Perceptions of Oregon Science Teachers Regarding the Integration of Science into the Agricultural Education Curriculum

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Abstract

Science teachers who taught in a high school with an Agricultural Science and Technology Program were targeted for this study to determine their support for integrating science into Agricultural Education Programs. The data indicated that science teachers have responded positively to the call to integrate science into the agricultural education curriculum. The participants agreed that agriculture is an applied science and students are more aware of the science connections and learn more through an integrated curriculum in agriculture. A majority of the science teachers agreed that teacher preparation programs should provide instruction on how to integrate science and student teachers should be placed in programs that integrate science. Science teachers believed that integrating science in agricultural education would contribute to educational reform by helping students meet state standards. According to the science teachers, barriers to integrating science included lack of equipment, funds, workshops, and the science teachers' lack of an agriculture background. The respondents agreed the science and agriculture programs have something to offer each other and would benefit students, however, one third of the teachers indicated a neutral response and one third disagreed that the science and agriculture departments worked together in a collaborative effort in their school.

Introduction/Theoretical Framework

The merging of agriculture and science in the public secondary schools of America is not just a trend of recent years. Integration of agriculture courses and science courses as well as collaboration between science and agriculture teachers were encouraged as early as 1918 (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).

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 that hinder integrating science and agriculture.

Objectives

The purpose of this study was to determine the perceptions and attitudes of Oregon high school science 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 science teachers who teach in schools with agricultural education programs?

2. What were the perceptions of science teachers concerning the integration of science and agriculture?

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

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

5. What were the perceptions of science teachers concerning support of the agricultural education program?

6. What were science teachers' perceptions toward meeting state standards with increased integration in agricultural education programs?

7. What were the science teachers' 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 agriculture programs during the 2001-2002 school year. The Oregon Department of Education provided the researchers with a current database containing the names and school addresses of science teachers in the state. All elementary and post-secondary science teachers and administrators were eliminated from the database, resulting in secondary science teachers, including chemistry, biology, physics, earth science and integrated science teachers with at last

half-time assignments in science. The resulting database was then matched with the database of all Oregon agricultural science and technology instructors during the 2001-2002 school year and science teachers employed at schools with no agricultural education program were eliminated. 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 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. It was also pilot tested by science teachers in a neighboring state (n=9) to establish face and content validity and reliability (α = 0.87). As a measure of the reliability of the attitudinal scale, internal consistency for the study was measured at $\alpha = 0.90$ using Cronbach's alpha. Construct reliability ranged from $\alpha = 0.71$ to $\alpha = 0.85$.

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 214 science teachers for an overall response of 59.4%. 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.

Results/Findings

Research question one sought to determine demographic information for the respondents. The average science teacher in Oregon teaching in a school with an agricultural education program was 42 years old (*SD*=10.0) with 14.7 years of teaching experience (*SD*=9.24) and had taught approximately 10 years at their current school (*SD*=8.18). The majority were male (68.6%) and lived in a town/city (60.6%). Approximately one in four science teachers (24.2%) 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 (46.5%) 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 (27.5%) reported they had taken agricultural education courses in high school and/or been involved in 4-H.

To address research questions two through seven the participants were asked to respond to 62 statements involving the integration of science into the agricultural education program at the high school where they taught. The responses were measured using a five-point Likert-type scale where 1=strongly disagree, 2=disagree, 3=neutral, 4=agree, and 5=strongly agree.

Research question two asked science teachers their perceptions concerning integrating science and agriculture. Internal consistency for the construct was measured at $\alpha = 0.85$. The results from the 12 statements indicated that a majority of the teachers either agreed or strongly agreed with all the statements (Table 1). Percentages of science teachers that agreed or strongly agreed with the statements ranged from 37.50% to 96.7% with means ranging from to 3.35 to 4.53. The

highest level of agreement was found in the statement that "agriculture is an applied science." More than half of the teachers indicated a neutral response (54.69%) toward the statement that integrating science into agriculture classes has increased ability to teach problem solving.

