Science Integration in Secondary Agriculture: A Review of Research

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Abstract

The Elementary and Secondary Education Act (No Child Left Behind) has put pressure on schools to increase their academic achievement, even if that means schools must eliminate courses that do not seem to have as much effect on that achievement. Because agricultural education has had a reputation for many years of being strictly vocational with no apparent academic qualities, agricultural courses are often among the first to consider being cut. Agricultural education, however, has known for several years that it needed to change its reputation to survive new and upcoming accountability standards. The researchers felt there was a need to examine research that could be used to support agricultural education's fight to survive and what future research may need to be conducted. The purpose of this article is to present the findings of a review of research on science integration in agricultural education during a ten year period (1993-2002). The findings support the belief that agricultural education is making strides in the right direction to achieve academic status. Further research is needed however, to ensure that students are getting the best information to help them achieve at the highest levels in secondary schools.

Introduction and Theoretical Framework

Agricultural education has entered a new era in its long evolution. The impact of No Child Left Behind is being felt nationwide. The act has the potential to change or even eliminate programs. To understand where agricultural programs are going to avoid such events, the history of agricultural education needs to be understood. This study is an attempt to understand what steps have been taken to update agricultural education programs and what support exists for these efforts.

The Smith-Hughes Act of 1917 established vocational agricultural education in the high schools. In these programs, students were to be taught skills that were needed in an agricultural career of the time (Chiasson & Burnett, 2001). Science was not considered a big part of the curriculum, leaving it up to the academic classroom, thereby creating the division between vocational and academic classes (Lohr, 1995).

In 1988, *Understanding Agriculture: New Directions for Education* was published by the National Research Council (NRC). This publication challenged the philosophy that vocational agriculture classes were supposed to be all about "cows and plows". Experts concluded that agricultural education must include science to be able to keep up with innovations and changes in the food and fiber industry (Lohr, 1995). Chiasson and Burnett (2001) stated that one of the best curricula to achieve this aim was agriscience. Courses in this area were already designed to meet the demands of the agricultural industry as far as training in sciences was concerned.

Over the years, vocational agriculture changed into agriscience or applied agricultural classes (Chiasson & Burnett, 2001). Production agriculture changed to include more science. Where production agriculture was no longer being taught, courses that involved more technology and science were taught (Sikinyi & Martin, 2002). Agriculture changed, and agricultural education did its best to keep up. Students today are taught skills that are new but are becoming common in the agricultural industry (Boehm, 2002).

American agriculture provides more and more of the world's food supply. New skills in so many new areas are taught to students, preparing them for a wide variety of careers that go far beyond just farming (Boehm, 2002). These skills are taught in a practical fashion, so students are able to apply them immediately in the workplace. Students are not just taught what they need to know to work, but how to do so as well (Chiasson & Burnett, 2001).

Lohr (1995) defined agriscience education as "the application of scientific principles in the teaching of agricultural practices" (p. 20). When the NRC called for improvements in agricultural education, Lohr (1995) stated, "Teaching science through agriculture would incorporate more agriculture into curricula, while more effectively teaching science" (p. 20). Williams and Dollisso (1998) stated "special emphasis was placed on the need for ongoing efforts to upgrade the scientific and technical content of the program" (p. 51).

Agricultural education can be an important part of the educational system. For a program to be successful, it must show that it is an integral part of any school's curriculum (Melodia & Small, 2002). To do this, agricultural education teachers need to make the curriculum interesting and make it relevant to the students in their programs (Sikinyi & Martin, 2002). For people who think agriculture cannot possibly be relevant to the majority of the students, they must realize that agriscience has already integrated its curriculum with math and science. Students learn principles that are founded in the real world and methods of dealing with real problems. Math and science have become concrete rather than abstract ideas that students can relate to (Melodia & Small, 2002). Students are encouraged to learn science when it is put into a form for which they can see a real application (Sikinyi & Martin, 2002).

Including science applications in an agriscience curriculum can only help students to achieve (Williams & Dollisso, 1998). When agricultural education teachers include science in their curriculum, they not only improve the academic aspect of it, but they are better able to prepare their students for more advanced careers in an area such as biotechnology (Sikinyi & Martin, 2002). Agricultural education is an able companion to science education in teaching students to be more scientifically literate (Chiasson & Burnett, 2001).

Agriculture is not just important to those who would work in the industry. The application of science in agriculture helps students to become better consumers. Everyone needs to know how agriculture works so they can be more effective citizens (Wilson, 2002).

