BARRIERS, SUPPORT, AND COLLABORATION: A COMPARISON OF SCIENCE AND AGRICULTURE TEACHERS' PERCEPTIONS REGARDING INTEGRATION OF SCIENCE INTO THE AGRICULTURAL EDUCATION CURRICULUM

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Abstract

This study is part of a larger investigation which focused on determining and comparing the perceptions of agriculture teachers and science teachers on integrating science into agricultural education programs. Science and agriculture teachers' perceptions of barriers to integrating science, the support of stakeholders, and collaboration between science and agriculture teachers and programs were investigated. The majority of both science and agriculture teachers were in agreement that funding, equipment, and the science teachers' lack of an agricultural background were barriers to integration. However, they differed in their level of agreement about curriculum and teachers' philosophical differences as barriers. Both groups agreed their school has strong science and agriculture programs, that collaboration would benefit students, and that the two departments have something to offer each other. However, fewer than one-half of teachers in both groups reported they work in a collaborative effort with the other department.

Introduction/Theoretical Base

As graduation requirements and external pressures for accountability have increased over the past few years, greater attention has been given to the integration of academic subjects into career and technical education, including the agricultural education curriculum. While career and technical educators have been criticized for providing overly specific training, academic educators have often been criticized for providing education void of application and connection to authentic world experiences. The call to integrate academic education with career and technical education has been made by educators, supported by business and industry, as well as by professional and academic organizations, and articulated by policy makers in the 1990 Carl Perkins Amendments (Lankard, 1992). 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. Furthermore, the American Association for the Advancement of Science (1993) has recommended connecting what students learn in school through interdisciplinary links, real-world connections, and connections to the world of work.

The merging of agriculture and science in the public secondary schools of America is not just a phenomenon of the past few years. Agriculture itself was considered a natural science and taught as such in the earliest textbooks used in agricultural education (Nolan, 1918). However, while the concept of agriculture as a science, or agriscience as it may be often labeled, is almost 100 years old, the content is certainly different as huge advancements in both agriculture and science have been made during that same time period.

Research findings support the claim that the integration of science into the agriculture curricula is an effective way to teach science. Students taught by integrating agriculture and scientific principles demonstrated equivalent or higher academic

achievement when compared with 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 that influence the amount of collaboration and integration between agriculture teachers and science teachers. Connelly and Clandinin (1988) indicated that identifying influential stakeholders and understanding their perceptions is essential for successful implementation of innovative educational programs. They define a stakeholder as "a person or group of persons with a right to comment on, and have input into, the curriculum offered in schools" (p. 124). In their planned behavior theory, Fishbein and Ajzen (1975) suggest 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). However, none of these studies compared the perceptions of science and agriculture teachers.

The perceptions of science teachers, in particular, are extremely important to the successful integration of science and agriculture (Johnson & Newman, 1993). Collaboration and resource sharing between the science teacher and agriculture teacher are often required, and it is often the 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) recommended further studies of science teachers' perceptions toward agriculture program quality.

Purpose/Objectives

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

1. Describe the demographic characteristics of agricultural science teachers and science teachers who teach in schools with agricultural education programs;

2. Describe and compare the perceived barriers to integrating science into the agricultural education program;

3. Describe and compare the perceptions of science teachers and agriculture teachers concerning

support of the agricultural education program as the level of science integration is increased; and

4. Describe and compare the perceptions of collaboration between science and agriculture departments.

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 in one western state. The state 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 agricultural science and technology instructors during the 2001-2002 school year. Science teachers employed at schools with no agricultural education program were not included in the final population. Careful consideration should be exercised when generalizing the results of the study beyond the population.

The instrument used in this study to identify the perceptions of science teachers 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, one for agricultural science teachers, and one for science teachers. The primary difference between the two forms was the wording of the questions. Both forms of the instrument consisted of three parts. Part one included 62 five-point summated rating 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, and part three consisted of four open-ended questions.

The two forms were pilot tested by science teachers (n = 9) and agriculture teachers (n = 10) in a neighboring state to establish initial instrument reliability (α = 0.87). Cronbach's alpha was computed to measure the internal consistencies of attitudinal scale included in the instrument. The coefficients obtained were 0.90 for science teachers and 0.86 for agriculture teachers.

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 as suggested by Linder, Murphy, and Briers (2001). The t-values obtained verified that the difference between early and late respondents was not statistically significant.

Data received from part one of the survey were analyzed and frequencies reported as the percentage of respondents that chose each of the five response levels. Following statistical analysis, to simplify reporting, strongly agree and agree were combined, as were disagree and strongly disagree. Responses by question and 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 (rating scale responses) and the independence of the sample groups (Mertens, 1997). The alpha level for statistical significance was set a priori at .05.