Table 1
Oregon Science Teachers' Perceptions of the Integration of Science and Agriculture

Question	Agree	Neutral	Disagree	Mean	SD
Agriculture is an applied science	96.71%	2.82%	0.47%	4.53	0.58
People in agriculture must have a greater understanding of science than 10 years ago.	95.31%	4.23%	0.47%	4.53	0.63
Students are more aware of connection between scientific principles and agriculture when science concepts are integrated	92.49%	6.10%	1.41%	4.35	0.66
Students learn more about agriculture when science concepts are integrated	92.02%	7.51%	0.47%	4.37	0.64
Applied science principles should be infused into the agriculture curriculum	90.61%	8.45%	0.94%	4.34	0.67
Ongoing efforts should be expanded to upgrade scientific content	85.31%	14.22%	0.47%	4.23	0.70
Agriculture students are better prepared in science if integration takes place	69.19%	20.85%	9.95%	3.85	0.96
Agriculture students learn scientific concepts when integrated into agriculture curriculum	68.87%	27.36%	3.77%	3.88	0.80
I feel comfortable working with the Ag. Dept. to develop a team teaching approach in integration	67.94%	20.57%	11.48%	3.77	1.01
Students understand science concepts easier when agriculture is integrated	63.18%	28.86%	7.96%	3.76	0.87
The agriculture teacher is competent enough in science to teach integrated science concepts	49.76%	33.17%	17.07%	3.49	1.06
Integrating science into agriculture classes has increased ability to teach problem solving	37.50%	54.69%	7.81%	3.35	0.76

Note: Strongly agree and agree are collapsed into agree column and strongly disagree and disagree are collapsed into the disagree column.

Almost half (49.67%) 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.

Research question three asked science teachers to identify perceived barriers to integrating science into agricultural education programs (Table 2). Internal consistency for the construct was measured at $\alpha = 0.72$. The results from the ten statements ranged from 19.41% to 64.52% of the teachers in agreement. Mean scores ranged from 2.64 to 3.56. Over 64% of the science teachers perceived their lack of an agriculture background as a barrier, while over 37% agreed that the agriculture teachers' lack of science competence as a barrier to integrating science. Over half of the science teachers disagreed that the lack of agriscience jobs in the local community was a barrier to integrating science into agriculture programs.

Table 2
Science Teachers' Perceptions of Barriers to Integrating Science

Question	Agree	Neutral	Disagree	Mean	SD
Science teacher's lack of agric. background	64.25%	21.26%	14.49%	3.56	0.91
Lack of federal, state, and local funding	64.08%	18.45%	17.48%	3.78	1.09
Lack of appropriate equipment	61.06%	22.60%	16.35%	3.66	0.99
Lack of integrated science curriculum	54.90%	27.94%	17.16%	3.53	0.99
Lack of agriscience inservice or workshops	50.74%	42.36%	6.90%	3.59	0.83
Lack of prior student preparation in science	39.42%	23.56%	37.02%	3.06	1.08
Teachers' philosophical differences	39.05%	29.52%	31.43%	3.07	1.12
Agric. teachers' lack of science competence	38.92%	36.45%	24.63%	3.18	1.00
Lack of close proximity to high-tech. firms	30.24%	39.02%	30.73%	3.06	1.00
Lack of agriscience jobs in the local community	19.81%	27.05%	53.14%	2.64	0.97

Note: Strongly agree and agree are collapsed into agree column and strongly disagree and disagree are collapsed into the disagree column.

