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INTEGRATING SCIENCE INTO THE AGRICULTURAL EDUCATION CURRICULUM: DO SCIENCE AND AGRICULTURE TEACHERS AGREE?

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Abstract

Agriculture teachers and science teachers who taught in a high school with an agricultural education program were targeted for this study to determine and compare their perceptions of integrating science into agricultural education programs. The data indicate that while both groups have responded positively to the call to integrate science into the agricultural education curriculum, some differences in attitudes do exist. A majority of the teachers indicated that teacher preparation programs should provide instruction on how to integrate science both at the preservice and inservice levels. More agriculture teachers were in agreement than science teachers that integrating science would help agriculture programs meet state standards and help students meet requirements for state standards. Although a majority of science teachers agreed, a significantly greater number of agriculture teachers agreed that students will be better prepared for standardized testing if they learn science through an agriculture context.

Introduction

The integration of agricultural education with academic subjects has been the topic of much discussion and interest over the past several years. Roberson, Flowers, and Moore (2001) defined integration between vocational education and academic subjects as "a marriage of both types of curricula in order to teach the many skills necessary for students' future successes" (p. 31). Furthermore, Farley and Taylor (2004) posited, "If we continue to teach all skills in isolation, we can only reinforce the idea that we acquire different skills for use in different subject areas" (p. 8).

Both academic and vocational groups have made calls for the integration of science and agriculture. The American Association for the Advancement of Science has recommended connecting what students learn in school through interdisciplinary links, real-world connections, and connections to the world of work (American Association for the Advancement of Science, 1993). In 1988, the National Research Council recommended that agriculture courses be expanded to increase scientific and technical content to better prepare students for advanced study and employment in the changing food and fiber industry. Additionally, The Carl D. Perkins Vocational and Applied Technology Act of 1990 encouraged academic and vocational teacher collaboration for pedagogy revision, multidisciplinary integration, and implementation of real-life learning experiences (Lankard, 1992).

Research findings support the claim that the integration of science into the agriculture curricula is a more effective way to teach science. Students taught by integrating agriculture and scientific principles demonstrated higher achievement than did students taught by traditional approaches (Chiasson & Burnett, 2001; Enderlin & Osborne, 1992; Enderlin, Petrea, & Osborne, 1993; Roegge & Russell, 1990; Whent & Leising, 1988).

The theoretical model for this study consists of factors influencing the amount of collaboration and integration between agriculture teachers and science teachers. Fishbein and Ajzen's (1975) planned behavior theory suggested that demographic variables, knowledge and observations influence beliefs, which influence attitudes, intentions, and finally behaviors. In

attempting to increase the level of collaboration and integration, the perceptions of agricultural science instruction by all stakeholders, including agriculture instructors, students, parents, administrators, guidance counselors, and science teachers, must be considered.

Over the past decade, several studies have provided insight into the perceptions of different groups of stakeholders. Attitudinal surveys of agriculture teachers in Oregon (Thompson & Balschweid, 1999), Mississippi (Newman & Johnson, 1993), Texas (Norris & Briers, 1989), South Carolina (Layfield, Minor, & Waldvogel, 2001), and Indiana (Balschweid & Thompson, 2002), as well as winners of the National FFA's Agriscience Teacher of the Year Award (Thompson & Schumacher, 1998b) have all provided information regarding the perceived needs and barriers of integrating science. Other studies have provided insight into the perceptions of guidance counselors, administrators, parents, and students toward integrating science into the agricultural education curriculum (Balschweid, 2002; Dyer & Osborne, 1999; Johnson & Newman, 1993; Osborne & Dyer, 2000; Thompson, 2001).

The perceptions of science teachers, in particular, are extremely important to the successful integration of science and agriculture (Johnson and Newman, 1993). Collaboration and resource sharing between the science teacher and agriculture teacher are often required, and it is often science teacher groups within a state, district, or school that influence whether or not students enrolled in agriscience courses receive science credit toward graduation. Greater understanding of the perceptions and attitudes of science teachers toward integrating science and agriculture should assist in implementing changes and programs that will increase the level of integration and collaboration. In a study of attitudes of Illinois high school science teachers toward education programs in agriculture, Osborne and Dyer (1998) found that science teachers agreed that stronger connections should be made between science and the agriculture curricula and that agriculture programs should become more science based. Osborne and Dyer also found that nearly one-half of the science teachers reported some collaboration with agriculture teachers. They recommended further studies of science teacher teachers' perceptions toward agriculture program quality.