Results/Findings

Research objective one was aimed at determining demographic information for the respondents (Table 1). The average science teacher teaching in a school with an

agricultural education program was 42 years old (*SD* = 10.1) with 14.6 years of teaching experience (*SD* = 9.27) and had taught approximately 10 years 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. 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 respondents (28.0%) reported they had taken agricultural education courses in high school and/or been involved in 4-H.

Table 1
Demographic Profile of Science and Agricultural Science 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)
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%	80.0%
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%

The average agriculture teacher was 39.6 years old (*SD* = 11.4) with 13.5 years of teaching experience (*SD* = 10.5) and had taught approximately 10 years 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. 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 majority of the respondents (87.6%) reported they had taken agricultural education courses in high school and/or been involved in 4-H. Over three in four science teachers (79.2%) reported they had participated in an inservice workshop or course that demonstrated how to integrate science and agriculture

Research objective two was focused at determining and comparing agriculture teachers' and science teachers' perceived barriers to integrating science into agricultural education programs. The extent of agreement for the 10 statements that measured barriers to integrating science ranged from 19.4% to 63.6% for science teachers, while for agriculture teachers, it ranged from 29.3% to 83.0% (Table 2).

Over 63% of the science teachers perceived their lack of an agriculture background as a barrier, while 39% agreed that the agriculture teachers' lack of science competence was a barrier to integrating science. A majority of the science teachers agreed that lack of funding (63% agreed) and lack of equipment (60% agreed) was a barrier to integrating science into agriculture programs. A majority of science teachers also agreed that lack of an integrated science curriculum (55% agreed) and agriscience workshops (50% agreed) were barriers to integrating science.

Table 2
Science and Agriculture Teachers' Perceptions of Barriers to Integrating Science

Question	Science A / DA	Agriculture A / DA	Mann-Whitney *U*
Science teacher's lack of agricultural background	64% / 21%	71% / 11%	8859.5*
Lack of federal, state, and local funding	63% / 21%	58% / 10%	10402.0
Lack of appropriate equipment	60% / 23%	83% / 8%	8025.0*
Lack of integrated science curriculum	55% / 27%	42% / 29%	8645.0*
Lack of agriscience inservice or workshops	50% / 44%	46% / 24%	8993.0*
Lack of prior student preparation in science	39% / 24%	36% / 38%	10431.5
Teachers' philosophical differences	39% / 29%	63% / 15%	7455.0*
Agric. teachers' lack of science competence	39% / 36%	29% / 30%	9480.0
Lack of close proximity to high-tech firms	29% / 41%	42% / 28%	9398.5
Lack of agriscience jobs in the local community	19% / 28%	30% / 30%	8944.0*

Note. A = agree, DA = disagree. 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. Following the statistical analysis, strongly agree and agree were collapsed into the agree column and strongly disagree and disagree were collapsed into the disagree column.
* $p < .05$

Over 83% of the agriculture teachers perceived the lack of appropriate equipment as a barrier to integrating science. Additionally, more than 70% of the agriculture teachers agreed that the science teachers' lack of agriculture background was a barrier to integrating science, while 30% of agriculture teachers agreed that their lack of science competence was a barrier. Agriculture teachers agreed (58%) that lack of funding was a barrier to integrating science into the agriculture program.

Eight statements in the barriers section were statistically significant when comparing the science and the agriculture teachers' perceptions. These included: lack of prior student preparation in science, funding, agriculture teachers' lack of science competence, lack of close proximity to high-tech firms, lack of agriscience inservice, lack of agriscience jobs in the local community, science teacher's lack of agricultural background, and lack of an integrated science curriculum.

Research objective three sought to determine and compare agriculture teachers' and science teachers' perceptions regarding support of the agricultural education program if the integration of science is increased (Table 3). Three of the six statements were statistically significant. Business/industry support, community support, and parental support all showed statistical differences between the science and the agriculture teachers' perceptions of increased support for agriculture programs.

Science teachers agreed more strongly (73% agreed) than agriculture teachers (56% agreed) that science teacher support would improve with increased integration of science, while agriculture teachers agreed more strongly (68% agreed) than science teachers (42% agreed) that administrator support would increase. The agriculture teachers also reported a higher level of agreement (63%) that counselor support would increase than did the science teachers (31%).

