Prediction Modeling of Resource Sharing Between Secondary School Agriculture Teachers and Science Departments

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Wirt (1991) noted 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). Sharing resources between secondary school science departments and agriculture teachers is one way to upgrade science content in agricultural education.

The National FFA Organization (1990) stated, “Agriculture and science are natural partners” (p. 1). Therefore, it seems logical for agriculture and science teachers to share resources for integrating science into agriculture classes and agriculture into science classes. Such sharing is common nationally. Michigan science teachers interact with agriscience and natural resource teachers in curriculum development and team teaching activities (Elliott, Connors, & Steeby, 1990). In Minnesota, Anoka High School agriculture teachers attend monthly science department meetings and social functions (Tremaine, 1992). Greenhouse and classroom facilities are shared by both departments. The Agriscience Institute and Outreach program (National FFA Organization, 1991) is a national effort to form partnerships between agriculture and science teachers.

In a national study at the secondary level, Dormody (in press) explored present and predicted (future) sharing of science department resources with agriculture teachers and present sharing of agriculture program resources with science departments. Based on data from the 1989-90 academic school year, agriculture teachers perceived they were sharing significantly more resources with science departments than they were using. Agriculture teachers also predicted higher future than present yearly use of science department resources. There were 67% of the agriculture teachers and 73% of the science departments who had shared resources during the year. However, average sharing frequencies for instructional services, equipment and supplies, curriculum and instructional materials, program support services, and facilities were only once or twice a year for each of these five resource categories.

The Dormody (in press) study proposed another research question. What factors predict resource sharing between agriculture teachers and science departments? Research to answer this question could expand our understanding of resource sharing, and provide timely information upon which to base efforts to increase sharing.

Purpose and Objectives

The purpose of this study was to determine the predictors of resource sharing between secondary school agriculture teachers and science departments in the United States. Specific objectives were to:

Describe the agriculture teachers by selected demographic variables.

Determine predictors of present and future sharing of science department resources with agriculture teachers, and present sharing of agricultural program resources with science departments.

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 was found to include 11,733 teachers. At a 95% 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 American Association for Agricultural Education (AAAE) regional representation, was then generated with **a** random numbers table.

The study used descriptive survey methodology. Conceptualizations for resource sharing between secondary school agriculture teachers and science departments and for agriculture teacher attitudes toward resource sharing were developed from three sources: a) the review of related literature; b) secondary school agricultural program and science department sharing experiences of the researcher; and c) input from a panel of experts consisting of two secondary school science teachers and 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.

To measure ***resource*** sharing, three Likert-type summative scales (the dependent variables) were constructed, each containing five resource sharing indicators representing the conceptual subdomains or resource categories of: a) instructional services, b) equipment and supplies. c) curriculum and instructional materials, d) program support services, and e) facilities (Dormody. in press). Each indicator in each summative scale contained four response categories ranging from 1 (never shared) to 4 (shared many times). One scale measured present sharing of agriculture program resources with science departments; a second scale measured present sharing of science department resources with agriculture teachers. These two scales were based on resource sharing during the 1989-90 academic school year. A third scale measured future sharing of science department resources with agriculture teachers. This scale was based on a future academic school year, allowing the respondents to predict what their annual use might become. Because of the doubtful accuracy of agriculture teachers' predictions of future use of agricultural program resources by science departments, they were not measured. To summarize, an example indicator from the summative scale for present sharing of science department resources with agriculture teachers was: "During the 1989-90 school year (not including summer) I used science department facilities in my ag program: not at all, once ***or*** twice, a few times, or many times."

The review of literature revealed no parallel studies of relationships between resource sharing and other variables. The researcher and panel of experts judged these agriculture teacher demographic (independent) variables likely to have relationships with the dependent variables: a) AAAE region, b) age, c) gender, d) years of teaching completed, e) from a multi-teacher or single-teacher agriculture program, f) highest degree held. g) instructional budget, h) number of science teachers at the school, i)

Table 1. Factor Analysis of Agriculture Teacher Attitudes Toward Resource Sharing (N=234)