Major questions of concern include the need for integration of science and agriculture as well as the ability and preparation of the agriculture teacher to integrate science into the agriculture curriculum.

Objectives

The purpose of this study was to determine the perceptions and attitudes of high school science teachers and agriculture teachers toward integrating science into the agricultural education curriculum. The following research objectives were addressed:

1. Describe the demographic characteristics of science teachers and agriculture teachers in Oregon who taught in schools with agricultural education programs;
2. Describe and compare perceptions of selected science teachers and agriculture teachers concerning the integration of science and agriculture;
3. Describe and compare selected science teachers' and agriculture teachers' perceptions regarding the role of teacher preparation programs in agriculture; and,
4. Describe and compare selected science teachers' and agriculture teachers' perceptions toward meeting state standards through increased integration in agricultural education programs.

Methods/Procedures

The target population for this study consisted of science teachers (N = 360) in schools that had secondary agriculture programs during the 2001-2002 school year and agriculture teachers (N = 121) during the 2001-2002 school year. The Oregon department of education provided the researchers with a current database

containing the name and school address of each science teacher. This database was matched with the database of all agriculture teachers during the 2001-2002 school year. Science teachers employed at schools with no agricultural education program were not included in the final population. Caution should be exercised when generalizing the results of the study beyond the population.

The instrument used in this study to describe the perceptions of science instructors was adapted from the Integrating Science Survey Instrument developed by Thompson and Schumacher (1998a). Face and content validity for the version of the instrument used in this study was established by a group of university teacher educators in agricultural education and science education, and by state supervisors of agricultural education. Two forms of the questionnaire were created by the researchers: one for agriculture teachers, and one for science teachers. The primary difference between the two forms was the wording of the questions. The two forms were pilot tested by science teachers (n = 9) and agriculture teachers (n = 10) in Utah to further establish face and content validity as well as initial reliability (α = 0.87). As a measure of the reliability of the attitudinal scale, internal consistency for the science teacher form was measured at α = 0.90 using Cronbach's alpha with construct reliability ranging from α = 0.71 to α = 0.85. Internal consistency for the agricultural science teacher form was measured at α = 0.86 with construct reliability ranging from α = 0.71 to α = 0.83.

The survey instrument was mailed to all subjects along with a cover letter and return envelope. Two weeks after the initial mailing, a follow-up postcard was mailed to all non-respondents. After another two week waiting period, a second survey instrument and return envelope were mailed to non-respondents. Usable responses were received from 222 science teachers for an overall response of 61.7% and from 106 agriculture teachers for an overall response of 87.6%. To examine for non-response bias a t-test was used to compare early and late respondents on the summated scale perception responses (Linder, Murphy, & Briers, 2001). The t-values obtained verified that the difference between early and late respondents was not statistically significant.

Each form of the instrument consisted of two parts. Part one included 62 five-point scale questions designed to obtain information about the perceptions of integrating science and agriculture. Subjects were asked to respond to statements using a 5 for strongly agree, a 4 for agree, 3 for neutral, 2 for disagree, and 1 for strongly disagree. Part two requested that the subjects report demographic information about themselves.

Data received from part one of the survey were analyzed and frequencies reported as the percent of respondents that chose each of the five response levels. To simplify reporting, following data analysis, strongly agree and agree were combined into one category named "Agree" and disagree and strongly disagree were combined into one category named "Disagree." Responses by construct from science teachers and agriculture teachers were then compared using the Mann-Whitney U Test. This test was chosen due to the ordinal nature of the data (scaled responses) and the independence of the sample groups (Mertens, 1997).

