

THE MOVE TO AGRISCIENCE AND ITS IMPACT ON TEACHER EDUCATION IN AGRICULTURE

Cynthia A. Shelley-Tolbert, Graduate Research Assistant

Carol A. Conroy, Assistant Professor

Amber L. Dailey, Graduate Teaching Assistant

Cornell University

Abstract

*Since the 1988 publication of *Understanding Agriculture: New Directions for Education* by the National Research Council, agricultural educators have experienced increased pressure to incorporate more science-based instruction. Recent research has examined where and how integration is occurring (Conroy, 2000; Johnson, 1996; Thompson, 1998). This qualitative study looks at the perceptions of agricultural educators and others regarding this shift in focus of instruction, and what implications exist for teacher education programs as a result of the shift. Results show unanimous support for more science-based instruction, but little agreement on how much, or how best, to integrate. Concerns also exist as to methodologies employed for science-based instruction in the agricultural classroom, and how those concerns can be met by changes in teacher education programs.*

Introduction and Theoretical Framework

Benjamin Franklin advocated the teaching of agriculture in every town as early as 1749 (Drache, 1996). At some point between 1821 and 1823, the first high school agriculture program was opened at Gardiner, Maine, with others to soon follow in both Maine and Massachusetts. Soon, other programs with a similar focus on agriculture became established throughout the country. Hillison (1996) contended that the Hatch Act of 1887 acted as the impetus for even greater growth in numbers and scope of agriculture-based programs in the United States. The Hatch Act established agricultural experiment stations, with most having an associated agriculture school that led to both practical and scientific application of agricultural developments (Hillison, 1996). It should be noted that, at this time, instruction was provided by a scientist and was focused on scientific principles that under girded agricultural practices, not the production practices, themselves.

With the passage of the Smith-Hughes Act

in 1917, agricultural education was made part of vocational education and became focused more on training than research (Hillison, 1996). Vocational agriculture programs trained the workforce for agriculture and helped the United States to become the leader in world food production. Advancements in technology and increased efficiency in agriculture production, however, led to changes in workforce dynamics. These factors changed the infrastructure and the types of workers who would be in demand (Drache, 1996). Efficient use of technology led to a greater decline in laborers in the middle 1970s, with a subsequent need for increased education of the agricultural workforce, in both science and technological applications. This demand began to be reflected in high school agricultural education program offerings.

In 1988, the National Research Council published a recommendation that all students need an understanding of basic science concepts. Teaching science through agriculture would incorporate more agriculture into overall school curricula, while more effectively teaching science

(NRC, 1988). This recommendation drove the development and implementation of what we now call “agriscience” in all areas of the curricula—plant and animal sciences, biotechnology and engineering systems, to name a few.

In 1988, a National Conference on AgriScience and Emerging Technologies was held to gather and identify strategies that incorporated teaching of science in high school agriculture programs. One outcome was a call for states to develop instructional materials for agricultural science content. From a review of this and other literature (Conroy & Peasley, 1997; NRC, 1988), the following definition of agriscience was developed:

AgriScience. Identifying and using concepts of biological, chemical, and physical science in the teaching of agriculture, and using agricultural examples to relate these concepts to the student. (Conroy & Walker, 1998, p. 12)

Many schools across the country grant science credit for students who complete agriscience courses (Conroy & Walker, 1998; Johnson, 1996; Thompson, 1998; Thompson, 1999). This was first interpreted as a positive development for agricultural education programs as it allowed greater credibility within certain educational communities; however, problems still existed. Budke (1991) stated, “the use of live examples as a part of the classroom for experimentation and observation provided an effective method to teach science concepts” (as cited in Thompson, 1998, p. 77), and he simultaneously concluded that “agriscience teachers agreed that teacher preparation programs should provide inservice for teachers and instruction for undergraduates on how to integrate science” (p. 79). Newman (1993) and Thompson (1999) echoed the need for increased inservice programming and science credentialing for

secondary agriculture teachers.

