

Principals' Perceptions of Integrating Science into Agriculture Programs

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Abstract

If integrating of science into the agricultural education curriculum is to be successful, there must be support from the school principal. Principals' perceptions were studied to determine their support for integrating science into agricultural education programs in Oregon. Secondary principals that had an Agricultural Science and Technology Program in their school were targeted for the study resulting in a 76.9% return rate.

Using a five point Likert-type scale, principals were asked to respond to statements concerning 1) integrating science and agriculture, 2) the role of teacher preparation programs in integrating science, 3) effects state standards will have on agricultural education programs, 4) teaching integrated science, 5) barriers to integrating science, and 6) support for integrating science. Principals also had the opportunity to respond to three open-ended questions regarding what should be given up to develop a more integrated science curriculum, factors causing programs to integrate science, and changes needed to meet state standards.

The data concluded that principals have responded positively to the call to integrate science into the agricultural education curriculum. Principals agreed that students were more aware of the connection between science and agriculture, students learn more about agriculture, and science concepts are easier to understand for students if science is integrated into the agricultural education curriculum.

A majority of the principals agreed that teacher preparation programs should provide instruction for undergraduates as well as teachers in the field, on how to integrate science. Principals agreed that student teachers and early field experience students should be placed in programs that integrate science. Principals supported an inservice activity for new teachers that required them to cooperate with a science teacher in their school district to integrate science.

Principals believed that integrating science in agricultural education programs would contribute to educational reform by helping students meet state standards. Alignment and integration are key changes principals listed to help programs meet state standards. The most common responses to what agricultural education programs would have to give up to develop a more integrated science curriculum were "nothing" and "traditional agriculture classes." Principals responded that meeting state standards and teacher initiative (or interest), inservice training, funding, and opportunities to integrate with a science teacher were the most common reasons to integrate science.

According to the principals, barriers to integrating science were lack of appropriate equipment, funds, and workshops. Moreover, principals agreed that administrator, science teacher, other teacher support, and parental support for agriculture programs will increase by integrating more science.

Introduction/Theoretical Framework

The American Educational system is currently undergoing reform in funding, governance, curriculum standards, staff development, assessment, and student support services (Fraser, 1996). Oregon set its course for improved student performance when the legislature passed the Oregon Educational Act of the 21st Century. The Act calls for raising student achievement by setting higher standards in curriculum, instruction, and accountability (Oregon Department of Education, 1998). The new standards specify what students should know and be able to do in English, math, science, social studies, the arts, second language, and career-related learning.

The pressures of increasing state standards have caused concern among many agricultural educators in Oregon. Increased high school graduation requirements have put pressure on agriculture programs by limiting opportunities for students to enroll in elective courses. Changing college entrance requirements have further challenged secondary agricultural educators to make their programs become more than just 'vocational'. Johnson (1995) reported that Arkansas teachers perceived that offering science credit for agriculture courses would increase enrollment, benefit students, and enhance the program image. Finn et al. (1998) contended that state standards would improve with time as states learn from each other. Raising standards for student achievement and increasing the knowledge and skills of graduates are occurring separately in most states (Koki, 1998).

Although science has been a part of agricultural education since the passage of the Hatch Act in 1887 (Budke, 1991; Vaughn, 1993; Christian & Key, 1994; Hillison, 1997), it wasn't until 1988 when the National Research Council gave a distinct charge to researchers to define methods necessary to guide educators as they updated their curriculum to make it more science based. Buriak (1992) defined agriscience as, "instruction in agriculture emphasizing the principles, concepts, and laws of science and their mathematical relationships supporting, describing, and explaining agriculture with a foundation in biological and physical science" (p. 4). Evidence exists that student performance increases when students are taught courses that integrate science and agriculture (Roegge & Russell, 1990).

Policymakers, educators, employers, scholars, and social critics have advocated vocational education reform that dealt with 'integration' (Stasz, Kaganoff, & Eden, 1994). According to researchers (Stasz and Grubb, 1991; O'Neil, 1992), vocational educators as well as critics of vocational education viewed integration of academics as a curricular reform that improved the academic content of vocational education and helped prepare students for employment in an ever-changing world of work.

School principals are key decision-makers in the curriculum at their high school and are influential in the continuation of the agricultural education program. Although they do not have full control over curriculum, their influence has great impact and their perceptions of agriscience courses determine its success (Johnson and Newman, 1993).

