' Knowledge of Principles of Science Associated with Selected Grade Level Expectations Related to Science (n = 141)

	Score		
Group	*M*	*SD*	Correct (%)
Novice instructors	9.24	3.23	46.20
Experienced instructors	7.95	3.10	39.75
Seasoned instructors	7.92	3.15	39.60
Females	9.44	3.24	47.20
Males	7.97	3.08	39.85
Overall score	8.40	3.19	42.00

Note. Novice = 1 to 5 years teaching experience, Experienced = 6 to 15 years teaching experience, Seasoned = 16 or more years teaching experience.

Conclusions, Implications, and Recommendations

According to findings, the profile of the typical agriculture instructor in Missouri is a 36-year-old male with 11 years of teaching experience. Although this conclusion is similar to the profile for this population 10 years ago, one major difference should be noted. According to data found in the *1997-1998 Agricultural Education Directory* (Missouri Department of Elementary and Secondary Education, 1997) females comprised less than 10% of all agriculture instructors in this state in 1997. In contrast, nearly 25% of the respondents in this study were female. It is likely that there are other changes in the characteristics of these teachers coinciding with this demographic shift. Such changes, no matter how subtle, should be considered when designing and delivering preservice and inservice programs.

It is clear from the findings of this study that instructors are confident they can teach all of the concepts of science the GLE that are related to agricultural education. This conclusion supports the findings of Thompson and Balschweid (1999), who found that agriculture instructors in Oregon believed they were prepared to teach science concepts. The confidence that agriculture instructors have in their ability to teach science concepts should be used as a foundation to create professional development programs to increase their effectiveness in teaching this content. On the other hand, one can only speculate why these teachers have such confidence, considering Harlin and Holroyd (1997) found that confidence in the subject matter is a primary challenge cited by science teachers. Regardless, this confidence to teach science should not be confused with competence to teach science.

The agriculture teachers in this state do not have an acceptable level of competence in the subject area of science. The average score of this group on the science knowledge examination is considered to be "not proficient" by ABCTE (Boots, 2007). The average score for the teachers in this study was 42% compared with the national average of science certification candidates' score of 64% (Boots). Only 13 of 141 (9.22%) agriculture instructors scored high enough on the examination to be considered proficient. According to Boots, the average score of agriculture instructors on this assessment would translate to 243 points; 251 points indicates proficiency. At the very least, this conclusion exposes the question of agriculture teachers' ability to effectively teach such content. The question of teacher competence is seemingly the proverbial elephant in the room regarding the issue of curriculum change in secondary agriculture. It must be addressed as curriculum reforms are promoted by leaders in agricultural education.

If agriculture instructors are going to be expected to teach science concepts, there must be an effective and focused inservice program designed to increase their knowledge about science and to expose them to the methods used to teach this content. Secondly, if science concepts are to be successfully implemented, teacher preparation programs need to examine the amount of science coursework that preservice agriculture instructors are taking. This recommendation is similar to recommendations from studies of Oregon agriculture instructors by Warnick and Thompson (2002) as well as Warnick, Thompson, and Gummer (2004). Both science instructors and researchers suggest that to be effective in integrating science into their coursework, agriculture instructors need more content knowledge (Warnick et al.).

Further, research must be conducted to measure competence in science concepts among preservice and current instructors. Measures must be taken to identify the needs of current instructors so that professional development can be provided to increase the competence of agriculture instructors.

Finally, the conventional wisdom of integrating more science, mathematics and reading into the secondary agriculture curriculum must be carefully considered. Leaders and stakeholders of secondary agricultural education must recognize that such a change will likely alter the very purpose of the program. If the teaching of science concepts is to become a greater part of the secondary agriculture curriculum, the following issues should be investigated:

- How should teacher certification programs be changed?
- What kind of inservice should be provided to current teachers?
- What will be the impact upon teachers' workload?
- What will be the impact upon teachers' job satisfaction?
- How will the student leadership organization be impacted?
- Is the SAE component compatible?
- How will the teaching of basic agricultural information be impacted?
- What students will be attracted to the program?
- Does such an emphasis fit with the provisions of federal funding for career and technical education?

References

American Board for Teacher Certification in Excellence (ABCTE). (2007). *A higher standard.* Retrieved August 6, 2007, from http://www.abcte.org/research

Ary, D., Jacobs, L. C., & Razavieh, A. (2002). *Introduction to research in education* (6th ed.). Belmont, CA: Wadsworth.

Balschweid, M. A. (2002). Teaching biology using agriculture as the context: Perceptions of high school students. *Journal of Agricultural Education, 43*(2), 56-67.

Balschweid, M. A., & Thompson, (2002). Integrating science in agricultural education: Attitudes of Indiana agricultural science and business teachers. *Journal of Agricultural Education, 43*(2), 1-10.

Belcher, G., McCaslin, N. L., & Headley, W. S. (1996). Implications of performance measures and standards for evaluation and assessment in agricultural education. *Journal of Agricultural Education, 37*(4), 1-7.