Additional credentialing in another subject area, as it is handled in most institutions across the country, usually does not involve content-specific methods classes for the second area of certification (Conroy, 1997). From this we might assume that states have taken the stand that teaching methods, to include the student teaching experience, are inherently “generic” and are not required, in duplicate, for dual certification. This practice is contrary to literature that emphasizes the importance of subject-specific methodologies as they relate to theories of contextualized learning and transferability of knowledge and skills across tasks and disciplines.

Contextualized Teaching and Learning

Contextual teaching and learning has recently been defined as “teaching that enables learning where pupils employ their academic understandings and abilities in a variety of out-of-school contexts to solve complex, real world problems, both alone and in various dyad and group structures” (Ohio State University, 1998, p. 1). Learning in these activities is commonly characterized as active, self-regulated, problem-oriented and responsive to a host of diverse learner needs and interests. Assessment is on-going and blended with this teaching and learning; it is reciprocal in nature with evaluation of both activities. Contextual teaching and learning is not described as one specific technique with fairly well defined rules for implementation. Rather, it is a set of strategies that provide a holistic approach to instruction. These strategies include: problem-based learning, self-regulated learning, service learning, work-based learning, and authentic assessment, all of which serve to assist students in connecting to the world outside the classroom (OSU, 1998).

Agricultural education instruction consists of three basic intra-curricular components: 1) classroom instruction, 2) experiential learning

through supervised experiences, and 3) leadership activities. The implementation of a well designed, integrated program utilizing these components provides for learning necessary content and life skills to prepare students for adulthood, including the science skills important to the increasingly technical agriculture industry (Dyer & Osborne, 1996; Swortzel, 1996).

It is without saying that one of the major purposes of schooling, regardless of level, is the transfer of knowledge and skills to new situations-academic, the workplace, or consumer- parent-oriented decision-making. Transfer has been defined as the “ability to think and reason about new situations through using previous knowledge” (Lee, 1999, p. 1). Although research on the transfer of general skills is inconclusive, it is evident that students have difficulty transferring a solution from one problem to another problem when the situations appear different to them (Lee, 1999). Transfer to a new situation depends on the student learning knowledge well in the first situation and then being able to see similarities within the subsequent situation(s). Learning in context should assist students to learn content in one or several related domains, building on prior knowledge.

Several research studies have highlighted agricultural education as beneficial in learning science concepts and skills, and transferring them to practical applications. Research by Mabie and Baker (1996) showed that using agriculture for instruction of basic science process skills of elementary students improved their achievement in science. Students studying aquaculture in an agriculture program reported that their achievement in science classes was higher as a result of their participation in agriculture based on comparisons with their past performances in those classes (Conroy & Walker, 1998).

In summary, agriculture has changed drastically since the inception of agricultural education. Today, less than 2% of persons

employed in agriculture work in production farming (USDA, 1996), and it has become a technologically sophisticated industry. As a result of these changes, the National Research Council (1988) and others (Conroy & Walker, 2000; Conroy & Walker, 1998; Johnson, 1996; Martin, Rajasekaran & Vold, 1989; Thompson, 1998) have recommended that agricultural education programs integrate more agricultural science into their course content. The literature clearly points to the relationship between opportunities to learn in context and the ability to transfer knowledge and skills across situations. The literature cited above has also made a convincing case that agricultural education programs at the local level provide a rich context in which to teach and reinforce science concepts and process skills. Teaching and learning in context, as well as subsequent transferability, would apply to any area of study, including teacher education. Opportunities to explore and reflect on methods learned within one discipline (agricultural education) cannot be transferred to the second discipline (in this case, science) without recognition of similarities and differences between the two (Lee, 1996). The context (teacher education) must provide the opportunity to explore and reflect within each discipline for which certification is being sought. Implications for teacher education in agriculture are great.