With the implementation of the 1990 Carl D. Vocational Education and Applied Technology Act Amendments, there is commitment at the federal level for supporting the initiative to integrate academics and vocational education. More recently, the United States Department of Agriculture funded a competitive grants program designed to strengthen agricultural education with the specific intent to prepare more students to pursue careers in

agriscience and agribusiness by incorporating agriscience into science, business, and consumer education programs (U. S. Department of Agriculture, 1999).

In the past decade, researchers (Kalme & Dyer, 1998; Johnson & Newman, 1993) have studied principals' perceptions of agricultural education programs. Johnson and Newman (1993) specifically studied principal's perceptions of integrating science and offering science credit for agriscience courses. The literature shows that principals viewed agricultural education on a scale between neutral and positive (Kalme & Dyer, 1998). While there is debate as to whether or not the initiative to integrate academics must come from top-down or bottom-up, there is little doubt that all levels of educational administration must support integrating academics if it is to be successful (Florida Department of Education, 1992).

Greenwald (1989) provided the theoretical framework for this study by concluding that individuals with positive attitudes toward a subject or situations tend to evaluate them positively. This suggested that support of principals toward integrating science could be measured by analyzing their beliefs about integrating science. If principals have a positive attitude toward integrating science, they will likely support the concept integrating science and the agriculture teacher's efforts to integrate science into the curriculum.

Purpose/Objectives

The purpose of this study was to determine how secondary principals in Oregon schools that had Agricultural Science and Technology (AST) perceived the impact of integrating science in agricultural education programs. To fulfill the purposes of the study, the following research questions were addressed:

1. What were selected demographic variables of principals in secondary schools that had an AST Program?
2. What were the perceptions of Oregon secondary principals concerning integration of science and agriculture?
3. What were Oregon secondary principals' perceptions concerning the role of teacher preparation programs in integrating science?
4. What effects will state standards have on agricultural education programs as perceived by Oregon principals?
5. What were the perceptions of Oregon secondary principals concerning teaching integrated science?
6. What were the perceived barriers to integrating science in the agricultural education program?
7. What were Oregon secondary principals' perceptions concerning support of the agricultural education program since integrating science?

Methods/Procedures

The target population for this study consisted of current secondary principals that had an Agricultural Science and Technology Program in their district. The list of schools offering Agricultural Science and Technology Programs and the names and addresses of principals were obtained in the Oregon School Directory (Oregon Department of Education, 1999). Caution should be exercised when generalizing the results of the study beyond the accessible sample.

The Integrating Science Survey Instrument developed by Thompson and Schumacher (1997) was used to identify the perceptions of the principals. Three additional questions were added to the survey to acquire state specific information. The authors (Thompson and Schumacher, 1997) established reliability (Cronbach's alpha = .88 pilot study, and .81 Instrument) and validity of the instrument. The survey instrument was pilot tested by seven principals that had previously been principals in a school that had an Agricultural Science and Technology Program. Cronbach's alpha for reliability of the instrument for the secondary principals in the study was .893.

The survey instrument and cover letter were mailed to the subjects. Two weeks after the initial mailing, a second mailing was sent to all non-respondents and finally two weeks after the second mailing was sent, a telephone call was placed to all non-respondents. Responses were received from principals for an overall response rate of 76.9%. Comparing early and late respondents on the mean attitude scales using a t-test showed the attitude means were not statistically significant.

Results/Findings

The average respondent was 49 years of age ($SD = 8.62$), had 13 years of experience as a high school principal ($SD = 7.42$) and had served approximately 4.5 years as principal at their current school ($SD = 5.78$). While 81% of the respondents were male, 16% were female. Over 19 % of the respondents had been enrolled in agricultural education while in high school. Forty-four (44%) percent of the respondents indicated their students received science credit for agricultural education classes in their school.

The respondents were asked to respond to 42 statements regarding integrating science into their Agricultural Education Programs. Their responses were measured using a five point Likert-type scale where 1=strongly disagree, 2=disagree, 3=neutral, 4=agree, and 5=strongly agree.