Results/Findings

Research question one sought to determine demographic information for the respondents. A summary of the demographic characteristics of science and agriculture teachers is presented in Table 1. The mean age of science teachers teaching in a school with an agricultural education program was 42 years old (SD = 10.1). Respondents had taught an average of 14.6 years (SD = 9.27) with 9.7 years of teaching experience at their current school (SD = 8.158). The majority were male (68.2%) and lived in a town/city (59.5%) at the time of the survey.

Table 1
Demographic Profile of Science and Agriculture Teachers

Demographic Variable	Science Teachers	Agriculture Teachers
Years of teaching experience	*M* = 14.59 (*SD* = 9.27)	*M* = 13.51 (*SD* = 10.49)
Years taught at current school	*M* = 9.71 (*SD* = 8.15)	*M* = 9.82 (*SD* = 8.81)
Age	*M* = 42.33 (*SD* = 10.11)	*M* = 39.55 (*SD* = 11.44)
School Size	*M* = 465 (*SD* = 247.1)	*M* = 365 (*SD* = 260.7)
Gender		
Female	39.3%	17.1%
Male	60.7%	82.9%
Participation in 4-H or agricultural education as a youth	28.0%	87.6%
Type of area raised in		
Farm/Rural	46.3%	84.6%
Town/City	53.7%	15.4%
Type of area lived in at the time of survey		
Farm/Rural	40.5%	74.0%
Town/City	59.5%	26.0%
Participated in inservice/workshop courses on integration		
Yes	24.7%	79.2%
No	75.3%	20.0%
Current school awards Science credit toward high school graduation for agricultural education courses		
Yes	46.9%	45.2%
No	53.1%	54.8%

Approximately one in four science teachers (24.7%) reported they had participated in an inservice workshop or course that demonstrated how to integrate science and agriculture and slightly fewer than half of the teachers (46.9%) reported that students attending their school received science credit toward high school graduation for successful completion of agricultural education courses. Slightly over one fourth of the science teachers (28.0%) reported they had taken agricultural education courses in high school and/or been involved in 4-H.

The mean age of agriculture teachers was 39.6 years (*SD* = 11.4) with 13.5 years

of teaching experience (*SD* = 10.5) and 9.8 years teaching experience at their current school (*SD* = 8.8). The majority were male (82.9%) and lived on a farm or in a rural area (74.0%) at the time of the survey. Over three in four agriculture teachers (79.2%) reported they had participated in an inservice workshop or course that demonstrated how to integrate science and agriculture. Slightly fewer than half of the teachers (45.2%) reported that students attending their school received science credit toward high school graduation for successful completion of agricultural education courses. A large majority of the respondents (87.6%) reported they had taken agricultural education courses in high school and/or been involved in 4-H.

Research question two sought to determine and compare science teachers' and agriculture teachers' perceptions concerning integrating science and agriculture. The results from the 12 statements indicated that a majority of the science teachers either agreed or strongly agreed with all the statements. Percentages of science teachers who agreed or strongly agreed with the statements ranged from 38.31% to 96.85%. The highest level of agreement was found in the statement that "agriculture is an applied science," where 97% of the science teachers agreed or strongly agreed and 100% of the agriculture teachers agreed or strongly agreed with the statement. More than half of the teachers indicated a neutral response (54%) toward the statement that "integrating science into agriculture classes has increased ability to teach problem solving." Approximately 50 percent of the science teachers agreed or strongly agreed that the agriculture teacher in their school was competent enough in science to teach integrated science concepts.

The majority of agriculture teachers also agreed or strongly agreed with all the statements related to integrating science into the agriculture curriculum. Percentages of agriculture teachers that agreed or strongly agreed with the statements ranged from 58% to 100%. The highest level of agreement was found for the statement that "agriculture is an applied science." Ninety-seven percent of the science teachers and 100% of the agriculture teachers agreed or strongly agreed that agriculture is an applied science and those involved in agriculture must have a greater understanding of science than ten years ago. A majority of the teachers (90% science; 88% agriculture) also agreed or strongly agreed that applied science principles should be infused into the agriculture curriculum, and that students are more aware of the connections and learn more about agriculture when science concepts and principles are integrated into the curriculum. Additionally, a majority (81.13%) of the agriculture teachers agreed or strongly agreed that they are competent enough in science to teach integrated science concepts.

