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

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Abstract

Agriculture teachers and science teachers who taught in a high school with an Agricultural Science and Technology 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. 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. A majority of both groups agreed that teacher preparation programs should provide instruction to undergraduates as well as inservice to teachers in the field on how to integrate science. While 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, less than half of both groups reported that they work in a collaborative effort with the other department.

Introduction

The merging of agriculture and science in the public secondary schools of America is not just a phenomenon of the past few years. Agriculture as a science course was debated at least ten years prior to the passage of the Smith-Hughes act of 1917 (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.

Both academic and vocational groups have made calls for the integration of science and agriculture. 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 (National Research Council, 1988). The American Association for the Advancement of Sciences 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).

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 (Enderlin & Osborne, 1992; Enderlin, Petrea, & Osborne, 1993; Roegge & Russell, 1990; Whent & Leising, 1988).

The theoretical model for this study consisted of factors that influence the amount of collaboration and integration between agriculture and science teachers. 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, 1998) 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 and 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) recommend further studies of science teacher teachers' perceptions toward agriculture program quality.

Major questions of concern include the need for integration of science and agriculture, the ability and preparation of the agriculture teacher to integrate science into the agriculture curriculum, and the barriers the hinder integrating science and agriculture.

Objectives

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

1. What were the demographic characteristics of Oregon agriculture teachers and science teachers who teach in schools with agricultural science and technology programs?

2. What were the perceived barriers to integrating science into the agricultural education program?

3. What were the agriculture teachers' and science teachers' perceptions regarding the role of teacher preparation programs in agriculture?

4. What were the perceptions of science teachers and agriculture teachers concerning support of the agricultural education program as the level of science integration is increased?

5. What were the perceptions of collaboration between science and agriculture departments?

Methods/Procedures

The target population for this study consisted of Oregon science teachers (N=360) in schools that had secondary agricultural science and technology programs during the 2001-2002 school year and Oregon agricultural science and technology 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 Oregon secondary school agriculture instructors during the 2001-2002 school year. Science teachers employed at schools with no agricultural science and technology

program were eliminated from the sample. Caution should be exercised when generalizing the results of the study beyond the sample.

The instrument used in this study to identify the perceptions of science and agriculture instructors was adapted from the Integrating Science Survey Instrument developed by Thompson and Schumacher (1998). 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 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 a neighboring state to establish face and content validity and initial reliability ($\acute{a} = 0.87$). As a measure of the reliability of the attitudinal scale, internal consistency for the science teacher form was measured at $\acute{a} = 0.90$ using Cronbach's alpha with construct reliability ranging from $\acute{a} = 0.71$ to $\acute{a} = 0.85$. Internal consistency for the agriculture teacher form was measured at $\acute{a} = 0.86$ with construct reliability ranging from $\acute{a} = 0.71$ to $\acute{a} = 0.83$.

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. The *t*-values obtained verified that the difference between early and late respondents was not statistically significant.

The two forms of the instrument consisted of three parts. Part one included 62 five-point Likert 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.

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. 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 (Likert-scale responses) and the independence of the sample groups (Courtney, 2002; Huck, 2000; Mertens, 1997). The alpha level for statistical significance was set a priori at .05.

Results/Findings

Research question one sought to determine demographic information for the respondents (Table 1). The average science teacher in Oregon teaching in a school with an agricultural science and technology 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
Demographics of Oregon 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)
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 in Oregon 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. 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 and 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. Eighty percent of the agriculture teachers had participated in inservice/workshops that taught them how to integrate science into the curriculum.

Research question two was explored by asking agriculture teachers and science teachers to identify perceived barriers to integrating science into agricultural education programs. Science and agriculture teachers differed in the level to which they agreed with perceived barriers to integrating science and agriculture (Mann-Whitney $U = 9316.5$, $p = .105$). Results from science teachers for the ten statements ranged from 19.35% to 63.59% of the teachers in agreement (Table 2). Over 63% of the science teachers perceived their lack of an agriculture background as a barrier, while only 39% agreed that the agriculture teachers' lack of science competence was a barrier to integrating science. Only 19% of the science teachers agreed that the lack of agriscience jobs in the local community was a barrier to integrating science into agriculture programs.

Agriculture teachers' response to the ten questions regarding barriers to integrating science ranged from 29.25% to 83.02% of the teachers in agreement (Table 2). Over 83% of the agriculture teachers perceived the lack of appropriate equipment as a barrier, and over 70% agreed that the science teachers' lack of agriculture background was a barrier to integrating science. Less than 30% of agriculture teachers agreed that their lack of science competence was a barrier.