Research question number four contained six statements designed to address the science teachers' perceptions regarding the role of teacher preparation programs in assisting teachers to integrate science (Table 3). Internal consistency for the construct was measured at $\alpha = 0.81$. The results of the six statements ranged from 47.62% to 90.05% teachers in agreement with the statements, and mean scores ranged from 3.50 to 4.22. A majority of the teachers strongly agreed or agreed that teacher education programs should provide instruction for undergraduates (90.05% agreed) and teachers in the field (86.85%) on how to integrate science into the agriculture curriculum. Almost 48% of the teachers felt science teachers should mentor beginning agriculture teachers in their school district, while 40% indicated a neutral response.

Table 3
Science Teachers' Perceptions of the Role of Teacher Preparation Programs in Agriculture

Question	Agree	Neutral	Disagree	Mean	SD
Provide instruction for undergraduates on how to integrate science	90.05%	8.06%	1.90%	4.22	0.69
Provide inservice for teachers in the field on how to integrate science	86.85%	12.68%	0.47%	4.18	0.66
Should place student teachers with a cooperating teacher who integrates science	80.66%	18.40%	0.94%	4.09	0.73
Teach a course that allows future teachers to learn to team teach and model collaboratively	74.76%	21.43%	3.81%	4.00	0.85
Required to take more basic science courses	67.15%	30.43%	2.42%	3.91	0.83
Science teachers should mentor beginning agriculture teachers to help them integrate	47.62%	40.00%	12.38%	3.50	0.92

Note: Strongly agree and agree are collapsed into agree column and strongly disagree and disagree are collapsed into the disagree column.

Research question number five asked science teachers for their perceptions regarding support of the agricultural education program if the integration of science is increased (Table 4). Internal consistency for the construct was measured at $\alpha = 0.84$. Six statements made up the construct with ranges of 33.50% to 73.58% of the teachers agreed or strongly agreed and mean scores ranging from 3.25 to 3.85. Almost three fourths (73.58%) of the participants agreed that science

Table 4
Science Teachers' Perceptions of Support for Agriculture Programs from Increased Integration of Science.

Question	Agree	Neutral	Disagree	Mean	SD
Science teacher support will increase	73.58%	20.28%	6.13%	3.85	0.78
Business/Industry support will increase	56.80%	41.26%	1.94%	3.66	0.71
Parental support will increase	42.44%	47.80%	9.76%	3.38	0.75
Administrator support will increase	42.51%	46.38%	11.11%	3.37	0.78
Community support will increase	40.29%	50.97%	8.74%	3.37	0.74
Counselor support will increase	33.50%	53.88%	12.62%	3.25	0.73

Note: Strongly agree and agree are collapsed into agree column and strongly disagree and disagree are collapsed into the disagree column.

teacher support will increase and over half (56.80%) agreed that business/industry support would increase by integrating more science into agriculture programs. Over half of the science teachers indicated a neutral response that counselor (53.88%) and community (50.97%) support would increase.

Research question six contained eight items that addressed state standards (Table 5). Internal consistency for the construct was measured at $\alpha = 0.77$. All items had mean scores above 3.25 (range 3.26 – 3.96) and over half of the science teachers agreed or strongly agreed with all but two statements concerning integrating science and state standards (range 44.39% to 80.57%). Almost 81% of the teachers agreed that integrating science would help agriculture programs align with state standards, and over three fourths of the teachers agreed that integrating science would help students meet requirements for Oregon's Certificate of Initial Mastery (77.73%) and Certificate of Advanced Mastery (73.33%).

Table 5
Science Teachers' Perceptions of Ability to Meet State Educational Standards with Increased Integration in Agriculture Programs

Question	Agree	Neutral	Disagree	Mean	SD
Integration will help Agriculture Programs align with educational standards	80.57%	16.11%	3.32%	3.96	0.71
Integrating will help students meet requirements for State Initial Mastery	77.73%	17.06%	5.21%	3.90	0.78
Integrating will help students meet requirements for State Advanced Mastery	73.33%	22.86%	3.81%	3.89	0.77
High School graduation credit should be offered for agriculture classes that integrate science	59.24%	16.59%	24.17%	3.41	1.18
Our school is actively engaged in meeting state standards	57.42%	22.97%	19.62%	3.55	1.18
Students will be better prepared for standardized testing if they learn the application of science	53.81%	31.90%	14.29%	3.48	0.93
Students in agriculture courses that integrate science should be credited toward college admission science requirements	49.52%	25.96%	24.52%	3.31	1.15
State standards will impact the way science content is delivered at our school	44.39%	34.63%	20.98%	3.26	0.97

Note: Strongly agree and agree are collapsed into agree column and strongly disagree and disagree are collapsed into the disagree column.