Students learn more advanced skills in agriscience. Classrooms and labs in agriculture include equipment that can be found in the best science laboratories. Skills in advanced technologies are taught in the agriscience classroom that students could not have dreamed of learning just a few years ago. It is not unusual to see laminar flow hoods, microvideo cameras attached to microscopes, and elaborate aquaculture systems in an Agriscience laboratory. Students learn to clone plants through tissue culture, and check water and air for pollutants that may harm human health or the environment.

Several organizations are developing new curricula based on the latest technology. The FFA's new biotechnology curriculum provides material on genetics and microbiology and cover modern scientific and technological developments the agricultural industry considers important (Sikinyi & Martin, 2002; Wilson, 2002). Other organizations include textbook publishers, the USDA, and private businesses with an interest in producing the next generation of employees. Curriculum is developed and updated constantly in order to keep pace with the changing agricultural industry. The biological revolution demands more knowledge than ever before. Students must also be able to converse knowledgeably about such a controversial topic as agricultural biotechnology. The mission of the NRC recognizes the importance of agricultural education in providing the information students need for this knowledge (Wilson, 2002).

In 1990, the U.S. Congress determined that performance measures and standards had to be established to ensure proper instruction and content in agriscience courses. The Carl D. Perkins Vocational and Applied Technology Education Act Amendments of 1990 mandated that states should develop a method to evaluate programs and help them improve their performance when necessary (Belcher, et al., 1996). For clarification, the Center for Law and Education defined a performance measure as a "description of an outcome, and a standard is the level or rate of that outcome" (Belcher, et al., 1996, p. 1).

Developing these standards was not an easy project. The Carl D. Perkins Act of 1990 required states to use at least some of the performance measures included in the legislation, but could also develop their own standards. Teachers needed to be included in development of new standards as well as keeping up with the standards being established by the agricultural industry. The whole process was important because measures and standards could affect what content is actually taught, and ultimately how it is evaluated (Belcher, et al., 1996).

Once standards were established, there needed to be a way to show these standards were being met. Some form of assessment was necessary. Typical examples of assessment usually included achievement testing (Chiasson & Burnett, 2001). Because of the integration of so many of the academic areas in agriscience, the most appropriate form of assessment was the standardized achievement tests (Lee, 2001). However, caution had to be taken not to create a "one-test-fits-all" type of assessment. Separate tests were needed for each major subject area, and test items had to assess knowledge in agriscience and applied science (Lee, 2001).

Teachers needed to be involved in developing the assessment instruments. This would help ensure that teachers focus on proper assessment in their own courses. Also, teachers who have developed appropriate methods of assessment should share methods with other agricultural educators (Weber & Stewart, 2001).

Because of the importance of knowing if learning is taking place, testing leads to accountability. Accountability means that, to survive, agricultural education programs must prove their worth (Ullrich, 2001). Schools are closing programs to concentrate on meeting demands for accountability (Melodia & Small, 2002). Usually these programs do not appear to be helping with student achievement in math, science or other core subjects. Many programs still have the appearance of being strictly “vocational.” Programs that meet accountability standards use deliberate instructional procedures that lead to increased student science achievement scores, and therefore can survive today’s climate of cleaning house of “dead weight” courses (Lee, 2001).

Even teacher education programs are being held to certain standards to ensure that new teachers going out in the field are prepared for accountability requirements. New teachers learn ethics and what the standards for the courses of the programs they will be teaching are, as well as methods for teaching these courses, so they will not have problems with accountability (Whittington, et al., 2002).

Purpose/Objectives

The objective of this paper is to synthesize research conducted, and opinions written in the last ten years to determine what changes have occurred in the integration of science concepts in agricultural programs and attitudes toward obtaining science credit for such programs. Research over the period of time in question covered such topics as: (a) the history and evolution of scientific agricultural education, (b) support for science-based agricultural programs, (c) the benefits of science integration, and (d) support for awarding science credit to agriscience programs.

Methodology

Data was gathered from three sources to meet the objectives of the study: *The Journal of Agricultural Education*, *The Agricultural Education Magazine*, and *Proceedings from the National Agricultural Education Research Meetings*. These references were found through a computer search of the archives of the Journal, the archives of the Proceedings, and a search of the library computer system of a Level I research institution.

The article titles, objectives, research questions, conclusions, and recommendations were analyzed to identify trends and attitudes toward the progression of agricultural education from a vocational basis to a science basis. The categories developed included: (1) a synopsis of the history and evolution of agricultural education, (2) existence of support for science-based agricultural programs, (3) reported benefits of science integration into the agricultural curriculum, and (4) existence of support for awarding science credit to students participating in agriscience programs. Approximately 30 articles were originally analyzed for key words and concepts. Any article that researched the categories listed above was included in the final data.