Table 2
Perceptions of Barriers to Integrating Science

Question	Science A / DA	Agriculture A / DA	Mann-Whitney *U*, *p*-value
Science teacher's lack of agric. Background	64% / 21%	71% / 11%	$U = 8859.5$, $p = .015$
Lack of federal, state, and local funding	63% / 21%	58% / 10%	$U = 10402.0$, $p = .889$
Lack of appropriate equipment	60% / 23%	83% / 8%	$U = 8025.0$, $p < .001$
Lack of integrated science curriculum	55% / 27%	42% / 29%	$U = 8645.0$, $p = .008$
Lack of agriscience inservice or workshops	50% / 44%	46% / 24%	$U = 8993.0$, $p = .029$

Table 2 (continued)

Question	Science A / DA	Agriculture A / DA	Mann-Whitney *U*, *p*-value
Lack of prior student preparation in science	39% / 24%	36% / 38%	$U = 10431.5$, $p = .922$
Teachers' philosophical differences	39% / 29%	63 % / 15%	$U = 7455.0$, $p < .001$
Agric. teachers' lack of science competence	39% / 36%	29% / 30%	$U = 9480.0$, $p = .145$
Lack of close proximity to high-tech. Firms	29% / 41%	42% / 28%	$U = 9398.5$, $p = .116$
Lack of agriscience jobs in the local community	19% / 28%	30% / 30%	$U = 8944.0$, $p = .025$

Note: A = agree, DA = disagree. Strongly agree and agree are collapsed into the agree column and strongly disagree and disagree are collapsed into the disagree column.

Research question number three contained six statements designed to address the agriculture and science teachers' perceptions regarding the role of teacher preparation programs in assisting teachers to integrate science (Table 3). Overall, the science and agriculture teachers differed in the level to which they agreed on the role of teacher preparation programs in integrating science and agriculture (Mann-Whitney $U = 7465.5$, $p < .001$). A majority of both the science teachers (90%) and agriculture teachers (92%) strongly agreed or agreed that teacher education programs should provide instruction for undergraduates as well as for teachers in the field (87% and 90% respectively) on how to integrate science into the agriculture curriculum. While 47% of science teachers agreed that science teachers should mentor beginning agriculture teachers, only 31% of agriculture teachers agreed. A higher percentage of science teachers agreed that student teachers in agricultural education should be placed with a cooperating teacher who integrates (80%) than did the agriculture teachers (54%).

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%	$U = 7027.0$, $p < .001$

Table 3 (continued)

Question	Science A / DA	Agriculture A / DA	Mann-Whitney *U*, *p*-value
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. Strongly agree and agree are collapsed into the agree column and strongly disagree and disagree are collapsed into the disagree column.

Research question number four asked agriculture teachers and science teachers for their perceptions regarding support of the agricultural education program if the integration of science is increased (Table 4). Science and agriculture teachers differed in the level to which they agreed with perceived increase in stakeholder support (Mann-Whitney $U = 9243.0$, $p = .022$). More science teachers agreed (73%) than agriculture teachers (56%) that science teacher support would increase with increase integration of science, while agriculture teachers agreed more strongly (68%) than science teachers (42%) 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 4
Perceptions of Support for Agriculture Programs from Increased Integration of Science.

Question	Science A / DA	Agriculture A / DA	Mann-Whitney *U*, *p*-value
Science teacher support will increase	73% / 6%	56% / 12%	$U = 8387.5$, $p < .001$
Business/Industry support will increase	56% / 2%	56% / 6%	$U = 10828.0$, $p = .836$
Administrator support will increase	42% / 11%	68% / 4%	$U = 7844.5$, $p < .001$
Parental support will increase	42% / 9%	58% / 4%	$U = 9076.0$, $p = .006$
Community support will increase	39% / 8%	51% / 6%	$U = 9635.0$, $p = .054$
Counselor support will increase	31% / 12%	63 % / 7%	$U = 7739.0$, $p < .001$

Note: A = agree, DA = disagree. Strongly agree and agree are collapsed into the agree column and strongly disagree and disagree are collapsed into the disagree column.

Research question number five was explored by asking agriculture teachers and science teachers to report their perceptions of collaboration and cooperation efforts between the agriculture and

science departments in their school (Table 5). For the construct, there was no evidence of an overall statistical difference between the two groups, but differences were seen in responses to the individual statements. Eleven statements were included in this construct with agreement percentages ranging from 3% to 95%. Some of the items were phrased negatively, which resulted in a wider range of means and percentages. Over 90% of the science teachers agreed or strongly agreed they had a strong science program in their school, while only 72% of agriculture teachers agreed they had a strong science program. Differences were also seen in the level to which they agreed that collaboration would benefit science students, with 91% of agriculture teachers in agreement and only 79% of science teachers agreeing. More agriculture teachers agreed (95%) than science teachers (75%) that the agriculture department had something to offer the science department. While 58% of the science teachers disagreed with the statement the agriculture program does not want to work with the science program, 82% of the agriculture teachers disagreed with this statement.

