SCIENTIFIC INQUIRY IN AGRICULTURAL EDUCATION TEACHER PREPARATION: A LOOK AT TEACHER EDUCATORS' PERCEPTIONS

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Abstract

The specific objectives of this study were to identify the attitudes of U.S. agricultural education teacher educators toward using scientific inquiry as an instructional method and to determine their level of comfort and awareness with new information and teaching methodologies in science. A mailed survey was sent to all agricultural education teacher preparation institutions in the United States. One-half of the respondents who indicated that they presented scientific inquiry to their pre-service teachers during the methods of teaching course indicated they were very comfortable with teaching technical agriculture content, while one in eight said they were very comfortable with teaching technical science content. A majority of respondents who said they presented scientific inquiry also indicated that they felt comfortable or very comfortable with presenting the scientific inquiry teaching method. Respondents rated themselves less than knowledgeable on "general science content" and "current discoveries in science." When asked their opinions of their comfort with various content areas and teaching methodologies 95% of teacher educators responded that they felt very comfortable or comfortable teaching technical agriculture content. Only 68% felt as confident when asked about teaching technical science content.

Introduction/Conceptual Framework

The call for enhanced science instruction in agricultural education at the secondary level is well known (National Academy of Sciences, 1988). However, efforts to increase science-based instruction within agricultural education programs have not been widely coordinated and are mostly unique and individualized to local schools (Shelley-Tolbert, Conroy, & Dailey, 2000). The generally accepted theory for teaching science in the 21st century is through the use of scientific inquiry (National Research Council, 1996). Although the agricultural education community recognizes the need for scientific inquiry-based classrooms in order to teach students important skills (Bottoms, 2000; Conroy & Trumbull, 2000), evidence indicates that secondary agricultural education students are engaged in inquiry based activities on average, about once a month (Washburn & Myers, 2008).

In reality, few agricultural education programs are actually making changes to incorporate scientific inquiry (Conroy & Trumbull, 2000). The literature suggests that agricultural educators face a need to redesign their curriculum to appropriately include scientific inquiry (Quinn, 2000). Most agricultural science and technology (AST) teachers in one study felt that few or no changes needed to be made in the structure of agricultural education's curriculum (Thompson & Balschweid, 2000). One reason for the uncertainty concerning the use of scientific inquiry may be that problem solving has long been an integral part of agricultural education, and many agricultural educators consider this teaching approach analogous to scientific inquiry (Case, 2003). Compounding the issue is teacher-perceived uncertainty between teacher-directed science inquiry and student-directed science inquiry (Washburn & Myers, 2008).

Before expecting scientific inquiry to be utilized as a teaching method by secondary agricultural educators, the extent that agricultural education teacher preparation programs are presenting scientific inquiry as a teaching method to pre-service and in-service teachers should be assessed. Scientific inquiry should be a part of teacher preparation programs if agriscience is to be a serious endeavor in agricultural education (Atherton & Harper, 1993). Scientific inquiry could fit naturally into a methods course (Melear, Goodlaxson, Warne, & Hickok, 2000). Pre-service teachers could be placed into a secondary agricultural education program that integrates science and agriculture and utilizes scientific inquiry for their student teaching experience (Thompson, 2000), making it easier to see scientific inquiry modeled as a teaching method. And practicing teachers could receive professional development in inquiry during in-service workshops (Deters, 2004).

We should expect that agricultural education teacher preparation programs are training their pre-service and in-service teachers in the method of scientific inquiry, as several university departments housing these programs recognize the importance of inquiry as a teaching method (College of Agricultural, Consumer and Environmental Sciences, 2005). Historically, the evolution of agricultural education has closely reflected reform movements in science education (Berkey, 1982), and the current science education reform movement focuses on inquiry (National Research Council, 1996, 2000). Agricultural education teacher preparation requires continual innovation to ensure agricultural education teachers are capable of teaching a dynamic subject like agriculture (Berkey, 1982). Therefore, as science educators have altered their focus to scientific inquiry as an ideal method for teaching science content, agricultural educators should also incorporate scientific inquiry for teaching science concepts in the agriculture classroom. As such, training of pre-service and in-service teachers on scientific inquiry as a part of agricultural education teacher preparation programs is expected, since agriculture programs are increasingly integrating science into their curriculum (National Academy of Sciences, 1988).