Table 1 presents the principals' perceptions of integrating science and agriculture. The majority of principals agreed or strongly agreed with all of the statements (over 50%) in research question number two. Principals felt students are more aware of the connection between scientific principles and agriculture (96.1% agreed or strongly agreed), and people must have a greater understanding of biological (89.5% agreed or strongly agreed), and physical (80% agreed or strongly agreed) science than ten years ago. Principals agreed or strongly agreed that students will learn more about agriculture when science concepts are an integral part of instruction (84.2%), science concepts will be easier to understand (76.3%), and students will be better prepared in science (71.1%) if science is integrated into the agriculture curriculum. Over half (51.3%) of the principals agreed or strongly agreed that students are more motivated to learn if science is integrated into the agricultural education program.

Table 1
Principals' Perceptions of Integrating Science and Agriculture (N = 76)

Agriculture and Science	Item	SA %	A %	N %	D %	SD %
	Students are more aware of the connection between scientific principles and agriculture when science concepts are an integral part of their instruction.	48.7	47.4	2.6	1.3	0
		96.1 _a			1.3 _b	
	People pursuing a career in agriculture must have a greater understanding of biological science than ten years ago.	51.3	38.2	10.5	0	0
		89.5 _a			0 _b	
	Students learn more about agriculture when science concepts are an integral part of their instruction.	39.5	44.7	15.8	0.0	0.0
		84.2 _a			0 _b	
	People pursuing a career in agriculture must have a greater understanding of physical science than ten years ago.	38.7	41.3	18.7	1.3	0
		80.0 _a			1.3 _b	
	Science concepts will be easier to understand for students if science is integrated into the agricultural education program.	25.0	51.3	21.1	1.3	1.3
		76.3 _a			2.6 _b	
	Students will be better prepared in science after they completed a course in Agric. Ed. that integrated science.	30.3	40.8	23.7	2.6	2.6
		71.1 _a			5.2 _b	
	Students will be more motivated to learn if science is integrated into the agricultural education program.	17.1	34.2	40.8	6.6	1.3
		51.3 _a			7.9 _b	

_a Strongly agree and agree combined

_b Strongly disagree and disagree combined

Two open-ended questions were asked to principals regarding integrating science into the agricultural education program. Principals were asked what had to be given up or what has been given up to develop a more integrated science curriculum and the most significant factor that will cause or has caused Agricultural Education Programs to integrate science. Of the fifty-nine responses, the most common response to what agricultural education programs would have to give up was “nothing” (35 responses), followed by traditional agriculture classes (15 responses), and “time” (5 responses). The most commonly listed items (76 responses) that caused or will cause the respondents to integrate science were to meet state standards (19 responses), teacher initiative and/or interest (13 responses), inservice training (8 responses), funding (7 responses), and opportunities to integrate with a science teacher (6 responses).

Research question number three contained six items designed to address the principals’ perceptions regarding the role of teacher preparation programs in assisting teachers in integrating science (Table 2). The principals agreed or strongly agreed that teacher preparation programs should provide instruction for undergraduates (96% agreed or strongly agreed) and inservice for teachers (94.6% agreed or strongly agreed) on how to integrate science into the Agricultural Education Program. Almost three fourths of the respondents agreed or strongly agreed (74.6%) that teacher preparation programs should place student teachers with a cooperating teacher that integrates science and pre-service teachers should be required to take more science courses in their undergraduate program (74.3% agreed or strongly agreed). Sixty-four percent (64%) of the principals agreed or strongly agreed that teacher preparation programs should require a follow-up activity requiring agriculture teachers to cooperate with science teachers in their school district to integrate science. Almost 63% of the principals agreed or strongly agreed that early field experience should be conducted with an agriculture teacher that integrates science.

Table 2

Principals' Perceptions Concerning the Role of Teacher Preparation Programs in Integrating Science in Agricultural Education Programs (N = 76)

Teacher Preparation Programs	Item	SA %	A %	N %	D %	SD %
Teacher prep. Programs in agriculture should provide instruction for undergraduates on how to integrate science.		38.7	57.3	4.0	0	0
		96.0 _a			0 _b	
Teacher prep. Programs should provide inservice for teachers in the field on how to integrate.		33.3	61.3	5.3	0	0
		94.6 _a			0 _b	
Teacher preparation programs should place student teachers with a cooperating teacher that integrates.		25.3	49.3	24.0	1.3	0
		74.6 _a			1.3 _b	
Teacher preparation programs in agriculture should require students to take more basic science courses.		21.6	52.7	20.3	5.4	0
		74.3 _a			5.4 _b	
Teacher prep/ programs should have an inservice activity that requires AST teachers to cooperate with a science teacher in their district to integrate science.		21.3	42.7	28.0	8.0	0
		64.0 _a			3.0 _b	
Teacher preparation programs should require that students conduct their early field experience with a teacher that integrates science.		22.7	40.0	33.3	4.0	0
		62.7 _a			4.0 _b	