Table 3
Perceptions of Support for Agriculture Programs with Increased Integration of Science

	Science	Agriculture	Mann-Whitney
Question	A / DA	A / DA	*U*
Science teacher support will increase	73% / 6%	56% / 12%	8387.5*
Business/Industry support will increase	56% / 2%	56% / 6%	10828.0
Administrator support will increase	42% / 11%	68% / 4%	7844.5*
Parental support will increase	42% / 9%	58% / 4%	9076.0*
Community support will increase	39% / 8%	51% / 6%	9635.0
Counselor support will increase	31% / 12%	63 % / 7%	7739.0*

Note. A = agree, DA = disagree. 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. Following the statistical analysis, strongly agree and agree were collapsed into the agree column and strongly disagree and disagree were collapsed into the disagree column.
* $p < .05$

Research objective four was aimed at determining and comparing agriculture teachers' and science teachers' perceptions of collaboration and cooperation efforts between the agriculture and science departments in their school (Table 4). Eleven statements were included in this section with agreement percentages for science teachers ranging from 11% to 91% and agriculture teachers ranging from 3% to 95% agreement. Six of the statements were statistically significant concerning the perceptions of the science and agriculture teachers.

Over 90% of the science teachers agreed or strongly agreed they had a strong science program in their school. A majority (85%) of the science teachers felt the science department had something to offer the agriculture department and 79% agreed that collaboration would benefit science students. Over three-fourths of the science teachers agreed that the agriculture department had something to offer the science department and 71% agreed they had a strong agriculture program in their school. Most science teachers disagreed that the science program does not want to work with the agriculture program (57% disagreed) and disagreed that the agriculture program does not want to work with the science program (58% disagreed).

Table 4
Perceptions of Collaboration and Cooperation Between Science and Agriculture Teachers

	Science	Agriculture	
Question	A / DA	A / DA	Mann-Whitney *U*
We have a strong science program	91% / 2%	72% / 9%	7095.5*
The science department has something to offer the agriculture department	85% / 2%	89% / 5%	9443.0
Collaboration would benefit science students	79% / 6%	91% / 2%	8617.0*
The agriculture department has something to offer the science department	75% / 9%	95% / 0%	7252.0*
We have a strong agriculture program	71% / 11%	80% / 7%	9941.5
The departments have a cooperative relationship	48% / 21%	56% / 16%	9375.0
The departments share similar viewpoints toward agriculture and the environment	43% / 21%	46% / 31%	9954.0
The agriculture and science departments have similar philosophies on teaching and learning	34% / 30%	49% / 23%	8874.55*
The departments work together in a collaborative effort	29% / 38%	39 % / 30%	9429.5
The science program does not want to work with the agriculture program	14% / 57%	14% / 61%	10277.5
The agriculture program does not want to work with the science program	11% / 58%	3% / 82%	7065.5*

Note. A = agree, DA = disagree. 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. Following the statistical analysis, strongly agree and agree were collapsed into the agree column and strongly disagree and disagree were collapsed into the disagree column.
* $p < .05$

A majority (95%) of the agriculture teachers agreed the agriculture department had something to offer the science department and 91% agreed collaboration would benefit science students. Similarly, 89% of the agriculture teachers agreed the science department had something to offer the agriculture department, 80% felt they had a strong agriculture program, and 72% agreed they had a strong science program in their school. Most agriculture teachers also disagreed with the statements that the agriculture program does not want to work with the science program (82% disagreed) and the science program does not want to work with the agriculture program (61% disagreed).

When asked the question on how teachers felt integration of science and agriculture can best be achieved in their school, the agriculture teachers provided 87 responses to the question and the science teachers provided 153 responses to the question. Teaming (24 responses), public relations/communication (10 responses), facility/funding/resources (10 responses), and science credit/Certificate of Initial Mastery/Certificate of Advanced Mastery/ integrate curriculum (17 responses) were the most common answers to the question provided by the agriculture teachers. The most common responses from the science teachers on how they felt integration can best be achieved were: cooperation/collaborative planning/teaming (40), time (28), workshops (15 responses), funding (11 responses), revise curriculum (9), administrative support (8), teacher commitment (6), and application/ integration (5).

Conclusions/Implications/ Recommendations

The theoretical framework of this study (Connelly & Clandinin, 1988) is important in determining the factors that will influence collaboration and opportunities for science teachers (stakeholders) and agriculture teachers to integrate science into the agricultural education curriculum. The data indicate that many science and agriculture teachers hold positive attitudes toward integrating science into the agricultural education curriculum. Further, Fishbein and Ajzen's planned behavior theory (1975) indicates that positive perceptions toward integrating science into the agricultural education curriculum will influence science and agriculture teachers' intentions and behaviors.