However, if scientific inquiry is not a part of agricultural education teacher preparation programs, it is unrealistic to expect scientific inquiry to be used as a teaching method in secondary agricultural education classrooms. The minimal research that exists reveals pre-service and practicing teachers alike are uncomfortable with inquiry if they lack the training and experience to use it as a teaching method (Cavicchi & Hughes-McDonnell, 2001). Agricultural education teacher preparation professionals have a responsibility to prepare prospective teachers adequately for the dynamic nature of agriculture, meaning they require knowledge of a broad range of teaching methods (Berkey, 1982), including scientific inquiry (Quinn, 2000). Given that student teachers tend to mimic the teaching methods they see their methods instructors, cooperating teachers, and other college instructors use (Avery, 1985; Black, 2003; Wardlow, 1999), scientific inquiry must be repeatedly modeled if pre-service teachers are to become familiar with it (Bourdeau, 2004; Melear et al., 2000; National Research Council, 2000).

Agricultural education teacher preparation programs cannot rely entirely on required science content courses to provide necessary science skills, such as knowledge of scientific inquiry, to pre-service agriculture teachers (Conroy & Trumbull, 2000), since not all of these courses incorporate scientific inquiry. Additionally, for the practicum portion of teacher education, programs must select cooperating teachers who model the desired teaching behaviors expected of student teachers (Garton & Cano, 1996). Agricultural education teacher educators must emphasize student-centered methods of teaching if pre-service teachers are to improve their teaching performance of these methods (Cano, Garton, & Raven, 1992; Melear et al., 2000). If agricultural education teacher preparation programs heed none of these recommendations, then it will be unlikely that a systematic change to include the scientific inquiry method of teaching will be found in secondary agriculture education classrooms. For agricultural education

teacher educators to take these recommendations seriously it may require changes in their attitudes toward science; agricultural educators must believe that pre-service teachers are capable of successfully implementing scientific inquiry and that there is value in using the approach (Atherton & Harper, 1993).

Purpose and Objectives

The purpose of the study was to identify perceptions of agricultural education teacher educators towards using scientific inquiry in their *methods of teaching* course. The objectives were to:

1. Identify secondary agricultural teacher educators' perceived comfort with various aspects of instructing pre-service teachers in the *methods of teaching* course.
2. Describe secondary agricultural teacher educators' perceptions of content knowledge used in the *methods of teaching* course.
3. Determine secondary agricultural teacher educators' awareness of current educational movements.

Methods and Procedures

A mail survey was administered to the instructors of the agricultural education teaching methods courses throughout the United States. Teacher educators who completed the survey provided information about the teaching methods presented to agricultural education pre-service teachers enrolled in their programs. A survey instrument was constructed containing a combination of question types, including multiple-choice items, Likert-type scale items, and open-ended questions, designed to collect information relating to the study's objectives. For the purpose of this study, science inquiry was defined as science labs or activities that are student-driven, or those in which students design their own questions and procedures. This definition is based upon the National Science Education Standard's definition for science inquiry (National Research Council, 1996).

The instrument was pilot tested with select agricultural education, science education, and biology faculty members at West Texas A&M University and Purdue University. Those faculty members participating in the pilot test were not involved in the study. Adjustments to the survey instrument were made consistent with pilot group recommendations. The population surveyed included faculty members of 86 agricultural education teacher preparation programs in 43 states. Copies of the survey were mailed to respondents according to Salant and Dillman's (1994) method of survey research. The initial mailing consisted of a cover letter, a survey in booklet format, and a postage-paid return envelope. A reminder postcard was mailed to each non-responder approximately 2 weeks after the initial survey was sent. Follow-up sets of surveys were mailed to non-responders 4 and 8 weeks after initial contact. Ten subjects chose not to participate either by returning their blank surveys or by emailing the researcher directly. In all, 63 responses were received for an overall response rate of 73%.