^a Strongly agree and agree combined

^b Strongly disagree and disagree combined

Research question number four (Table 3) contained three items that addressed state standards or Certificate of Initial Mastery (CIM) and Certificate of Advanced Mastery (CAM). Principals agreed or strongly agreed that integrating science will help align programs with educational standards (88.2%), support programs by helping students meet state requirements (85.5%) and be an asset to the agriculture program (69.8%).

Table 3
 Principals' Perceptions Concerning State Standards (N = 76)

Meeting State Standards	Item	SA %	A %	N %	D %	SD %
Integrating science will help align AST Programs with emerging educational standards (CIM/CAM).		32.9	55.3	10.5	1.3	0.0
		88.2 _a				
Integrating science will support AST Programs by helping our students meet state standards (CIM/CAM).		34.2	51.3	11.8	1.3	1.3
		85.5 _a				
State standards (CIM/CAM) will be an asset to what we are trying to do in our agriculture program.		31.6	38.2	17.1	9.2	3.9
		69.8 _a				

^a Strongly agree and agree combined

^b Strongly disagree and disagree combined

Participants were asked to respond to an open-ended question concerning changes that AST Programs would have to go through to meet state standards (CIM/CAM). Of the 61 responses, most principals felt that curriculum alignment with state standards (17 responses), integrating science (16 responses), and nothing (13 responses) were the changes most often listed that respondents felt would have to be made to meet state standards.

Table 4 presents the principals' modal attitude toward teaching integrated science in agricultural education. Almost 63% of the respondents agreed or strongly agreed that integrating science requires more preparation time. Over half (50.7%) of the respondents agreed or strongly agreed that their agriculture teacher was prepared to teach integrated biological science concepts, while only 24% of the respondents agreed or strongly agreed that their agriculture teacher was prepared to teach integrated physical science concepts. Over half (53.4%) of the principals agreed or strongly agreed the agriculture teacher teaches integrated science concepts that focus more on the biological than the physical science concepts.

Table 4
Principals' Perceptions Toward Teaching Integrated Science in Their Agricultural Education Program (N = 76)

Teaching Integrated Science Item	SA %	A %	N %	D %	SD %
Integrating science into the agricultural education program requires more preparation time.	17.3	45.3	22.7	9.3	5.3
	62.6 _a			14.6 _b	
My agriculture teacher teaches integrated science concepts in agricultural education that focus more on the biological science concepts than the physical science concepts.	6.7	46.7	36.0	10.7	0
	53.4 _a			10.7 _b	
My agriculture teacher is prepared to teach integrated biological science concepts.	20.0	30.7	29.3	17.3	2.7
	50.7 _a			20 _b	
Integrating science into agriculture classes has increased our school's ability to teach students to solve problems.	6.7	32.0	53.3	6.7	1.3
	38.7 _a			8.0 _b	
My agriculture teacher has integrated more science in the advanced courses than the introductory courses.	1.4	35.1	37.8	23.0	2.7
	36.5 _a			25.7 _b	
My agriculture teacher is prepared to teach integrated physical science concepts.	13.3	22.7	40.0	21.3	2.7
	36.0 _a			24.0 _b	

_a Strongly agree and agree combined

_b Strongly disagree and disagree combined

Table 5 presents the principals' modal attitude toward barriers to integrating science into the agricultural education program. Over sixty-five percent (65.8%) of the respondents agreed or strongly agreed that lack of appropriate equipment is a barrier to integrating science and almost fifty-eight percent (57.9%) of the respondents agreed or strongly agreed that lack of adequate federal, state, or local funds is a barrier to integrating science. Almost fifty-eight percent (57.9%) of the principals agreed or strongly agreed that a lack of agriscience workshops for agriculture teachers is a barrier to integrating science. Principals disagreed or strongly disagreed (52.7%) that lack of agriscience jobs in the local community is a barrier to integrating science.