Findings

History and Evolution of Agriculture Programs

Agricultural education has gone through many changes since its formal inception in 1917. It has gone from being science-based to vocational training-based, and back toward science-based in its long history. Hillison (1996) researched the evolution of agricultural programs, and said that the Hatch Act in 1887 established a scientific and experimental basis for agricultural research. Because of this, early developers of secondary and post-secondary courses recognized the importance of science to agriculture. Instructors for programs were expected to have a strong science background in their training and the courses they taught included chemistry and other sciences within the curriculum. Hillison cited Chamber's Encyclopedia with a definition of agricultural education that emphasized the importance of scientific instruction in teaching the practice of agriculture.

Hillison stated that it was only in later years, around the time of the Smith-Hughes Act of 1917, that less emphasis was placed upon science in agricultural education. The Act basically stated that secondary agricultural education should be for the training of students over fourteen years of age that work or intend to work on the farm. Agricultural education should not be of post-secondary quality, and the main purpose for said education should be to prepare students for "useful employment" (p. 10). Control over agricultural education shifted from the United States Department of Agriculture, which emphasized science and academic orientation, to the Federal Board for Vocational Education, and then to the U.S. Department of Education, which continued the vocational emphasis of the program. This was in spite of the fact the field of agriculture continued to be strongly based in the sciences.

Support for Science-Based Agriculture Programs

Once agriscience was accepted as a course, the possibility of making it an alternative for basic science courses began to be considered. Curriculum planners and instructors started talking about how science should best be integrated into the programs, and what would be the best way to get them recognized as legitimate science courses. One of those methods was to get the local administrators involved in the integration process. At the local level Thompson (2001) stated, "If integration of science into the agricultural education curriculum is to be successful on the secondary level, there must be support from the principal" (p. 58). Thompson and Balschweid (1999) found that the largest proportion of teachers believed that integration of science into their programs increased the support they received from administrators as well as parents. Thompson (2001) concluded principals believed the integration of science into agricultural education curriculum would increase support from administrators, other teachers and parents.

Another area of research conducted to ascertain the support that agricultural education programs could benefit from was the opinions of secondary school counselors. Dyer and Osborne (1999) found that counselors believed agriculture was a very technical field in which training for it would develop students capable of succeeding in college or employment. Johnson and Newman (1993) found that while agriscience courses were perceived by administrators and counselors, as well as science teachers, as being good preparation for mostly those students planning careers in agriculture, other students should also consider enrolling in the courses. This statement was made regardless of the students' post-secondary college plans. agriscience courses were considered useful for giving students agricultural literacy training, regardless of their future career plans.

Benefits of Science Integration

For agricultural education to survive the era of No Child Left Behind, students may need to be encouraged to take agriscience courses. Students may not realize how beneficial it can be to take agriscience courses. Many students have difficulty with basic science courses because they cannot relate what they learn in the course with what is in the real world. Hillison (1996) stated that understanding basic science concepts is important to all students. Whether they are learning science using agricultural examples in the curricula, or as Thompson (1998) stated, learning agriculture using scientific concepts and their application to agriculture, students will understand science better and be better able to use that knowledge in a current employment position. Balschweid (2002) reported in a research study that students who learned biology through agriculture were better able to connect how the two subjects were interrelated. Thompson's research in 2001 found that principals agreed that science integration would benefit students who chose to enter the agriscience program.

For teachers, integrating science may be a good method of recruiting students into their program (Thompson & Balschweid, 1999). Higher ability students who may not be attracted to a class that teaches welding, woodworking, and livestock feeding, may find that a science-integrated agricultural class has a lot more to offer them. Teachers believed that upgrading with science concepts would increase the credibility of the agriscience program and should result in increased program enrollment, including greater numbers of higher achieving students (Thompson, 1998).

There are a couple of studies that compare agriscience and non-agriscience students' scores on standardized achievement tests. The State of Louisiana administers a Graduate Exit Examination (GEE) to all 11th grade students. A study was conducted that compared agriscience and non-agriscience students who took the GEE on their science achievement. Agriscience students outscored non-agriscience students on the overall scaled score and on three out of the five science domains tested and were only outscored by the non-agriscience students on one domain. The researchers felt that agriscience students were better prepared to pass the science portion of the GEE and that should encourage students to take agriscience (Chiasson & Burnett, 2001). Connors and Elliot (1995) referenced a research report that stated students in agriscience classes scored higher than biological science students on a standardized biology test.