Demographics indicated that science teachers and agriculture teachers are similar in years of teaching experience (15 and 14 years average) and years taught in the same school (10 years). However, science teachers on average are three years older than agriculture teachers and average 20% more females in the profession than agriculture teachers. While 80% of the agriculture teachers in this study have participated in workshops to integrate, only 25% of the science teachers have had support or taken advantage of opportunities to participate in integration types of workshops. The researchers recommend that teacher educators in science and agricultural education work together to develop integrative activities that bring together agriculture and science teachers. Teacher educators must also model collaboration within teacher education programs on the university level.

Science and agriculture teachers identified specific barriers to integrating science concepts into the agricultural education curriculum. The three barriers that over half of the science and agriculture teachers agreed upon included the science teacher's lack of an agricultural background, and lack of funding and equipment. Studies by Balschweid and Thompson (2002) of Indiana agriculture teachers, Layfield et al (2001) of South Carolina agriculture teachers, and Thompson and Balschweid, (1999) of Oregon agriculture teachers, and a study of Oregon principals (Thompson, 2001) indicated the same items as barriers to integrating science. Levels of agreement were significant in lack of funding, lack of student preparation in science, the agriculture teacher's lack of science competence and lack of proximity to high technology firms. Therefore, it is recommended that science teachers and agriculture teachers seek external funding sources for grants that emphasize integrating academics. Teacher education programs and

the State Department of Education should provide inservice and workshops to support integration of science and agriculture. Collaborative workshops may bring agriculture and science teachers together not only to learn how to integrate, but to develop technical skills in science and agriculture and build successful teaching teams.

A high percentage of science and agriculture teachers felt the science teachers' lack of an agricultural background was a barrier to integrating science. Agricultural literacy programs for teachers, such as Summer Agriculture Institute and Agriculture in the Classroom are excellent programs for science teachers to learn about agriculture. Teacher educators and teachers can help market these programs specifically to science teachers in schools that have agriculture programs.

Science teachers were unsure how some stakeholders would respond as a result of integrating more science into agricultural education programs. However, almost three-fourths of the science teachers were in agreement that support from their colleagues in science will increase when more science is integrated into the agricultural education program. Over half of the respondents were unsure if community and counselor support will increase from more integration of science into the curriculum. Although science teachers were unsure of administrator support, an earlier study of high school principals in Oregon (Thompson, 2001) indicated almost 70% agreed administrator support would increase by integrating more science into agriculture programs. Conversely, agriculture teachers were more confident than science teachers that administrative, parental, and counselor support will increase by integrating more science into agriculture programs. It is important to communicate to agriculture teachers that almost three-fourths of the science teachers in this study believe science teacher support will increase if agriculture teachers integrate more science into their programs.

Johnson and Newman (1993) indicated the perceptions of science teachers are critical to the successful integration of science into agriculture. This study confirmed that a majority of the science teachers agreed that the science department has something to offer the agriculture department and the agriculture department has something to offer the science department. Both the science department and agriculture departments are perceived by the science and agriculture teachers as strong programs in their schools. However, less than half of the participants in each group hold similar philosophies on teaching and learning. At the same time, less than half of the science teachers and just over half of the agriculture teachers believe the departments have a cooperative relationship and only about one-third indicated that collaboration now occurs. This data suggest that collaboration will be difficult to achieve at a substantial level. Teachers agreed that integration of science and agriculture can best be achieved by a cooperative, collaborative teaming effort that involves time and planning.

There are several factors that may affect the amount of collaboration between science and agriculture teachers. The amount of time provided or available for teachers to work together during the school day and the school schedule could all factor into the ability to effectively collaborate. The teachers' motivation and desire to collaborate, their perspective on teaching and learning, and their attitude on the value of collaboration could all be factors that determine the amount of collaboration that occurs in the school system.

The data presented serves as a benchmark for identifying science teachers' perceptions of integrating science and agriculture. Further investigation of the data will assist researchers in determining correlations and relationships of demographic variables to perceptions. Further studies using qualitative methods of collaboration between science and agriculture programs will provide contextual models for integration. It is also recommended since science teachers were unsure that counselor support would increase if agriculture teachers integrate more science into the curriculum, counselors be studied to determine their support for agriculture programs and integrating science into the curriculum.

The instrument for this study has proven to be reliable and valid. Replication of this study in other states and/or regions will help determine the attitudes of science and agriculture teachers toward integrating science into the curriculum. Research on effective collaboration and teaming efforts among teachers will help advance integration and contextual teaching and learning. By studying collaborative efforts that have been proven effective, state and school leaders can set the stage for teachers to be more effective in contextualizing the curriculum.

Agriculture teachers must make concerted efforts to "pull out" scientific concepts and show where the science is applied in the curriculum. This research supports the concept that science teachers are committed to support agriculture programs that integrate more science into the curriculum.

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