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Science Credentialing and Science Credit in Secondary School Agricultural Education

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Wirt (1991) noted that the 1990 Carl D. Perkins Vocational and Applied Technology Act called for integration of academic and vocational education to link "thought with action" (p. 426). In agricultural education, The National Research Council (1988) has promoted a recent focus on agricultural science or agriscience education, recommending "Ongoing efforts should be expanded to upgrade the scientific and technical content of vocational agriculture courses" (p. 35). 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" (p. 4), with a foundation in biological and physical science. Recent research on the integration of science and agriculture in secondary schools has focused on agriculture student attitudes and performance, agriculture teacher attitudes and adoption, and resource sharing between agriculture and science programs.

Roegge and Russell (1990) found that students who were subjected to lessons that integrated biological with agricultural principles demonstrated higher overall achievement, biology achievement, and more positive attitudes toward the learning experience than students subjected to a traditional approach. An Ohio study found high school production agriculture teachers were teaching a moderate number of the agriscience competencies from a new agriscience core curriculum (Peasley & Henderson, 1992). These teachers displayed positive attitudes toward the core and the term agriscience. Iverson, Carpentier, Robinson, and Boreing (1991) found over half (53.1%) of a sample of agriculture teachers from Georgia, Maryland, and Tennessee infused biotechnology subject matter into regular agriculture classes. Availability of teaching materials, funding for equipment and supplies, inservice preparation, and ability level of the students were factors related to the respondents' decisions to teach biotechnology. In a national study, agriculture teachers were moderately interested in infusing bioscience subject matter into agriculture (Martin, Rajasekaran, and Vold, 1989). They generally agreed this helps students understand agriculture, learn about a wider range of agricultural careers, and develop new agriculturally related skills.

In a national study at the secondary level, Dormody (in press-a) found 67% of the agriculture teachers and 73 percent of the science departments had shared resources during the 1989-90 academic school year. Dormody (in press-b) found that agriculture teacher attitudes toward science, number of inservice courses or workshops taken covering science-related teaching methods, and instructional budget were predictors of present bi-directional resource sharing and future sharing of science department resources with agriculture teachers. Kramer (1989) found that approximately 25 percent of the Colorado secondary science teachers surveyed used agriculture teachers as a source of agricultural information for their classes.

While many agriculture teachers are quick to integrate science and agriculture, others are more cautious. Martin et al. (1989) reported some agriculture teachers believed their students were not very interested in learning agriculturally-related bioscience. The teachers "were concerned that too much focus on the sciences of agriculture may hurt enrollment" (p. 246). Peasley and Henderson (1992) found teachers were polarized strongly in favor or strongly against science credit for agriculture courses. Some respondents cited recruitment and retention enhancement as benefits of science credit. One respondent worried about competing with the science department for students. Another stated the following:

> "If we grant science credit, we will become just another science class and administrators will use this as a reason to treat ag classes as just another general science class. I'm not sure this is desirable. If we grant science credit, what happens to the FFA? I think this is a big mistake. (p. 42)."

A previously unpublished comment on Dormody's (in press-b) questionnaire related a similar concern about science credentialing for agriculture teachers.

> "The administrator would like me to have a biology endorsement. This would enable him/her to use me to teach non-ag science as well as to receive science credit for agriscience. I could conceivably wind up teaching mostly science and have the ag program swallowed up due to enrollment."

Are these valid concerns about science credit for agriculture courses and science credentialing for agriculture teachers?

Purpose and Objectives

The primary purpose of this study was to explore secondary school agriculture teacher credentialing in science, and science credit for agriculture courses in the United States. Specific objectives were:

To describe the agriculture teachers demographically, including whether or not they have a science credential, the number of agriculture courses taught during the 1990-91 academic school year receiving science credit toward graduation, and the number of nonagricultural science courses taught during the 1989-90 and 1990-91 academic school years.

To determine if agriculture teachers with or without science credentials are more likely to teach both agriculture courses receiving science credit or nonagricultural science courses.