Statement of the Problem

With the calls for teacher education in agriscience (as opposed to vocational agriculture), two questions arise: 1) Are methods and pedagogical approaches taught in teacher education in agriculture programs appropriate for the instruction of science-based agriculture curriculum? And 2) Are the breadth and depth of science instruction in agriscience courses sufficient enough to award science credit to students who participate in these courses? This study was an attempt to gather preliminary information toward the long-term goal of answering these questions. It was expected that the study would provide

insight into problems and help shape future research focused on changes to teacher education in agriculture to ensure that program graduates are prepared to teach agriculture as a science:

Purpose of the Study

This study was part of a larger study funded by the National Science Foundation to examine needed changes in agricultural education, with particular focus on those changes required to teach agriculture as a science. The main purpose of this study was to assess how teachers and others involved in agricultural education conceptualize the shift from vocational agriculture to agriscience and the current and future impacts of that shift, both on local programming and teacher education. This purpose was met by the following objectives:

1. Determine how agricultural educators and others conceptualize the differences between vocational agriculture and agriscience education;
2. Identify participants' perceptions of the adequacy of teacher education programs to prepare teachers to teach agriculture as a science; and
3. Develop a set of recommendations based on the data analysis and literature review to guide future teacher education in agriculture programming and research.

Methods and Procedures

The qualitative-descriptive research design for this study allowed the researchers to focus on several in-depth and probing questions related to the study objectives and were presented to study participants (Gall, Borg & Gall, 1996; Seidman, 1991). Interviewees were purposefully selected according to their availability and willingness to participate. Primary data were collected using semi-structured interviews (Patton, 1991).

We conducted 20 interviews with attendees at the 1999 National FFA Convention in Louisville, KY, on October 28 and 29, 1999. Respondents were selected using maximum variation techniques to ensure a wide range in experience, geographical distribution, and job responsibilities. They included two high school students, six undergraduate agricultural education majors, three graduate students in agriculture education, one USDE representative, one USDA representative, three college/university staff, and four university faculty. The 20 interviewees represented 13 states, one U.S. territory, and the nation's capitol. A second sample of six additional persons was interviewed in New York in early January 2000: three high school agriculture teachers, one high school principal, and two university faculty.

Interviews utilized a flexible interview protocol of open-ended questions guided by the objectives. Consistency in the interview process was enhanced by adherence to Patton's (1991) guidelines for conducting interviews, and a set interviews conducted together by the two interviewers. Each participant was interviewed once; interviews ranged from 15 to 60 minutes in length. All responses were audiotaped with permission from the study participants. Taped responses were transcribed and coded in order to maintain confidentiality. Trustworthiness of the data was ascertained through multiple methods triangulation and a detailed audit trail (Patton, 1991). Cross-case analysis was used in the final analysis of the interview data. This involved grouping together answers from different people to common questions or analyzing different perspectives on central issues which identified similar and dissimilar domains or data categories (Patton, 1991).

The Interview Questions

The interview protocol consisted of the following questions developed through a review of the literature and through informal discussions:

1. How would you describe the difference between agricultural education, agriscience and vocational agriculture?
2. What changes need to be implemented to teacher education programs so that graduates are better prepared to work in current and future programs?
3. Do teacher education programs adequately prepare agriculture teachers to instruct agriculture as a science?
4. What are the greatest challenges facing agricultural education today?

Objective 3 was met through an analysis of the interview data to develop questions and foci for future research. This information is presented in the Conclusions and Recommendations section.

Results and Discussion

For the past 10+ years, research and other relevant literature has referred to the need to respond not only to our environment, but also to the changing needs of the now broadly defined agriculture industry. As a result of these changing industry needs, as well as changes in the types and backgrounds of students entering agriculture programs, there have been efforts to increase the science-based instruction within the programs. These efforts have not been widely coordinated, and are mostly unique and individualized to local schools. The following discussion of the findings from our study will detail how respondents conceptualized the differences between traditional/vocational agricultural education and agriscience, and their perceptions of whether there was a need to implement more science-based instruction into the high school curriculum. Two other areas of inquiry were explored:

1. The degree to which agriscience should be integrated into curricula; and

2. Respondents' perceptions as to how teacher preparation programs need to be modified to ensure graduates are adequately prepared to teach agriculture as a science.