Table 5
Perceived Barriers to Integrating Science In Agricultural Education Programs (N = 76)

Barriers	Item	SA %	A %	N %	D %	SD %
Lack of appropriate equipment is a barrier to integrating science into agricultural education programs.		21.1	44.7	17.1	13.2	3.9
		65.8 _a			17.1 _b	
Lack of agriscience workshops for agricultural education teachers is a barrier to integrating science.		17.1	40.8	26.3	13.2	2.6
		57.9 _a			15.8 _b	
Lack of adequate federal, state, or local funds is a barrier to integrating science into agricultural education programs.		17.1	40.8	18.4	18.4	5.3
		57.9 _a			23.7 _b	
Lack of science competence among teachers in agricultural education is a barrier to integrating science.		9.2	40.8	30.3	28.9	3.9
		50.0 _a			19.7 _b	
Lack of close proximity to high-technology firms is a barrier to integrating science in agricultural education programs.		15.8	22.4	28.9	28.9	3.9
		38.2 _a			32.8 _b	
Lack of an integrated science curriculum is a barrier to integrating science into the agricultural education program		7.9	28.9	28.9	26.3	7.9
		36.8 _a			34.2 _b	
Lack of student preparation (prior to enrolling in agricultural education) in science is a barrier to integrating science.		2.6	25.0	25.0	39.5	7.9
		27.6 _a			47.4 _b	
Lack of agriscience jobs in the local community is a barrier to integrating science in the agricultural education program.		6.6	18.4	22.4	39.5	13.2
		25.0 _a			52.6 _b	
Lack of a science teacher who is willing to help me integrate science concepts has been a barrier to integrating science		5.3	17.1	31.6	36.8	9.2
		22.4 _a			46.0 _b	

^a Strongly agree and agree combined

^b Strongly disagree and disagree combined

Table 6 presents the principals' modal attitude toward program support for the agricultural education program. A majority of the principals agreed or strongly agreed that local administrator support (67.1% agreed or strongly agreed), that science teacher support (60.5% agreed or strongly agreed), and other teacher support (51.3% agreed or strongly agreed) will increase by integrating more science into the agricultural education program. The majority of principals (52.7%) agreed or strongly agreed that parental support will increase by integrating more science into the agricultural education program.

Table 6
Principals' Perceptions Concerning Program Support of Integrating Science into Their Agricultural Education Program (N = 76)

Program Support	Item	SA %	A %	N %	D %	SD %
Local administrator support will increase by integrating more science into the agricultural education program.		13.2	53.9	22.4	10.5	0
		67.1 _a			10.5 _b	
Science teacher support will increase by integrating more science into the agricultural education program.		11.8	48.7	30.3	6.6	2.6
		60.5 _a			9.2 _b	
Parental support will increase by integrating more science into the agricultural education program.		6.6	46.1	38.2	9.2	0.0
		52.7 _a			9.2 _b	
Other teacher support has/will increase(d) by integrating more science into the agricultural education program.		7.9	43.4	38.2	9.2	1.3
		51.3 _a			10.5 _b	
Community support will increase by integrating more science into the agricultural education program.		9.2	39.5	42.1	7.9	1.3
		48.7 _a			9.2 _b	
School counselor support will increase by integrating more science into the agricultural education program.		7.9	38.2	43.4	9.2	1.3
		46.1 _a			10.5 _b	

_a Strongly agree and agree combined

_b Strongly disagree and disagree combined

Conclusions/Recommendations/Implications

If integration of science into the agricultural education curriculum is to be successful on the secondary level, there must be support from the principal. This study provided base-line data to ascertain the perceptions of principals toward integrating science and can be used to assist agriculture teachers, the state department of education, and teacher preparation programs in making decisions toward curriculum changes. Administrator support is an important aspect of program development and expansion. Therefore, this study may be useful in making decisions to provide inservice and curriculum changes in Agricultural Science and Technology Programs.

The data concluded that principals in this study have responded positively to the call of integrating science into the agricultural education curriculum. Philosophically, principals can see the value that integrating science in agricultural education programs will benefit student learning. A majority of secondary principals that oversee Agricultural Science and Technology Programs were in agreement that students were more aware of the connection between science and agriculture, that students learn more about agriculture, and science concepts are easier to understand for students if science is integrated into the agricultural education program.