Boots, J. (personal communication, November 29, 2007)

Carl D. Perkins Act. (1998). P. L 109-270, 109th Congress.

Chaisson, T. C., & Burnett, M. F. (2001). The influence of enrollment in agriscience courses on the science achievement of high school students. *Journal of Agricultural Education, 42*(1), 61-71.

Dyer, J. E., & Osborne, E. W. (1999). The influence of science applications in agriculture courses on attitudes of Illinois guidance counselors at model student-teaching centers. *Journal of Agricultural Education, 40*(4), 57-66.

Goecker, A. D. (1992). Priorities for college and university agricultural education faculty. *Journal of Agricultural Education, 33*(3), 2-7.

Harlen, W., & Holroyd, C. (1997). Primary teachers' understanding of concepts of science: Impact on confidence and teaching. *International Journal of Science Education, 19*(1), 93-105.

Hillison, J. (1996). The origins of agriscience: Or where did all that scientific stuff come from. *Journal of Agricultural Education, 37*(4), 8-13.

Johnson, D. (1996). Science credit for agriculture: relationship between perceived effects and teacher support. *Journal of Agricultural Education, 37*(3), 9-17.

Johnson, D., & Newman, M. E. (1993). Perceptions of administrators, guidance counselors, and science teachers concerning pilot agriscience courses. *Journal of Agricultural Education, 34*(2), 46-54.

Kregcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and Psychological Measurement, 30*, 607-610.

Missouri Department of Elementary and Secondary Education. (1997). 1996–1997 *Missouri Agricultural Education Directory*. Jefferson City, MO: Author.

Missouri Department of Elementary and Secondary Education. (2006). 2006-2007 *Missouri Agricultural Education Directory*. Jefferson City, MO: Author.

National Research Council. (1988). *Understanding agriculture: New directions for education.* Washington, DC: National Academy Press.

Newman, M. E., & Johnson, D. (1993). Perceptions of Mississippi secondary agriculture teachers concerning pilot agriscience courses. *Journal of Agricultural Education, 34*(3), 49-58.

Norris, R. J., & Briers, G. E. (1989). Perceptions of secondary agriculture science teachers towards proposed changes in agriculture curricula for Texas. *Journal of Agricultural Education, 39*(2), 8-16.

Osborne, E. W., & Dyer, J. E. (1998). Attitudes of Illinois high school science teachers toward educational programs in agriculture. *Journal of Agricultural Education, 39*(1), 8-16.

Phipps, L. J., Osborne, E. W., Dyer, J. E., & Ball, A. (2007). *Handbook on agricultural education in public schools* (6th ed.). Clifton Park, NY: Thomson Delmar Learning.

Smith-Hughes Act. (1917). P. L. 347, 64th Congress, Section 18, 39 Stat. 936.

Team AgEd. (2007). *Unmistakable potential: 2005-2006 Annual report on agricultural education*. Retrieved November 15, 2006, from http://www.teamaged.org/ webAR.pdf

Thompson, G. W. (2001). Perceptions of Oregon secondary principals regarding integrating science into agricultural science and technology programs. *Journal of Agricultural Education, 42*(1), 49-59.

Thompson, G. W., & Balschweid, M. A. (1999). Attitudes of Oregon agricultural science and technology teachers towards integrating science. *Journal of Agricultural Education, 40*(3), 21-29.

University of Missouri (2007). *How to Apply*. Retrieved August 10, 2007, from http://admissions.missouri.edu/howtoapply/freshman/requirements.php

Warnick, B., & Straquadine, G. S. (1998). Measuring the impact of agricultural applications in the teaching of biology on student achievement as measured by a state biological science competency test. *Proceedings of the 25th Annual National Agricultural Education Research Conference.* New Orleans, LA.

Warnick, B. K., & Thompson, G. W. (2002). Perceptions of Oregon science teachers regarding the integration of science into the agricultural education curriculum. *Proceedings of the 29th Annual National Agricultural Education Research Conference.* Las Vegas, NV.

Warnick, B. K., Thompson, G. W., & Gummer, E. S. (2004). Perceptions of science teachers regarding the integration of science into the agricultural education curriculum. *Journal of Agricultural Education, 45*(1), 62-72.

JASON SCALES is an Assistant Professor in the Agricultural Education Program at the University of Central Missouri, Grinstead 126, Warrensburg, MO 64093. 660-429-5579 E-mail: jscales@ucmo.edu.

ROBERT TERRY, JR. is a Professor in the Department of Agricultural Education at the University of Missouri, 127 Gentry Hall, Columbia, MO 65211. 573-884-7375 E-mail: robterry@missouri.edu.

ROBERT M. TORRES is a Professor in the Department of Agricultural Education at the University of Missouri, 126 Gentry Hall, Columbia, MO 65211. 573-884-7376 E-mail: torresr@missouri.edu.