Although a majority of the teachers agreed with all but one statement in the construct concerning perceptions of science and agriculture, eight of 13 statements were found to be statistically significant between the science teacher and the agriculture teacher. Science and agriculture teachers differed in the level to which they agreed with integrating science and agriculture. Agriculture teachers agreed more strongly than science teachers (Mann-Whitney U = 7883.5, p = .004). A summary of the perceptions of science teachers and agriculture teachers is presented in Table 2.

Table 2
Percentage of Agreement Between Science and Agriculture Teachers on Their Perceptions of the Integration of Science and Agriculture

Question	Science A / DA	Agriculture A / DA	Mann-Whitney *U*, *p*-value
Agriculture is an applied science.	97% / <1%	100% / 0%	$U = 7286.0$, $p < .001$
People in agriculture must have a greater understanding of science than 10 years ago.	96% / <1%	96% / 0%	$U = 8977.5$, $p = .137$
Students are more aware of connection between scientific principles and agriculture when integrated.	93% / 1%	93% / 0%	$U = 9594.0$, $p < .670$
Students learn more about agriculture when science concepts are integrated.	92% / <1%	89% / 1%	$U = 7998.5$, $p = .003$
Applied science principles should be infused into the agriculture curriculum.	90% / 1%	88% / 0%	$U = 8967.0$, $p = .157$
Ongoing efforts should be expanded to upgrade scientific content.	85% / <1%	82% / 2%	$U = 8813.0$, $p = .098$
Science teachers should examine curricula used for integration opportunities.	73% / 7%	86 % / 3%	$U = 8151.0$, $p < .007$
Agriculture students learn scientific concepts when integrated into agriculture curriculum.	70% / 4%	86% / 0%	$U = 7318.5$, $p < .001$
Agriculture students are better prepared in science if integration takes place.	70% / 10%	86% / 0%	$U = 7741.5$, $p = .001$
I feel comfortable working with the Ag./Science Department to develop a team teaching approach in integration.	68% / 11%	64% / 17%	$U = 9032.5$, $p = .209$
Students understand science concepts easier when agriculture is integrated.	65% / 8%	68% / 1%	$U = 6544.5$, $p < .001$
The agriculture teacher is competent enough in science to teach integrated science concepts.	50% / 17%	81% / 6%	$U = 7077.5$, $p < .001$
Integrating science into agriculture classes has increased ability to teach problem solving.	38% / 7%	58% / 6%	$U = 7970.0$, $p = .003$

Note: A = agree, DA = disagree. Following data analysis, strongly agree and agree were collapsed into the agree (A) column and strongly disagree and disagree were collapsed into the disagree (DA) column.

Research question number three contained six statements designed to address the science and agriculture teachers' perceptions regarding the role of teacher preparation programs in assisting teachers to integrate science (Table 3). The results of the six statements ranged from 47% to 90% of the science teachers in agreement and 31% to 92% of the agriculture teaches in agreement with the statements. Four statements in the teacher preparation construct exhibited statistically significant differences concerning the degree of agreement, including providing instruction for pre-service teachers, providing instruction for inservice teachers, and that teacher educators should teach a course modeling team teaching and collaboration.

Over 87% of the science teachers and 90% of the agriculture teachers strongly agreed or agreed that teacher education programs should provide instruction for undergraduates and teachers in the field on how to integrate science into the agriculture curriculum. There was only one statement in the teacher preparation construct with which a majority of the teachers did not agree. Forty-seven percent of the science teachers and 31% of the agriculture teachers agreed with the statement that science teachers should mentor beginning agriculture teachers in their school district. Almost half (49%) of the agriculture teachers and 40% of the science teachers indicated a neutral response concerning science teacher mentoring. Table 3 provides a summary of science teachers' and agriculture teachers' perceptions of the role of teacher preparation programs in integrating science and agriculture.