To determine if agriculture instructors teaching or not teaching agriculture courses receiving science credit are more likely to teach non-agricultural science courses.

To determine if there is a trend toward agriculture instructors teaching more nonagricultural science courses.

To determine course titles for agriculture courses receiving science credit.

Procedures

All secondary school agriculture teachers from the United States served as the population for the study. Using the Agriculture Teachers Directory (Henry, 1990) as a data base, the population included 11,733 teachers. At a 95 percent confidence level a sample size of 372 was needed to represent the population (Krejcie & Morgan, 1970). This number was rounded up to 400. A random sample of secondary school agriculture teachers, stratified proportionally by state to ensure state and regional representation, was then generated using a random numbers table.

The study used descriptive survey methodology. Variables measured by the questionnaire were: (a) age, (b) gender, (c) years of teaching completed, (d) highest degree held, (e) number of preservice courses taken covering science-related teaching methods, (f) number of inservice courses or workshops taken covering science-related teaching methods, (g) credentialing to teach science, (h) number of agriculture courses taught during the 1990-91 academic school year that received science credit toward graduation, (i) number of non-agricultural science courses taught during the 1989-90 academic school year, and (g) number of non-agricultural science courses taught during the 1990-91 academic school year. The questionnaire also determined course titles for agriculture courses receiving science credit toward graduation.

A panel of experts consisting of two secondary school science teachers, two secondary school agriculture teachers, a teacher educator in science education, a teacher educator in agricultural education, a statistician, and a state supervisor of agricultural education assessed the questionnaire for content and face validity. The instrument was field-tested for clarity, validity, and reliability using 31 secondary school agriculture teachers who were not part of the sample. The Cronbach's alpha reliability coefficient for the quantitative portion of the questionnaire was .79.

Data were collected during October-December 1990 following the Dillman procedure for mail questionnaire administration (1978). Incentives were sent with all four mailings to increase response rate. A 68 percent response rate (n=273) was obtained. After follow-up phone calls were made to complete questionnaires with missing data, a 60 percent (n=241) usable response rate was obtained. Thirty-two questionnaires were unusable because they had gone to an adult educator or administrator (n=8), or a teacher who had not taught agriculture during the 1989-90 academic school year (n=10); the school had no science department or agriculture program (n=9); or data were incomplete (n=5). Respondents to the first two questionnaire mailings and follow-up postcard (early respondents) were compared with respondents to the third questionnaire mailing (late respondents) to check for non-response bias (Miller & Smith, 1983). Late respondents were more likely to take inservice courses or workshops covering science-related teaching methods than early respondents, limiting discussion of this item to the respondents. For the other items, data are considered to be representative of the sample.

Objectives 1, and 5 were analyzed using descriptive statistics (i.e., frequencies and percentages). Objectives 2, 3, and 4 were analyzed using chi-square tests of homogeneity. A significance level of .05 was set a priori for the statistical analyses.

Results

Of the agriculture teachers in the sample, 93.4 percent were males. The teachers averaged 39.4 years in age and 14.5 years teaching experience. A bachelor's degree was held by 47.5 percent and a master's degree by 48.3 percent. Science credentials were held by 113 (46.9%) teachers from 34 (72.3%) of the 47 states represented in the study. Preservice courses covering science-related teaching methods had been taken by 106 (44.0%) of the teachers (Table 1). Forty-nine (20.3%) had taken four or more of these courses. Inservice courses or workshops covering science-related teaching methods had been taken by 148 (61.4%) of the teachers. Over 25 percent (n=64) had taken four or more of these inservice courses or workshops. Agriculture courses receiving science credit were taught by 82 (34.0%) teachers from 33 (70.2%) of the 47 states represented. The majority of these (n=59) were teaching two or fewer agriculture courses receiving science credit. Only 23 (9.5%) and 27 (11.2%) of the teachers taught non-agricultural science courses during 1989-90 and 1990-91, respectively. Agriculture teachers with a science credential were more likely to teach both agriculture courses receiving science credit and non-agricultural science courses than those without a science credential (Table 2). Agriculture teachers with a science credential were more likely to teach agriculture