Defining Agriscience

Respondents described agriscience as a program that increases the number of science concepts integrated into agricultural classes. Examples from plant or animal science courses were those most frequently provided. Agriscience was also viewed as how programs adapted to changes in industry and education standards, as one respondent portrayed:

I think that agriscience again encompasses that change, that shift in agriculture from a primary production focus to a more well rounded focus, because a lot of the programs today and a lot of agricultural activities are science based and I think that's the reflection of the science involved.

Participants viewed agriscience as incorporating many of the biological and physical science concepts that were taught in the traditional high school biology curriculum in a manner that included agricultural examples:

They are getting the strong science base, plus the practical application of it, which I think, helps the students understand it and it stays with them longer.

Why Agriscience?

The overwhelming awareness of respondents about the emerging emphasis on science-based instruction-agriscience-in agriculture led us to probe further for their thoughts of why this was occurring. Two major

themes emerged from the analysis of the interview data, among which were promotion and perception of local programs, and agricultural literacy.

Perceptions of Local Programs

Respondents indicated that they believed agricultural education programs must continually struggle with the public perceptions of the image of vocational agriculture, based on the previous emphasis on vocational skills training. Many of the respondents expressed that administrators, students and community members retain the idea that agricultural education is not an academic program, leading to a lack of encouragement for brighter students to enroll. Respondents also believed their peers and colleagues see agricultural education as lacking in rigor. One university staff member stated that the change in names of courses to reflect an emphasis on science, as well as instruction focused on concept development and higher expectations for performance, has helped make agricultural education programs attractive to the more academically talented pool of students.

There is a more diverse population of students participating in agricultural education programs today as compared to the past. Many students have little or no background in traditional production agriculture. These changes in student demographics increase the responsibility of the teacher to create an image at the local level in order to recruit the types of students appropriate to the demands of the workforce of the future. Agricultural education at the national level has the same responsibility for image development and enhancement. Overwhelmingly, respondents felt that marketing these changes--course names, academic emphases, and employment opportunities--were important to the success of local programs. They also noted that it is an ongoing process:

Every time I switch an administrator, a guidance counselor, I (need to) educate that

person as to what agriculture education is. A lot of my time is spent doing that and it shouldn't have to be. What I see as the biggest problem is letting people know what agriculture is.
(Secondary Teacher)

Agricultural Literacy

Participants cited agricultural literacy as a second reason for the importance of the movement to science-based agriculture curricula. The change in curricular emphasis would enhance the recruitment of more academically talented students into agricultural education programs, as indicated above, which would likely lead to improved overall agricultural literacy due to reaching wider audiences. Students can learn about the vast agriculture, food, fiber, and natural resources system, and they can also be made aware of the diverse career opportunities that abound in the broadly defined agricultural industry. Furthermore, an emphasis on science concepts and pedagogy would provide students with a basis to make their own decisions, increasing cognitive skills such as critical thinking and questioning, and questioning information to avoid misconceptions, all hallmarks of modern science education methodologies. Providing opportunities for new ways of thinking through agriscience courses would be an ideal opportunity to create "informed decision makers going to the polls and dealing with agricultural issues," as stated by one respondent. Not all respondents agreed, however, as to the degree agriscience should be embraced and integrated into the high school agriculture programs as expressed by one secondary agriculture teacher:

I am afraid that if we go too heavy into the sciences that we could possibly miss some good kids and kids that can benefit from some of those foundational, vocational things that we still do tend to

do.... I think that there's a place for some science in all classes, maybe that is (in the range of) 40 to 60 percent.. . sometimes you just have to adjust to the class, some kids and some classes will eat all the science you can give them, and others, you will have to adjust to.