Research question number seven asked science teachers to report their perceptions of collaboration and cooperation efforts between the agriculture and science departments in their school (Table 6). Internal consistency for the construct was measured at $\alpha = 0.85$. Twelve statements were included in this construct with mean scores ranging from 2.90 to 4.28 and agreement percentages ranging from 27.75% to 91.43%. Some of the items were phrased negatively which resulted in a wider range of means and percentages. Over 90% of the science teaches agreed or strongly agreed they had a strong science program in their school, while 71.90% agreed they had a strong agriculture program in their school. Over 84% of the teachers agreed the science department had something to offer the agriculture department, while 74.88% agreed the agriculture department had something to offer the science department. Almost 62% of the science teachers disagreed with the statement they had a limited background in agriculture.

Table 6
Science Teachers' Perceptions of Collaboration between Science and Agriculture Departments

Question	Agree	Neutral	Disagree	Mean	SD
We have a strong science program	91.43%	7.14%	1.43%	4.28	0.66
The science department has something to offer the agriculture department	84.43%	13.21%	2.36%	4.02	0.66
Collaboration would benefit science students	77.99%	15.31%	6.70%	3.91	0.80
The agriculture department has something to offer the science department	74.88%	16.59%	8.53%	3.83	0.84
We have a strong agriculture program	71.90%	17.62%	10.48%	3.89	1.02
I know my agriculture teacher(s) well	58.65%	21.15%	20.19%	3.56	1.15
The agriculture program does not want to work with the science program	10.84%	31.53%	57.64%	3.63	0.91
The science program does not want to work with the agriculture program	14.15%	28.29%	57.56%	3.54	0.93
The agriculture teacher in our school has limited background in science	18.50%	44.50%	37.00%	3.27	0.94
The agriculture and science departments have similar philosophies on teaching and learning	34.78%	35.75%	29.47%	3.06	0.95
I have limited background in agriculture	61.68%	8.88%	29.44%	2.61	1.23
Collaborative efforts between the departments	27.75%	33.97%	38.28%	2.90	1.08

Note: Strongly agree and agree are collapsed into agree column and strongly disagree and disagree are collapsed into the disagree column.

Conclusions/Implications/Recommendations

Many of Oregon science teachers hold positive attitudes toward the integration of science in the agricultural education curriculum. Science teachers believed agriculture is an applied science and people involved in agriculture must have a greater understanding of science than ten years ago. This finding corresponds with a previous study of Illinois science teachers (Osborne & Dyer, 1998). Science teachers responded positively toward student benefits when science is integrated into the agricultural education curriculum. It is recommended that agriculture teachers be made aware that science teachers, in general, hold positive attitudes toward integrating science and agriculture and may be interested in working with the agriculture program in their school.

Science teachers identified specific barriers to integrating science concepts into the agricultural education curriculum. The five barriers that over half of the science teachers agreed upon included the science teacher's lack of an agricultural background, lack of funding and equipment, lack of an integrated science curriculum, and lack of agriscience workshops. 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. Therefore, it is recommended that science teachers and agriculture teachers team up to seek external funding sources for grants that emphasize integrating academics. Teacher education programs and the State Department of Education should provide inservice and workshops on how to integrate and develop collaborative efforts in writing grants to support integration of science and agriculture. Collaborative workshops may bring agriculture and science teachers together to not only learn how to integrate, but to develop technical skills in science and agriculture and build successful teaching teams.