Table 1 Agriculture Teacher Science Training, Agriculture Courses Receiving Science Credit, and Non-agricultural Science Courses Taught (n=241)

Item		None	1	Number 2	3	4 or more
Preservice courses (science-	n	135	17.	26.	14.	49
related teaching methods)	%	56.0	7.1	10.8	5.8	20.3
Inservice courses/workshops	n	93	29	34	21	64
(sci.-rel. teaching methods)	%	38.6	12.0	14.1	8.7	26.6
Ag. courses taught receiving	n	159	35	24	14	9
science credit in 1990-91	%	66.0	14.5	10.0	5.8	3.7
Non-ag. science courses taught	n	218	12	10	1	0
in 1989-90	%	90.4	5.0	4.1	0.4	0.0
Non-ag. science courses taught	n	214	16	10	1	0
in 1990-91	%	88.8	6.6	4.1	0.4	0.0

courses receiving science credit and no non-agricultural science courses (n=41) than non-agricultural science courses and no agriculture courses receiving science credit (n=8) (X^2=27.52, p<.001). Agriculture teachers without a science credential were also more likely to teach agriculture courses receiving science credit and no non-agricultural science courses (n=24) than non-agricultural science courses and no agriculture courses receiving science credit (n=2) (X^2=21.07, p<.001).

Agriculture teachers receiving science credit for agriculture courses were more likely to teach non-agricultural science courses than teachers not receiving science credit for agriculture classes (Table 3). However, many more teachers taught agriculture courses receiving science credit and no non-agricultural science courses (n=65) than taught both agriculture courses receiving science credit and non-agricultural science courses (n=17). These 17 teachers taught a total of 31 agriculture courses receiving science credit and 26 non-agricultural science courses in 1990-91.

Using a McNemar test, there was no change from 1989-90 to 1990-91 in the number of agriculture teachers teaching non-agricultural science courses (X^2=.32, p<.70). Of the 23 and 27 teachers teaching non-agricultural science courses in 1989-90 and 1990-91, respectively, 16 taught them both years. Seven teachers were dropped and 11 were added to this group in 1990-91. There was also no change from 1989-90 to 1990-91 in the

Table 2 Science Credentialling and Teaching Agriculture Courses Receiving Science Credit or Non-agricultural Science Courses (n=241)

Contingency table cell	n	E(n)	X^2	R
Teaching agriculture courses receiving science credit				
Science credentialed/teaching ag. for science credit	54	38.45	6.29	2.51**
Science credentialed/not teaching ag. for science credit	59	74.55	3.24	-1.80
Not science credentialed/teaching ag. for science credit	28	43.55	5.55	-2.36**
Not science credentialed/not teaching ag. for sci. credit	100	84.54	2.86	1.69
Totals	241		17.94*	
Teaching non-agricultural science courses				
Science credentialed/teaching non-ag. science	21	12.66	5.59	2.34**
Science credentialed/not teaching non-ag. science	92	100.34	0.69	-.83
Not science credentialed/teaching non-ag. science	6	14.34	4.85	-2.20**
Not science credentialed/not teaching non-ag. science	122	113.66	0.61	.78
Totals	241		11.64*	

Note: *p<.001

Note: **Cells in which |standardized residual|>2.00 are major contributors to a significant X^2 value (Hinkle, Wiersma, & Jurs, 1988, p. 556).