Conceptual subdomain	Indicator	SSC*
Factor 1 - Interpersonal Relations with Science Department Personnel		
Cooperation	At this school. the science department doesn't want to work with the ag program.**	0.23
Familiarity	I know the science teachers at my school well	0.21
Cooperation	I have a cooperative relationship with the science department at my school	0.20
Compatibility	I get along with the science teachers at my school	0.18
Compatibility	The science teachers here aren't friendly.**	0.16
Convenience	I have the time to develop a relationship with the science department	0.10
Reward	My administration encourages interaction between my agprogram and the science department	0.09
Familiarity	I'm aware of the resources the science department has that could help my program	0.08
Factor 2 - Knowledge and Skill in Science		
Competence	I feel competent in science	0.36
Competence	My understanding in science is weak.**	0.28
Affiliation	I'm uncomfortable when it comes to approaching other faculty.**	0.20
Affiliation	I have no trouble asking other teachers in my school for help	0.18
Ambivalence	The subject matter in my ag classes has a lot in common with what they teach in science	0.12
Factor 3 - Attitude Toward Science		
Self Sufficiency	There's nothing I need from the science department to teach agricultural science.**	0.28
Reward	There is no pay-off to my ag program for working with the science department.**	0.27
Ambivalence	My mission isn't to teach science, its to teach agriculture**	0.24
Cooperation	At this school, the science department doesn't want to work with the ag program.**	0.22
Ambivalence	The subject matter in my ag classes has a lot in common with what they teach in science.	0.16
Self Sufficiency	My budget is such that I can afford to buy what I need to teach agricultural science.**	0.13
Unnested Indicator		
Convenience	My facilities are a distance from the science department.**	

*Standardized Scoring Coefficients (SSC) greater than 0.08 are reported.
**Coding was reversed before data entry.

licensed or not licensed to teach science, j) number of different ag courses taught receiving science credit toward graduation, k) number of non-ag courses taught in the science department during the 1989-90 academic school year, l) number of non-ag courses taught in the science department during the 1990-91 academic school year, m) number of preservice courses taken covering science-related teaching methods, and n) number of inservice courses or workshops taken covering science-related teaching methods. A scale to measure agriculture teacher attitudes toward resource sharing provided the other independent variables in the study.

To measure agriculture teacher attitudes toward resource sharing, an 18 item Likert-type scale was developed containing two items representing each of nine conceptual subdomains measuring perceptions of their: a) affiliation with other teachers, b) ambivalence toward science in agriculture, c) compatibility with science teachers, d) competence in science, e) convenience for interacting with the science teachers and their resources, f) cooperation with the science department, g) familiaritv with science teachers and their resources, h) reward for sharing, and i) agricultural science self sufficiency. Response categories for each indicator ranged from 1 (strongly disagree) to 5 (strongly agree). Using factor analysis with an orthogonal (Varimax) prerotation and nonorthogonal (Promax) rotation, the scale was found to actually contain and three factors (or conceptual subdomains) and one unnested indicator that were used as independent variables in data analysis (Table 1). Based on the commonalities suggested by their most important components, the factors were named: a) interpersonal relations with science department personnel, b) knowledge and skill in science, and c) attitude toward science. Original conceptualizations, indicators, and results of the factor analysis appear in Table 1.

The panel of experts 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. Cronbach's alpha reliability coefficients for the scales measuring: a) agriculture teacher attitudes toward resource sharing; b) present sharing of agriculture program resources with science departments; c) present sharing of science department resources with agriculture teachers; and d) future sharing of science department resources with agriculture teachers were .85, .88, .81, and .91, respectively.

Data were collected during October-December 1990 following the Dillman (1978) procedure for mail questionnaire administration. Incentives were sent with all four mailings to increase response rate. A 68% response rate (n=273) was obtained. After follow-up phone calls were made to obtain missing data, a 59% (n=234) usable response rate was obtained. Thirty-nine questionnaires were unusable because they had gone to an adult educator or administrator (n=8), 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=12). 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). No significant differences in responses to the four scales or their component indicators were identified; therefore, the data collected are considered to be representative of the sample.

Objective 1 was analyzed using descriptive statistics (i.e., frequencies, percentages, means, and standard deviations). Objective 2 was analyzed using stepwise, multiple regression. Because of missing data, the independent variable instructional budget was analyzed in a second stepwise, multiple regression analysis. The categorical independent variable AAAE region was analyzed with analysis of covariance (ANCOVA), using all variables found to be significant in multiple regression as covariates. Given the exploratory nature of this study and the regression analysis, a Type II error was judged potentially as serious as a Type I error. Therefore, a significance level of .10 was set a priori for the analyses.

Because of the large number of independent variables used in the regression analyses, multicollinearity (Pedhazur, 1982) indices for each model were compared to an index (Belsley, Kuh. & Welch, 1980). The regression models were found to have from low to moderate multicollinearity. Therefore, no further investigation of multicollinearity was deemed necessary.