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 integrates science. Moreover, science 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 team teach. A majority of the science teachers agreed that agriculture teachers should take more basic science courses in science at the undergraduate level. This finding is in agreement with Oregon (Thompson & Balschweid, 1999) and South Carolina agriculture teachers (Layfield, et al, 2001), and the FFA AgriScience Teachers of the Year (Thompson & Schumacher, 1998). It is recommended that teacher preparation programs in agriculture review the amount of science offerings in the undergraduate level to determine if there are appropriate science classes that can be added to the undergraduate program.

Science teachers were unsure how some stakeholders would respond as a result of integrating science into agricultural education programs. However, almost three fourths of the science teachers were in agreement that science teacher support will increase by increased integration of science 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.

Oregon science teachers felt that integrating science is an important component in helping agriculture programs align with state standards and help students meet requirements for initial and advanced mastery of Oregon's state standards. Over half of the science teachers agreed that students should get science credit for agriculture classes that integrate science. It is recommended this study be presented to agriculture teachers to help them understand that in general, science teachers have positive attitudes toward integrating science in agriculture and how it can help students meet requirements for state standards.

Collaboration efforts between the science and agriculture departments will benefit students. Science teachers agreed that the science department has something to offer the agriculture department and at the same time, the agriculture department has something to offer the science department. Both the science department and agriculture departments are perceived by the science teachers as strong programs in Oregon schools, although the participants in this study are uncertain as to sharing similar philosophies on teaching and learning.

The data presented serves as a benchmark for identifying science teachers' perceptions of integrating science and agriculture. Further investigation of the data will assist the researchers in determining correlations and relationships of demographic variables to perceptions. Further studies using qualitative methods of exemplary programs that integrate science and agriculture will provide a model for integrating science. It is also recommended that, 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.

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Perceptions of Oregon Science Teachers Regarding the Integration of Science into the Agricultural Education Curriculum

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The researchers are commended for their contributions to further "triangulating" this important question—curriculum integration and the role of agricultural education. Notably, Dr. Thompson has consistently demonstrated persistence in pursuing this line of inquiry, i.e., perceptions of agriculture teachers and school administrators, and now science teachers.

The manuscript was well written. The literature base for the study appeared sound and sufficiently vetted but perhaps it was more "middle theory" or "substantive" (see Camp, 2001) than "theoretical." The study's sampling procedure was thorough and well done. A pilot test was conducted to verify the instrument's content validity; overall and construct reliability estimates were reported. Although not cited, Dillman's survey research follow-up procedures were followed. In addition, appropriate statistical procedures were used to compare early and late respondents; no statistically significant differences were found. Importantly, the researchers' conclusions and recommendations were congruent with the study's findings. Questions stimulated by the manuscript follow:

1) Are there unforeseen, and, perhaps, unwanted consequences associated with the term "applied" as it was used to describe the science that may be well taught and well learned in the context of agricultural education?

2) Are science teachers and agricultural education researchers (and, implicitly agriculture teachers) "operationalizing" problem solving and the problem solving method similarly or differently?

3) If agricultural education teacher preparation programs are to be vehicles for preparing agriculture teachers to systematically integrate science into their curricula, then, what should teacher educators be doing to ensure that these competencies are learned? Are there specific program policies/requirements that should be instituted? Moreover, are there philosophical positions that may require reflection and, ultimately, revision?

4) How should teacher educators assess the acumen of cooperating teachers regarding their ability to integrate curriculum and to effectively model these behaviors?

5) In attending to the call for greater collaboration between agriculture and science teachers, are there particular (even peculiar) "affective" behaviors of both groups that warrant investigation if we are to understand how relationships inherent for successful colleagueship may be established and then sustained?

The researchers have identified school counselors as another significant stakeholder group whose views should be a part of this important conversation. Accordingly, I look forward to learning more from them about this and related research topics in the future.