Table 3. Teaching Agriculture Courses Receiving Science Credit and Teaching Non-agricultural Science Courses (n=241)

Contingency table cell	n	E(n)	X^2	R
Science credit/teaching only ag. courses	65	72.81	.84	-.92
Science credit/teaching ag and non-ag. sci. courses	17	9.19	6.64	2.58**
No science credit/teaching only ag. courses	149	141.19	.43	.66
No science credit/teaching non-ag. sci. courses	10	17.81	3.43	-1.85
Totals	241		11.34*	

Note: *p<.001

Note: **Standardized residual>2.00

number of agriculture teachers teaching non-agricultural science courses and no agriculture courses receiving science credit (X^2=.22, p<.70). Of the 8 and 10 teachers teaching non-agricultural science courses and no agriculture courses receiving science credit in 1989-90 and 1990-91, respectively, five taught them both years. Three agriculture teachers were dropped and five were added to this group in 1990-91.

Of the 82 agriculture teachers receiving science credit for agriculture courses in 1990-91, 77 provided 100 different titles used for 166 agriculture courses receiving science credit (Table 4). Nearly two-thirds (106) of the courses had or were likely to have an agricultural production emphasis. Courses in forestry and horticulture also received science credit. In addition, small numbers of courses in agribusiness, agricultural mechanics and engineering, agricultural processing, and resource management received science credit.

Conclusions, Implications, and Recommendations

Agriculture teachers with a science credential are more likely to teach both agriculture courses receiving science credit and non-agricultural science courses. When they receive

Table 4. Agriculture Courses Receiving Science Credit (n=77)

Areas of instruction	Course title or roots of title	n	%
Agribusiness	Agricultural Business (5 variations)	5	3%
Ag. mech. and engineering	Agricultural Mach. or Power (5 var.)	5	
	Agricultural Mech. or Eng. (4 var.)	4	
	Agricultural Construction	1	
	Recreational Vehicles	1	
	Small Gas Engines	1	
	Subtotal	12	7%
Agricultural processing	Meat Processing	1	1%
Agricultural production	Animal and/or Plant Science	27	
	Agricultural Production (7 variations)	8	
	Livestock Mgt., Prod., Sci. or Tech.	4	
	Crop Production or Science	3	
	Veterinary Science	3	
	Aquaculture or Hydroponics	2	
	Dairy or Equine Science	2	
	Plant Parts, Functions & Growth Req.	1	
	Subtotal	50	30%
Likely an ag. production emphasis	Vo-Ag or Ag. I, II, IV and V	25	
	Ag. Science (5 variations)	14	
	Ag. Science and Tech. or Mech.	4	
	Basic, Adv. or Specialized Ag. Skills	4	
	Agricultural Education I, II or III	3	
	Agricultural Biology	2	
	Introduction to Agriculture	2	
	Agricultural Lab Skills	1	
	Occupational Science	1	
	Subtotal	56	34%
Forestry and horticulture	Horticulture (7 variations)	15	
	Forestry or Forest Science (3 var.)	6	
	Greenhouse Mgt. or Tech. (3 var.)	3	
	Landscaping and/or Nursery (3 var.)	3	
	Turf and Garden Management	1	
	Urban Forestry	1	
	Subtotal	29	17%
Resource management	Natural Resources (4 variations)	7	
	Conservation and/or Environ. Sci.	3	
	Wildlife Conservation or Mgt.	2	
	Soil Science	1	
	Subtotal	13	8%
Total		166	

science credit for agriculture courses, they are more likely to teach non-agricultural science courses than teachers not receiving science credit. However, science credentialing and science credit were much more likely to be used to benefit agriculture programs than science departments. There is no evidence to indicate a trend toward agriculture teachers teaching more non-agricultural science courses.

Agricultural educators should not be worried that science credentialing or science credit will be catalysts for consolidating agriculture teachers and programs with science departments. While there will be exceptions, in most cases, science credentialing and science credit will be used to benefit agriculture programs. Science credentialing may increase the chances of receiving science credit for agriculture courses. The image-enhancing and recruitment benefits of both are worth considering.
Agriculture teachers with a science credential may also be more marketable, especially in rural school districts with small numbers of students, that often seek teachers who are credentialed in more than one subject.