The American Association for Agricultural Education database was used to identify agricultural education teacher educators. The participants in this study included the entire population of agricultural teacher educators currently teaching methods courses at universities within the United States offering agricultural education teacher preparation programs. One faculty member per institution was surveyed. Surveys were sent to the department head of each institution with an agricultural education teacher preparation program. The department heads were requested to route the survey to the individual responsible for teaching the standard methods course for agricultural education pre-service teachers.

Non-response error was addressed using Lindner, Murphy, and Briers' (2001) model comparing early to late respondents. This approach stems from the work of Pace (1939) who conceptualized that late responders are similar to non-responders. With the small population and sample size in this study, Lindner et al. recommend

that ―late respondents be defined operationally as the later 50% of respondents" (p. 52). After the first 2 weeks of data collection, 50% of the surveys were returned and categorized as ―early" responses. The surveys returned after 2 weeks were deemed ―late" responses. A statistical comparison for the early and late groups of responses was set *a priori* using a two-tailed *t*-test at alpha 0.05. This was done for a subset of 14 survey questions. To control for the equality of variance between the early and late groups, Levene's test for equality of variance was used. When the *p*-value for Levene's test was <0.05, the two-tailed significance was calculated on unequal variance between the two groups (Ramsey & Shafer, 1997, p. 99). Early and late responders were found to have no statistically significant difference in the responses to the subset of questions used. The researchers retained all questions and assumed that there was no difference between answers from early responders and those of late responders.

Statistics used to analyze the data included frequencies, percentages, means and standard deviations. Generalizations from this research can only be applied to the population under study and cannot be construed as representative of any other population.

Findings

The purpose of this study was to identify the attitudes of U.S. agricultural education teacher educators toward using scientific inquiry as an instructional method and to determine their level of comfort and awareness with new information and teaching methodologies in science. Forty-one of 62 respondents (66.1%) said that they presented scientific inquiry to pre-service teachers enrolled in their *methods of teaching* courses. The remaining 21 (33.9%) said they did not present scientific inquiry to pre-service teachers enrolled in their *methods of teaching* courses (data previously presented in French and Balschweid, in press).

The first objective of the study was to identify secondary agricultural teacher educators' perceived comfort with various aspects of instructing pre-service teachers in the *methods of teaching* course. One-half of the respondents (50.0%) presenting scientific inquiry to their pre-service teachers during the *methods of teaching* course indicated that they felt ―very comfortable" with teaching technical agriculture content, while 12.2% said they felt ―very comfortable" with teaching technical science content. Table 1 presents the details of these findings.

Table 1
Opinions of Secondary Agricultural Teacher Educators on Self-Comfort with Various Aspects of Instructing Pre-service Teachers in the Methods of Teaching Course (n = 41)

Comfort level with:	*f*	%
Teaching technical agriculture content		
Very comfortable	20	50.0
Comfortable	18	45.0
Somewhat comfortable	2	5.0
Teaching technical science content		
Very comfortable	5	12.2
Comfortable	23	56.1
Somewhat comfortable	12	29.3
Not at all comfortable	1	2.4
Presenting scientific inquiry teaching method		
Very comfortable	16	39.0
Comfortable	18	43.9
Somewhat comfortable	6	14.6
Not at all comfortable	1	2.4
Presenting problem-solving teaching method		
Very comfortable	27	65.9
Comfortable	14	34.1
Presenting reflective teaching method		
Very comfortable	18	43.9
Comfortable	20	48.8
Somewhat comfortable	3	7.3
Presenting student-assisted instruction teaching method		
Very comfortable	11	28.2
Comfortable	20	51.3
Somewhat comfortable	5	12.8
Not at all comfortable	3	7.7

Note. Responded to only by those respondents who indicated ~~"y~~es" to the survey indicating they taught the science of inquiry method.