Results

The 234 respondents included agriculture teachers from all states except Massachusetts, New Hampshire, and Rhode Island. Most (93.6%) of the teachers were males. They averaged 39.4 (SD=9.4) years in age and 14.4 (SD=8.8) years teaching experience. A Bachelor's Degree was held by 47.5% and a Master's Degree by 48.3%. Ten (4.2%) were teaching without at least a Bachelor's Degree. Many (47.9%) were licensed to teach science classes. During the 1989-90 and 1990-91 academic school years, they averaged teaching 0.2 (SD=0.6) and 0.2 (SD=0.5) non-ag science classes, respectively. They had taken an average of 1.3 (SD=1.6) preservice courses and 1.7 (SD=1.7) inservice courses or workshops covering science-related teaching methods.

There were 65% percent of the teachers teaching in a single-teacher agriculture department. Their instructional budgets averaged $5.018, but varied greatly from school to school (SD=$7,020). An average of 0.7 (SD=1.1) agriculture classes receiving science credit toward graduation were taught per teacher. The number of science teachers averaged 4.3 (SD=3.4) per school.

Table 2. Multiple Regression Analysis of present Sharing of Agriculture program with Science Departments (N=234)

Source of variation	ss	df	MS	F	Prob.
Regression	1060.7	6	176.8	19.0	.0001
Residual	2118.4	227	9.3		
Total	3179.1	233			

Variables in the equation

Variables	R square	Cumulative R square	E	Prob.
Science-related inservice courses taken	0.1424	0.1424	38.5	.0001
Nonag science courses taught in 1990-91	0.0914	0.2338	27.6	.0001
Factor 3	0.0577	0.2915	18.7	.000 1
Factor 2	0.0220	0.3 135	7.3	.0072
Nonag science courses taught in 1989-90	0.0120	0.3255	4.1	.0449
Number of science teachers	0.0081	0.3336	2.8	.0979
Insignificant variables	0.0148	0.3484		

Six independent variables: a) number of inservice courses or workshops taken covering science-related teaching methods, b) number of non-ag courses taught in the science department during the 1990-91 academic school year, c) Factor 3 (attitude toward science), d) Factor 2 (knowledge and skill in science), e) number of non-ag courses taught in the science department during the 1989-M) academic school year, and f) number of science teachers at the respondent's school, explained approximately 33% of the variance in present sharing of agriculture program resources with science departments (Table 2). All had positive relationships with the dependent variable. By themselves, the fist three variables to enter the model explained almost 30% of the variance in the dependent variable. The 10 other variables that were not significant only accounted for another 1.48% of the variance.

Five independent variables: a) attitude toward science, b) Factor 1 (interpersonal relations with science department personnel), c) number of inservice courses or workshops taken covering science-related teaching methods, d) age, and e) number of non-ag courses taught in the science department during the 1990-91 academic school year, explained approximately 35% of the variance in present sharing of science department resources with agriculture teachers (Table 3). All had positive relationships with the dependent variable with the exception of age. By itself, Factor 3 explained almost 27% of the variance in the dependent variable. The 11 other variables that were not significant only accounted for another 3.05% of the variance.

Table 3. Multiple Regression Analysis of Present Sharing of Science Department Resources with Agriculture Teachers (N=234)

Source of variation	ss	df	MS	F	prob.
Reeression	680.2	6	113.4	21.0	.0001
Residual	1215.7	227	5.4		
Total	1895.9	233			

Variables in the equation

Variable	R square	Cumulative R square	F	Prob
Factor 3	0.2676	0.2676	84.8	.0001
Factor 1	0.0442	0.3119	14.9	.0002
Science-related inservice courses taken	0.0138	0.3257	4.7	.0310
Age	0.0155	0.3412	5.4	.0212
Nonag science courses taught in 1990-91	0.0115	0.3527	4.1	.0450
Insignificant variables	0.0305	0.3832		

Three independent variables: a) attitude toward science, b) years of teaching completed, and c) number of inservice courses or workshops taken covering science-related teaching methods, explained approximately 39% of the variance in future sharing of science department resources with agriculture teachers (Table 4). All had relationships with the dependent variable with the exception of years of teaching completed. By itself, Factor 3 explained almost 35% of the variance in the dependent variable. The 13 other variables that were not significant only accounted for another 4.06% of the variance.