Whether or not science credit is pursued, agriculture teachers should work closely with science departments when developing, implementing, and evaluating agriscience courses. Some states have developed core curricula that meet state requirements for science credit. If science credit is pursued without a state core, agriculture teachers will probably have to convince local decision makers that science credit is a good idea, and that science competencies are addressed in the agriscience curriculum. Whether or not science credit is pursued, agricultural competencies should be clearly cross-referenced with science competencies to show how agriscience courses reinforce science competencies. State supervisors and teacher educators in agricultural education should consider addressing this topic during preservice or inservice education.

Although agriculture courses receiving science credit can fit into six different areas of instruction, most probably have an agricultural production emphasis. Agriculture teachers should consider courses in agricultural mechanics and engineering, agricultural processing, and resource management for science credit. The teachers should be encouraged to expand their concept of agriscience to include the physical sciences as recommended by Buriak (1992). The agricultural mechanics laboratory (e.g., hydraulics), land laboratory (e.g., soil properties), and greenhouse (e.g., climatic factors) are motivational settings for teaching physical science principles. From a program marketing standpoint, more descriptive and scientific course titles (e.g., Animal and Plant Science) over traditional titles (e.g., Ag I) are recommended for agriscience courses, whether or not they receive science credit.

Further research should determine factors related to agriculture teachers' instructional assignments (e.g., enrollment or increased graduation requirements). Other factors related to receiving science credit for agriculture courses should be investigated (e.g., science teacher attitudes or science enrollment figures). A period of longer than one year (e.g., five years) would provide more accurate data of a trend toward agriculture teachers teaching more non-agricultural science courses. Parallel studies in agricultural education or other areas of vocational education could investigate other integration efforts with academic areas.

References

Buriak, P. (1992, March). Filling the gap in agriculture. The Agricultural Education Magazine, pp. 4, 23.

Dillman, D. (1978). Mail and telephone surveys: The total design method. New York: John Wiley & Sons.

Dormody, T. J. (in press-a). Exploring resource sharing between secondary school teachers of agriculture and science departments nationally. Journal of Agricultural Education.

Dormody, T. J. (in press-b). Prediction modeling of resource sharing between secondary school teachers of agriculture and science departments. Journal of Agricultural Education.

Henry, S. (Ed.). (1990). Agriculture teachers directory. Greenburg, PA: Charles M. Henry Printing Co.

Hinkle, D. E., Wiersma, W., & Jurs, S. G. (1988). Applied statistics for the behavioral sciences (2nd ed.). Boston: Houghton Mifflin Co.

Iverson, M. J., Carpentier, D. R., Robinson, B. F., & Boreing, D. R. (1991). A tri-state assessment of current attitudes toward biotechnology held by teachers of agriculture in the public schools. Proceedings of the Eighteenth Annual National Agricultural Education Research Meeting, 18, 165-171.

Kramer, L. L. (1989). Colorado secondary science teacher perceptions of agriculture. Unpublished master's thesis, Colorado State University, Ft. Collins.

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. Educational and Psychological Measurement, 30, 607-610.

Martin, R. A., Rajasekaran, B., & Vold, L. (1989). A national study to determine the role of bioscience/biotechnology in the study of agriculture as perceived by vocational agriculture instructors. Proceedings of the Sixteenth Annual National Agricultural Education Research Meeting, 16, 243-250.

Miller, L. E. & Smith, K. L. (1983). Handling nonresponse issues. Journal of Extension, 21, 45-50.

National Research Council. (1988). Understanding agriculture: New directions for education. Washington D.C.: National Academy Press.

Peasley, D. D., & Henderson, J. L. (1992). Agriscience curriculum in Ohio agricultural education: Teacher utilization, attitudes, and knowledge. Journal of Agricultural Education, 33(1), 37-45.

Roegge, C. A., & Russell, E. B. (1990). Teaching applied biology in secondary agriculture: Effects on student achievement and attitudes. Journal of Agricultural Education, 31(1), 27-31.

Wirt, J. G. (1991, February). A new federal law on vocational education: Will reform follow? Phi Delta Kappan, pp. 425-433.