The mean score for secondary agricultural teacher educators' comfort level with teaching technical agriculture content was 3.45 (*SD* = 0.60) on a 4-point Likert-type scale. Comparatively, the mean score for respondents' comfort level with teaching technical science content was 2.78 (*SD* = 0.69) on the same 4-point Likert-type scale. Comfort with presenting the scientific inquiry teaching method had a mean of 3.20 (*SD* = 0.78). Table 2 summarizes these findings.

Nearly all of the respondents (98.4%) indicated that they felt ―knowledgeable" or ―very knowledgeable" of general agriculture content, with 73.0% indicating the same knowledge level for general science content. Similarly, nearly three-quarters of respondents (74.6%) indicated that they felt ―knowledgeable" or ―very knowledgeable" of current discoveries in agriculture, with 54.0% indicating the same knowledge level of current discoveries in science.

Table 2
Descriptive Statistics for Opinions of Secondary Agricultural Teacher Educators on Self-Comfort with Various Aspects of Instructing Pre-service Teachers in the Methods of Teaching Course (n = 41)

Aspect of instructing the *methods of teaching* course	*M*	*SD*
Presenting problem-solving teaching method	3.66	0.48
Teaching technical agriculture content	3.45	0.60
Presenting reflective teaching method	3.37	0.62
Presenting scientific inquiry teaching method	3.20	0.78
Presenting student-assisted instruction teaching method	3.00	0.86
Teaching technical science content	2.78	0.69

Note. 1 = not at all comfortable, 2 = somewhat comfortable, 3 = comfortable, 4 = very comfortable. Responded to only by those respondents who indicated ―yes" to the survey item summarized in Table 1.

On a 4-point Likert-type scale, the mean score for respondents' knowledge of general agriculture content was 3.48 (*SD* = 0.54), while the mean score for knowledge of general science content was 2.86 (*SD* = 0.62). The mean score for respondents' knowledge of current discoveries in agriculture was 2.90 (*SD* = 0.64), while the mean score for knowledge of current discoveries in science was 2.59 (*SD* = 0.59). Table 3 summarizes this data.

Table 3
Perceptions of Secondary Agricultural Teacher Educators Self-Knowledge of Content (n = 63)

Content area	*M*	*SD*
General agriculture content	3.48	0.54
Current discoveries in agriculture	2.90	0.64
General science content	2.86	0.62
Current discoveries in science	2.59	0.59
Self knowledge of:	*f*	%
General agriculture content		
Very knowledgeable	31	49.2
Knowledgeable	31	49.2
Somewhat knowledgeable	1	1.6
Current discoveries in agriculture		
Very knowledgeable	10	15.9
Knowledgeable	37	58.7
Somewhat knowledgeable	16	25.4
General science content		
Very knowledgeable	8	12.7
Knowledgeable	38	60.3
Somewhat knowledgeable	17	27.0
Current discoveries in science		
Very knowledgeable	3	4.8
Knowledgeable	31	49.2
Somewhat knowledgeable	29	46.0

Note. 1 = not at all knowledgeable, 2 = somewhat knowledgeable, 3 = knowledgeable, 4 = very knowledgeable.

All (100.0%) respondents felt "aware" or "very aware" of current movements in agricultural education. The mean awareness level, on a 4-point Likert-type scale, of current movements in agricultural education was 3.65 (*SD* = 0.48). In addition, 63.4% of respondents felt "aware" or "very aware" of current movements in science education. The mean awareness level of current movements in science education was 2.65 (*SD* = 0.68) on a similar 4-point Likert-type scale. Table 4 highlights this data.

Table 4
Perceptions of Secondary Agricultural Teacher Educators of Self-Awareness of Current Education Movements (n = 63)

Current education movement awareness	*M*	*SD*
Agricultural education	3.65	0.48
Science education	2.65	0.68
Awareness of current movements in agricultural education	***f***	**%**
Very aware	41	65.1
Aware	22	34.9
Awareness of current movements in science education		
Very aware	4	6.3
Aware	36	57.1
Somewhat aware	20	31.7
Not at all aware	3	4.8

Note. 1 = not at all aware, 2 = somewhat aware, 3 = aware, 4 = very aware.