Table 5
Perceptions of Collaboration between Science and Agriculture Departments

Question	Science A / DA	Agriculture A / DA	Mann-Whitney *U*, *p*-value
We have a strong science program	91% / 2%	72% / 9%	$U = 7095.5$, $p < .001$
The science department has something to offer the agriculture department	85% / 2%	89% / 5%	$U = 9443.0$, $p = .113$
Collaboration would benefit science students	79% / 6%	91% / 2%	$U = 8617.0$, $p = .005$
The agriculture department has something to offer the science department	75% / 9%	95% / 0%	$U = 7252.0$, $p < .001$
We have a strong agriculture program	71% / 11%	80% / 7%	$U = 9941.5$, $p = .456$
The departments have a cooperative relationship	48% / 21%	56% / 16%	$U = 9375.0$, $p = .120$
The departments share similar viewpoints toward agriculture and the environment	43% / 21%	46% / 31%	$U = 9954.0$, $p = .472$
The agriculture and science departments have similar philosophies on teaching and learning	34% / 30%	49% / 23%	$U = 8874.55$, $p = .024$
The departments work together in a collaborative effort	29% / 38%	39 % / 30%	$U = 9429.5$, $p = .146$

Table 5 (continued)

Question	Science A / DA	Agriculture A / DA	Mann-Whitney *U*, *p*-value
The science program does not want to work with the agriculture program	14% / 57%	14% / 61%	$U = 10277.5$, $p = .779$
The agriculture program does not want to work with the science program	11% / 58%	3% / 82%	$U = 7065.5$, $p < .001$

Note: A = agree, DA = disagree. Strongly agree and agree are collapsed into the agree column and strongly disagree and disagree are collapsed into the disagree column.

Conclusions/Implications/Recommendations

Many of Oregon's science and agriculture teachers held positive attitudes toward the integration of science in the agricultural education curriculum. Demographically, science and agriculture teachers were quite similar in age, years of teaching experience, and the number of years taught at their current school. However, science teachers and agriculture teachers were quite different in gender makeup, as agriculture teachers were an 83% male dominated profession, while science teachers were 61% male dominated in this state. Agriculture teachers tend to have grown up and presently live in more rural areas, and were in 4-H and/or agricultural education while in high school as compared to science teachers.

While just under one-fourth of the science teachers had participated in workshops that taught them to integrate, 80% of the agriculture teachers had participated in workshops on integration of academics. Agriculture teachers should be encouraged to form partnerships with science teachers and share not only resources, but also teaching material that was presented at workshops. Programs such as the Agriscience Institute and Outreach Program (National FFA, 1991) for science and agriculture teachers should be reinvigorated on the state level. Science and agricultural education teacher preparation programs should work together to develop workshops that integrate science and agriculture, and encourage participation from science and agriculture teachers.

Science and agriculture teachers identified specific barriers to integrating science concepts into the agricultural education curriculum. The teachers differed in the level to which they agreed with perceived barriers, but most were in agreement that funding, equipment, and the science teacher's lack of an agriculture background were barriers to integrating science. 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) all rated the highest scores on the same barriers to integrating science. The biggest disagreement concerning barriers between the science and agriculture teachers was the teacher's philosophical differences. More agriculture teachers (over 20% more) agreed or strongly agreed that the teachers' philosophical differences was a barrier to integrating science. It should also be noted that less than 40% of the science teachers were in agreement that the agriculture teachers lack of science competence was a barrier to integrating science into the agricultural education curriculum. It is recommended that science

and agriculture teachers team up to seek external funding sources for grants that emphasize integrating academics.

Both the science and agriculture teachers felt teacher preparation programs should provide instruction on how to integrate science both at the preservice and inservice levels. The teachers also agreed that student teachers should be placed with cooperating teachers who integrate science. Although differing in amount of agreement, both science and agriculture teachers agreed that undergraduates need more basic science courses and team teaching should be emphasized in teacher preparation programs.

It should be noted and communicated to agriculture teachers that science teachers agreed more strongly than agriculture teachers that science teacher support will increase if integration of science is increased in agriculture programs. Knowing this, agriculture teachers may be more willing to work with science teachers in a collaborative effort to integrate science.

At the same time, agriculture teachers should be made aware that almost three fourths of the science teachers perceive they have a strong agriculture program, which has something to offer the science program in their school. At the same rate, agriculture teachers feel they have strong science programs in their school, and the science program has something to offer the agriculture program. This positive attitude toward the science and agriculture programs can be the catalyst to collaboration and cooperation amongst programs. Presently, less than half of the science and agriculture teachers do not work together in a collaborative effort, but over half of the science and agriculture teachers disagree that the science and agriculture programs want to work together. It seems the attitudes and respect for each program is present, the teachers are aware of the benefits of integrating science and agriculture, but integration isn't happening to a high degree. Administrators should be made aware of the implications of these findings to incorporate ways to help science and agriculture teachers form partnerships.

The data presented serves as a benchmark for identifying and comparing science and agriculture teachers' perceptions of integrating science and agriculture. Effective strategies for collaboration should be studied to help develop an effective model of integration between science and agriculture teachers. Further studies should be initiated to assess students' achievement using agriculture as the context to teach science skills.

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