Support for Awarding Science Credit to Agriscience Programs

After it was determined that there was strong support for science-integrated agricultural classes, agricultural educators started trying to acquire science credit for agriscience courses. Johnson (1996b) stated that the courses this should be attempted for were those that were related to the life sciences rather than the physical sciences. These courses were more likely to be able to gain science credit.

The NRC recommended that science elective credits should be awarded for applied science courses. States such as Louisiana have begun allowing students to apply for science credit if they have completed 2 years of agriscience (Chiasson & Burnett, 2001). To ensure the credits actually help students, courses will therefore have to consistently include more science, mathematics, and language in their content. Teachers will need to place more emphasis on the science aspect in their courses (Belcher, et al, 1996). Schools do not need to try to teach more content, but teach what is essential for the students to learn the science concepts in a more effective manner (Connors & Elliot, 1995).

The provision most researchers felt should be required was the curricula for which science credit was to be requested needed to meet state science objectives. Johnson (1996b) found that Arkansas teachers reported that over half of the curriculum they taught was related to the state science curriculum. Dormody (1993) found that regardless of attempts to gain science credit, agriculture teachers should work with their school's science departments to ensure the curriculum is sufficiently science-based. The presence of science competencies in the curriculum would make it easier to gain support for their program.

Two studies cautioned that researchers should determine whether or not students are actually learning science competencies before requesting science credit. Thompson and Balschweid (1999) recommended further research on the subject and Newman and Johnson (1993) recommended research be conducted on achievement to be used in applying for science credit for a new agriscience program in Mississippi. A study conducted in Utah (Warrick & Straquadine, 1998) found that while the students in an agriculture-based biology class had a lower overall GPA than traditional biology students, they were able to score equally well on the Biology Core Test in that state. This finding would indicate that using agriculture to teach biology at least does not hinder students trying to learn the subject.

It is strongly believed that offering science credit will be of benefit to the students and the agriculture program. Agriculture teachers generally agree that offering science credit would have a positive effect (Johnson, 1996a). Johnson and Newman (1993) found that administrators, counselors, and science teachers also supported awarding science credit for agriscience courses. The science teachers were the strongest supporters and should be used as advocates when science credit is applied for.

Conclusions

Evolution of Agriculture Programs

Agricultural education is returning to its scientific roots. The creators of the original agricultural education programs recognized the need for scientific knowledge. However, for some reason, the need was rejected in favor of strictly vocational training. Currently, though, the need for a scientific basis in agriculture is again being recognized and efforts are being made to reinstate and strengthen its presence in current agricultural programs.

Support for Agriculture Programs

There is strong support amongst many of the groups that would have an impact on and would be affected by vocational programs for the creation and maintenance of strong, scientifically based agriscience programs. It is believed that agriscience courses would be of great benefit to students wishing to learn science in a practical, reality-based form. Administrators, counselors, and science teachers all believe that agriscience can offer students a practical method of learning science, in a manner that encourages students to learn about and understand science using real-world applications.

Benefits of Science Integration

Offering science integration and science credit has been shown to generate benefits to both the students enrolled and the agricultural programs that offer it. Students learn science competencies using real-world applications that can encourage further interest in science. The programs gain students who might not otherwise have enrolled. This would result in larger, stronger programs with even more to offer in the future.

Support for Science Credit

Teachers and other groups believe that agriscience programs are of such strength in science competencies that the courses are deserving of science credit. While it is cautioned that credit should not be blindly awarded, if studies of programs prove the courses do have sufficient scientific basis and the teachers are properly trained to teach such courses, then science credit could be safely awarded for the programs. Such credit could only be of benefit to the students and programs where it is awarded.

Implications and Recommendations

In the end, agricultural education has come a long way from mere job preparation. Now an agriscience classroom is more like a scientific laboratory. The teacher must make an effort to meet the standards established to be accountable: to the school, the community, the parents, and most of all to the students. Teachers must also make an effort to be sure that others realize the value of the agriscience program, and to avoid losing programs that give students another option for learning science, in real-world applications.

Research has consistently shown that agriscience is a valid course of education with much to offer schools and students. For such programs to compete in the climate of No Child Left Behind, they need to obtain science credit for their students and ensure the students are learning the skills they are supposedly being taught. Further research should be conducted to determine if such learning is taking place, and where necessary, shown to administrations that may want to cut such programs to make room for others deemed more important or efficacious.

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