Table 3
Perceptions of the Role of Teacher Preparation Programs in Agriculture

Question	Science A / DA	Agriculture A / DA	Mann-Whitney *U*, *p*-value
Provide instruction for undergraduates on how to integrate science	90% / 2%	92% / 0%	$U = 10577.5$, $p = .663$
Provide inservice for teachers in the field on how to integrate science	87% / <1%	90% / 0%	$U = 10176.5$, $p = .295$
Should place student teachers with a cooperating teacher who integrates science	80% / 1%	54% / 11%	$U = 7027.0$, $p < .001$
Teach a course that allows future teachers to learn to team teach and model collaboratively	75% / 4%	65% / 5%	$U = 8793.5$, $p = .003$
Increase basic science course requirements for undergraduates	67% / 2%	54% / 20%	$U = 8114.5$, $p < .001$
Science teachers should mentor beginning agriculture teachers to help them integrate	47% / 12%	31% / 30%	$U = 7939.5$, $p < .001$

Note: A = agree, DA = disagree. Following data analysis, strongly agree and agree were collapsed into the agree (A) column and strongly disagree and disagree were collapsed into the disagree (DA) column.

Research question four contained eight statements that addressed state standards. Overall, science teachers and agriculture teachers differed in the level to which they agreed with questions about how increased science integration affects the ability to meet state standards (Mann-Whitney U = 6025.0, $p < .001$). Additionally, five statements in the state standards construct were found to be statistically significant between the science and agriculture teachers' level of agreement. A summary of responses related to state standards is provided in Table 4.

Table 4
Perceptions of the Ability to Meet State Standards with Increased Science Integration

Question	Science A / DA	Agriculture A / DA	Mann-Whitney U, p-value
Integration will help Agriculture Programs align with educational standards.	80% / 2%	85% / 0%	$U = 9503.0$, $p = .057$
Integrating will help students meet requirements for State Initial Mastery.	77% / 5%	89% / 0%	$U = 8970.0$, $p = .007$
Integrating will help students meet requirements for State Advanced Mastery.	73% / 4%	84% / 3%	$U = 8821.0$, $p = .005$
High School graduation credit should be offered for agriculture classes that integrate science.	59% / 24%	90% / 2%	$U = 4868.5$, $p < .001$
Our school is actively engaged in meeting state standards.	57% / 21%	60% / 20%	$U = 10309.5$, $p = .529$
Students will be better prepared for standardized testing if they learn the application of science.	55% / 14%	78% / 5%	$U = 7272.5$, $p < .001$
Agriculture courses that integrate science should be credited toward college admission science requirements.	51% / 24%	92% / 2%	$U = 4893.0$, $p < .001$
State standards will impact the way science content is delivered.	43% / 21%	40 % / 12%	$U = 7939.5$, $p = .383$

Note: A = agree, DA = disagree. Following data analysis, strongly agree and agree were collapsed into the agree (A) column and strongly disagree and disagree were collapsed into the disagree (DA) column.

Both science and agriculture teachers agreed (80% and 85%, respectively) that integration will help agriculture programs align with educational standards. Five out of eight of the statements were statistically significant. Although not statistically significant, 90% of the agriculture teachers agreed or strongly agreed and 59% of the science teachers agreed or strongly agreed that high school graduation credit should be offered for agriculture classes that integrate science. Further, 92% of the agriculture teachers and 51% of the science teachers agreed that these courses should be credited toward college admission science requirements, and 78% of the agriculture teachers and 55% of the science teachers agreed that students will be better prepared for standardized testing if they learn the application of science.

Conclusions/Implications/ Recommendations

The purpose of this study was to determine attitudes and perceptions of science and agriculture teachers toward integrating science into the agricultural education curriculum. Although there was variation in the level to which agriculture teachers and science teachers agreed with the individual statements in the survey instrument, both groups of teachers generally expressed positive attitudes toward the integration of science into the agricultural education curriculum. Fishbein and Ajzen's planned behavior theory (1975) provides a framework for explaining the potential for integrating science into the agricultural education curriculum based upon the positive perceptions of both science and agriculture teachers in this study. They indicate that the positive perceptions held by science and agriculture teachers toward integrating science into the agricultural education curriculum will influence their intentions and behaviors. In understanding stakeholder perceptions (in this study, science teachers), it can be concluded that since science teachers hold positive perceptions toward similar concepts concerning integrating science as agriculture teachers, there is potential to integrate more science into the agricultural education curriculum.