Three respondents indicated that communities should determine the amount and type of agriscience offered in the local curriculum. The agriscience content appropriate for any type of agricultural practice prevalent in one area of the country may not be appropriate or relevant to practice in another region. These respondents felt that standardizing curricula across regions is difficult in light of this diversity of practice. They also agreed that local program emphasis needs to evolve around the various animal, plant, mechanical and natural resources applications found in the community. While respondents stressed that agricultural education programs should emphasize local context, they also indicated a need to respond to the globalization of the marketplace and emerging global political reality.

Teacher Preparation Concerns of University Professionals and Practicing Teachers

College/university professionals and practicing teachers agreed that current teacher preparation programs are doing a "good job" addressing changes in agricultural education, but felt that more needs to be done. Concerns focused on how science instruction is actually documented and accounted for, as well as difficulties in knowing how to teach science within the context of SAEs and FFA experiences.

This group of respondents stressed that (secondary) teachers need to attend inservice opportunities in order to remain current of the content within agriscience. One university staff member conceded that, although not all teachers have the "innovative spirit to include agriscience",

they " teach (agriscience) because that is what the school is demanding, and it will meet the needs of their students. . . and communities." Teachers indicated they do not always meet this change in emphasis with enthusiasm due to feelings of inadequacy when teaching science, which supports the research of Johnson (1996) and others (Conroy & Bruening, 1994). We should note that the very pedagogical issues with which participants struggle-student inquiry (where the teacher does not know the answer to the problem), teacher as guide and facilitator, reflective teaching, among other methods-are the hallmarks of reform in science education. Most interviewees expressed confusion about the best ways to teach science concepts in an applied classroom. Clearly, teacher education programs were not viewed as addressing these issues well.

Another related issue was the backgrounds of students entering teacher education programs. As was noted by a number of the university faculty and staff, students entering teacher certification programs are not as familiar with agricultural education as they were in the past. Many current students have not attended a high school that offered agricultural education and lack the associated opportunity to participate in the FFA. Many also do not have a farm background. Teacher educators and other respondents fear that these new students, while being able to deliver outstanding science-based agriculture instruction, may not fully understand and value Supervised Agricultural Experiences (SAEs) and FFA enough to promote them and integrate them into their educational programs. One university faculty detailed his concerns about agriculture program identity by noting the following:

I am afraid that we will become no different from anyone else. (As new teachers) feel the pressures of being a brand new teacher something has to go. If you don't know SAE, and you don't know leadership . . . you are going to go

back to a place you are comfortable, which might be agriscience, which might be (something else).

Other respondents agreed and elaborated a fear that agricultural education will lose its unique identity and value if an emphasis on science-based instruction becomes the sole purpose of programming to the detriment of SAT3 and the leadership opportunities available through the FFA. The faculty member cited above cautions with the following:

What are we doing that's really any different than anyone else in the educational field? What makes us any different? If I, with my administrator lens on, look at (the ag ed program) and I see there isn't anything that I can't do with a regular (science) teacher. . . . then why do I need an ag program?

This concern could be interpreted as a threat that could give rise to justification for elimination of local secondary agricultural education programs. In spite of expressed concerns, interview data overwhelmingly supported the literature that calls for agriculture teachers to pursue science credentialing in addition to their agriculture certification (Conroy, 2000; Thompson & Balschweid, 1998; Thompson, 1999). It was believed that dual certification would validate and secure agricultural education programs as effective alternatives to traditional science education, allowing students to receive credits for applied science education in agriculture.

In summary, agricultural education has changed over the past 75 years, as have the needs of the students. Preparing workers for the agricultural occupations of today and the future no longer requires the vocational training or production focus that was prevalent during the previous century. Teacher skills and experiences

are also changing, with more individuals entering the field who are not familiar with agriculture and the leadership opportunities offered by the FFA. Individuals participating in this study confirmed that, if the value and benefits typically associated with agricultural education were to remain into the next century, then the content delivered in the classroom and the corresponding teaching methods will need to adapt. The question then becomes "How will teacher education in agriculture have to change to meet the needs for agriscience instruction?"