This study will assist teacher preparation programs in planning curriculum for pre-service teachers and inservice activities for practicing teachers. A compilation of principals and teachers' perceptions (Thompson & Balschweid, 1999) will give leaders in agricultural education information to assist in redesign efforts to meet the demands of educational reform in Oregon. Principals agreed that student teachers and early field experience students should be placed in programs that integrate science. Teacher preparation programs can use the data to assist in making the decision to develop an inservice activity for new teachers that requires them to cooperate with a science teacher in their school district to integrate science.

Will agricultural education programs survive this round of education reform and state standards? How do principals view Agricultural Education Programs' contribution to educational reform? The principals in this study felt that integrating science will help students meet the standards in Oregon's Certificate of Initial Mastery (CIM) and Certificate of Advanced Mastery (CAM). Principals believe that integrating science will help align programs to meet state standards and teachers should continue their work to align with state standards. Principals feel that alignment and integration are key changes that will have to be made in Agricultural Education Programs to meet state standards. Practicing teachers can learn from the data of this study by understanding the perceptions of principals toward integrating science.

The data indicated principals agreed that administrator, science teacher, other teacher and parental support for the agriculture program will increase by integrating more science. It can be noted that principals understand that more preparation time is needed to integrate science and therefore, they may be more supportive to the time commitment involving integrating science. However, knowing that principals believe teachers integrate more biological than physical sciences and are more prepared to teach integrated biological than physical sciences will provide teachers with the understanding of how the majority of principals perceive biological and physical sciences. Teachers may need to highlight their knowledge in physical sciences and how their agricultural mechanization program emphasizes physical science concepts. Agriculture teachers should benefit from administrative involvement in curricular advancement.

At the same time, agriculture teachers need to do more to educate principals about the need for integrating science into the curriculum and the benefits to students and the school system. This study sought to investigate the perceptions of Oregon principals in high schools that had Agricultural Science and Technology Programs. The data presented serves as a benchmark for identifying principals' perceptions of barriers, enrollment issues, program support, state standards, the role of teacher preparation programs, and their perception of teaching integrated science concepts in agricultural programs.

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Principals' Perceptions of Integrating Science into Agriculture Programs

A Critique

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The success of curriculum reform efforts typically hinges on the perceptions and subsequent actions of school administrators. In this study, integration of science into the agricultural education curriculum is the reform being sought, and the perceptions of secondary school principals toward this effort in Oregon are the focus of the research. The researcher is to be commended for selecting a topic of great importance to agricultural educators nationally and for surveying the perceptions of a key potential catalyst (or gatekeeper) in any educational system, the high school principal.

This paper is well organized and includes an excellent review of literature related to the study. The theoretical framework is presented clearly, pivoting on the rationale that if principals have a positive attitude toward integrating science, they will likely support the concepts [of] integrating science and the agriculture teacher's efforts to integrate science into the curriculum. Both purpose and the research questions to be addressed were logically defined and pursued. Appropriate research methods and procedures were used. The target population was all secondary principals of schools that had an Agricultural Science and Technology (AST) Program. The Integrating Science Survey Instrument, which the author developed in 1997, was augmented with three additional questions. Reliability and validity were established. Over three-quarters of the population responded, and non-response error was controlled for those who did not. In short, this was a well designed and implemented study.

A few concerns or questions come to mind, however, as one reflects upon the conclusions, recommendations, and implications of the study--several of which the researcher, himself, has raised. Even though the tabular data indicate that one-half of the responding principals perceived (strongly agree/agree) that a lack of science competence among teachers in agricultural education is a barrier to integrating science, the author omitted any comment on this finding. Perhaps this is a case of the glass being half full or half empty, depending on one's perspective; however, it is a measure of the principals' perceived level of science competence of their AST (agriculture) teachers. This reserved assessment of AST teacher competence in science ranged from approximately one-half (49%) of the principals implying their teachers weren't prepared to teach integrated biological science concepts (neutral to strongly agree) to nearly two-thirds (64%) with similar reservations about their AST teachers' preparation for teaching integrated physical science concepts. The author did acknowledge the perceptual difference reported by principals that AST teachers are better prepared to integrate biological science than physical science, suggesting that teachers may need to highlight their knowledge in physical sciences and how their agricultural mechanization program emphasizes physical science concepts. A very useful benchmark study!