Although the science teachers and the agriculture teachers in this study held positive attitudes toward the integration of science in the agricultural education curriculum, they differed in the levels to which they agreed with integrating science and agriculture. It is recommended that agriculture teachers, teacher educators, school administrators, and state officials be made aware that science teachers in this study generally hold positive attitudes toward integrating science and agriculture and may be interested in working with the agriculture program in their school.

Teachers agreed agriculture is an applied science and people involved in agriculture must have a greater understanding of science than 10 years ago. These findings correspond with a previous study of Illinois science teachers (Osborne & Dyer, 1998). Science and agriculture teachers responded positively toward student benefits when science is integrated into the agricultural education curriculum. Integration of science into the curriculum should produce more science literate students that have a deeper understanding of agriculture and how the connection and application of science and agriculture are integral.

Teacher education programs can have a dynamic impact on helping teachers develop the pedagogical and technical skills to increase the science content in the agricultural education curriculum. A majority of the teachers indicated that teacher preparation programs should provide instruction on how to integrate science both at the preservice and inservice levels, and that student teachers should be placed with a cooperating teacher that makes concerted efforts to integrate science into the curriculum. Moreover, science and agriculture teachers felt teacher education programs in science and agriculture should model collaboration by teaching a course that helps future teachers in science and agriculture learn how to collaboratively teach.

Although the teachers differed in their level of agreement, the majority of science teachers and agriculture teachers agreed that preservice agriculture teachers should take

more basic science courses at the undergraduate level. When both agriculture teachers and science teachers recommend more basic science skills, it may be time to re-evaluate the science requirements of agricultural education programs. Teacher educators should design the preservice curriculum incorporating basic science classes that will help future agriculture teachers develop necessary science skills. Adding more science courses alone may not necessarily increase integration of more science into the agriculture curriculum, but agriculture teachers may feel more confident in their science skill level to teach to some level of depth. Further, teacher educators should work with science teacher educators to not only model teaming, but to also help preservice teachers learn the pedagogy of teaching science. The generally positive findings of this study toward integrating science and agriculture support prior research (Conroy & Walker, 2000; Layfield et al., 2001, Thompson & Balschweid, 1999; Thompson & Schumacher, 1998b). It is recommended that teacher preparation programs in agriculture review the amount of science offerings at the undergraduate level to determine if there are appropriate science classes that can be added to the undergraduate program.

Do science teachers know and understand the science content in the agricultural education curriculum? Teachers should be encouraged to crosswalk their curriculum with science teachers and show where science standards are incorporated into the curriculum. Agriculture teachers and science teachers should work together to develop strategies that best integrate science into the curriculum. Administrators can assist with the process by providing time for teachers to collaborate as suggested by several science teachers in this study.

More agriculture teachers were in agreement than science teachers that integrating science would help agriculture programs meet state standards and help students meet requirements for state standards. The biggest area of disagreement between the science and agriculture teachers was offering science graduation credit and college admissions' science requirements for agriculture courses that integrate science. With additional research, this may explain why science teachers sometimes oppose the integration of science and agriculture subject matter. Although a majority of teachers agreed, a significant number of agriculture teachers were more in agreement that students will be better prepared for standardized testing if they learn science through an agriculture context.

The data presented serves as a benchmark for identifying and comparing science and agriculture teachers' perceptions of integrating science and agriculture. Further areas of research include: (a) examining exemplary programs that integrate science and agriculture may yield a model for integrating science; (b) assessing the influence of integrating science in the agricultural education curriculum on student achievement in science would add to the knowledge base on contextual learning; (c) determining other stakeholder perceptions of integrating science into the agricultural education curriculum; (d) assessing agriculture teachers' knowledge of basic science concepts would provide a more independent measure of teacher science competence; and (e) identifying effective collaboration approaches for academic and agriculture teachers.

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