Conclusions and Recommendations

This study highlighted a general awareness of the change to science-based agricultural education and reasons for the change. Based on Gall, Borg, and Gall (1996) the findings of this qualitative study cannot be generalized beyond the participants and it is the responsibility of the readers to determine applicability to their respective situations. We have identified five themes that have emerged as conclusions from our analysis of the data.

First, a change to science-based programming would help improve the image of agricultural education. All participants believed that the image of agricultural education must be enhanced in order to attract higher-level students. They believed that image enhancement would also improve overall agricultural literacy through higher enrollments resulting from program changes and the ability of higher-level students to communicate more effectively to their peers, families and others about issues.

Second, there were different opinions as to the degree and type of science that should be infused into the agricultural education curriculum. This can be coupled with the third conclusion-that science based agricultural education needs to retain experiential learning and leadership opportunities. These statements both reflect concerns vocalized by a majority of

participants. The unique experiential learning and leadership components of agricultural education are viewed as being valuable enough to retain, regardless of any program focus. There was also no clear consensus about how to properly integrate more science instruction while not diminishing the SAE and leadership components. Participants believed that teacher education programs must address challenges in these conclusions.

Fourth, the unique nature of community-based agricultural education should still drive the curriculum, not only the occupational emphases, but the science emphases, as well. As a consequence, individual teachers must develop skills to integrate science instruction based on the agriculture within their communities. It is only through this process that contextualized teaching and learning can be truly effective and transferability of science knowledge and skills will be enhanced. This transferability is the basic purpose for the 1) science integration as indicated in the majority of agricultural education literature since the publication of New Directions in 1988 and 2) changes reflected in the Carl D. Perkins Acts.

Fifth, teacher education programs face not only issues with pedagogical changes, but also with the backgrounds of students entering their programs. Both these issues impact delivery of agricultural education at the local level.

Several recommendations for teacher education in agriculture are made as a result of the data analysis. The profession needs to agree on exactly what agriscience instruction is, and how it differs from traditional agricultural education. The researchers believe that agriscience education involves parallel planning of a scope and sequence for delivery and assessment of science content, along with the agriculture, a process that is not typically a part of teacher education in agricultural coursework. This notion contrasts with our observations over the past eight years that

agricultural content scope and sequence are typically developed first, and the addition of science concepts may follow a rather random pattern of inclusion. Since it is known that the addition of more complex concepts to a schema in which the rudimentary concepts have not been learned is counterproductive (Apelman, Hawkins & Morrison, 1985; Erlwanger, 1973), it does not appear that a random process of science inclusion is very beneficial to students in the long run. In conjunction with this recommendation is that teacher education in agriculture should begin to identify pedagogical changes necessary for the instruction of agriculture as a science, and incorporate those into their methods courses. A further recommendation is for integration and/or team teaching with science education faculty so that science education students can benefit from agricultural education practices, as well.

Research, development, and implementation projects are needed to explore how to combine rigorous science education, particularly if they are planned according to the above recommendation, with SAE projects and FFA activities and events. Some recent research has indicated that SAE participation has declined in some areas (Steele, 1997); no research has examined whether this decline was related to pressure at the local level to teach agriscience. The outcome of this recommended research should be flexible curriculum guides and other materials for programs to improve and enhance their SAE and FFA offerings within the context of agriscience.

Agriculture teachers must be able to assess their environments and make necessary changes to meet the needs of students and their communities. Some of these skills are typically taught in a traditional program planning course, along with how to utilize advisory committees. These processes need to be re-examined within the context of the literature on change and the new emphases on technical agriculture, contextualized learning, and workplace skills (SCANS, 1991).

The information utilized for The National Council on Agricultural Education's Reinventing Agricultural Education for the Year 2020 project may be helpful in this effort. It is the opinion of the researchers that agricultural education is the premier vehicle for contextualized teaching and learning within any community setting. In order for it to meet both the demands of the broadly defined agriculture industry, as well as students within communities in which programs are housed, agricultural education must change. Some of the change can be effected by reflection and further research of the information reflected in this study.

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