Conclusions/Implications/ Recommendations

The objectives of this study were to identify the perceptions of U.S. agricultural education teacher educators toward using scientific inquiry as an instructional method and to determine their level of comfort and awareness with new information and teaching methodologies in science. Two-thirds of the instructors surveyed responded that they presented scientific inquiry to the pre-service teachers enrolled in their primary *methods of teaching* course. This implies that a majority of pre-service agricultural education students are getting trained in the use of scientific inquiry as an appropriate method for teaching agricultural science.

When asked their opinions of their comfort with various content areas and teaching methodologies 95% of teacher educators responded that they felt "very comfortable" or "comfortable" teaching technical agriculture content. Only 68% felt as confident when asked about teaching technical science content. This generates concern since many states recognize secondary agricultural education teachers as science teachers and many agricultural education teachers are called upon to teach one or more science classes throughout the school day. Unless those teachers are receiving additional instruction in a *methods of teaching science* class a third of them are receiving instruction for teaching science from teacher educators "somewhat comfortable" or "not at all comfortable" with teaching science content. If agricultural educators are to help raise the science literacy of school-aged children, this must change. *Methods of teaching* courses in agricultural education must be taught by those possessing a high level of comfort with not only technical agricultural but technical science as well. In addition, those *methods of teaching* instructors in agricultural education need to be well versed in the latest accepted methodologies for teaching agriculture and science.

On a scale of 1 (*not at all knowledgeable*) to 4 (*very knowledgeable*), respondents rated themselves less than knowledgeable on "general science content" and "current discoveries in science." Teacher educators are in a unique position to serve as role models for future generations of agricultural educators. In that position, pre-service teachers learn from watching and listening to the material presented by their *methods of teaching* course instructor. *Methods of teaching* instructors model what

is important for the classroom and the best ways for presenting that important information. If teacher educators are not knowledgeable, proficient, and informed about science as well as agriculture, their students run the risk of picking up on that practice. Teachers who feel uncomfortable with content or delivery methods may shy away from those areas. Based upon the current science literacy climate agricultural education teacher preparation programs cannot afford to graduate teachers uncomfortable with lessons in science or teaching methodologies in science.

Additionally, 9 of 10 respondents indicated they were "very aware" or "aware" of current movements in agricultural education, while just over 60% indicated the same for their awareness of current movements in science education. This sits at the heart of the issue since staying current within the field of science education could impact both the comfort level of agricultural education teacher educators in their knowledge of science content and their ability to effectively deliver science content to their students with confidence.

It has been almost two decades since the National Research Council's call for agricultural education to integrate more science and linkages between agriculture and science in the agriculture curriculum (National Academy of Sciences, 1988). And although some local schools and individual classroom teachers have embraced this concept, there appears to be a lack of systematic change among agricultural education teacher educators responsible for presenting the *methods of teaching agriculture* course. There may be no more effective pre-service course for influencing the way future teachers view their subject matter and teaching methodology than in the *methods of teaching agriculture* course. And, there may be no greater time for influencing a captive audience of pre-service teachers than those enrolled in a course that they anticipate will teach them how to teach. It is recommended that agricultural education teacher educators revisit the critical decision for how the *methods of teaching agriculture* course is taught and who is responsible for teaching it at each institution. And that the emphasis for establishing credibility for teaching the course be focused not only on knowledge and comfort of agriculture and the teaching methodologies associated with that field, but the knowledge and comfort level of science and the teaching methodologies associated with science as well.

It is recommended that the American Association for Agricultural Education utilize the professional development committee structure to focus on this issue at current and future regional and national meetings. The focus of development should include elements of the national science standards, science inquiry, and other aspects of teaching science that overlap with agricultural education.

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