Table 4. Multiple Regression Analysis of Future Sharing of Science Department Resources with Agriculture Teachers (N=234)

Source of variation	ss	df	MS	F	Rob.
Regression	1210.0	4	302.5	37.3	.0001
Residual	1863.3	230	8.1		
Total	3073.3	234			

Variables in the equation

Variables	R square	Cumulative R square	F	Prob.
Factor 3	0.3479	0.3479	125.4	.0001
Years of teaching completed	0.0197	0.3675	7.3	.0075
Science-related inservice courses taken	0.0197	0.3872	7.5	.0067
Insignificant variables	0.0406	0.4278		

When instructional budget was included in the regression analyses the number of respondents with complete data fell to 207, or 52% of the sample. Instructional budget was significant in all three models. It was the fifth variable entering the model for predicting present sharing of agricultural program resources with science departments, explaining 1.98% of its variance. It was the third variable entering the model for predicting present sharing of science department resources with agriculture teachers, explaining 1.88% of its variance. Instructional budget was the second variable entering the model for predicting future sharing of science department resources with agriculture teachers, explaining 2.21% of its variance. It had positive relationships with all three dependent variables. It is worth noting that the indicator in Factor 3: “My budget is such that I can afford to buy what I need to teach agricultural science,” was recoded to produce positive correlations with the dependent variables. Teachers’ perceptions of the relationship between instructional budget and resource sharing was opposite from the relationship based on actual dollars. Finally, using ANOVA, AAAE Region was found to be insignificant in all three models, whether or not instructional budget was used as a covariate.

Conclusions, Implications, and Recommendations

The three prediction models suggest agriculture teacher profiles for encouraging sharing relationships with science departments. A predictive profile for agriculture teachers who share agricultural program resources with their science departments includes taking inservice courses or workshops covering science-related teaching methods, teaching non-ag science courses in the science department, having a positive attitude toward science, having knowledge and skill in science, and working in a school with a relatively large number of science teachers. The predictive profile for agriculture teachers using science department resources includes having a positive attitude toward science, having positive interpersonal relations with science department personnel, taking inservice courses or workshops covering science-related teaching methods, and teaching non-ag science courses in the science department. The predictive profile for agriculture teachers using science department resources in a future academic school year includes a relatively new teacher taking inservice courses or workshops covering science-related teaching methods and having a positive attitude toward science.

Attitude toward science, number of inservice courses or workshops taken covering science-related teaching methods. and probably instructional budget are predictors of all three resource sharing dependent variables. Inservice efforts **like** the Agriscience Institute and Outreach Program For Science and Agriculture Teachers (National FFA Organization, 1991) that form agriculture teacher and science teacher partnerships. improve science knowledge and skill, and supplement agriculture and science program budgets for participants, have aspects that address these three predictors and should be encouraged. Teaching non-ag science courses was a bi-directional predictor of present resource sharing. By teaching in the science department, teachers of agriculture may be increasing knowledge of and access to both science department and agricultural program resources.

Attitude toward science appears to be the best overall predictor of resource sharing between teachers of agriculture and science departments. Agriculture teachers who feel they can use some help and there is a pay-off for interacting with the science department, think science is integral to agriculture, and feel a spirit of cooperation with their science department are likely to share resources. How can such positive attitudes be developed? Firstly, agriculture's scientific base should be persistently reinforced through preservice and inservice education, professional conferences, new curriculum materials, and other print and non-print materials. Teachers must believe that much of what is taught in agricultural education is applied science. Secondly, agriculture teachers should be encouraged to form partnerships with science teachers. Isolationism can lead to wasteful duplication of effort and resources, and lost opportunities. School-wide strengthening of agricultural and science literacy, coupled with extending the use of scarce resources, should be publicized probable outcomes of resource sharing. Thirdly, agriculture teachers and state supervisors of agricultural education should continue to investigate ways for students to receive science credit for agricultural science classes. Science credit can boost enrollment and improve the image of the agricultural education program. In overcrowded schools, it can help reduce class size in the science department. In districts where science credit may not be possible, team teaching and course swapping strategies between science and agriculture teachers could still improve image and establish teamwork.

The prediction models explained between 30 and 40% of the variance in the dependent variables. Replication of this study could look for other predictors of resource sharing. Research to answer why agriculture teachers do or don't have positive attitudes toward science (Factor 3) would help structure programming to enhance resource sharing. Another valuable study would simultaneously measure science teachers' perceptions of resource sharing with agriculture teachers. A longitudinal replication of this study could compare projected (future) resource sharing between science departments and agriculture teachers to realized levels. This study provides methodology and results to guide parallel studies measuring resource sharing between agriculture teachers and other natural academic partners (e.g., math or social studies), and resource sharing between other areas of vocational education and their natural parmers in academic education (e.g., home economics and science or business education and math). Determining the predictors of resource sharing between natural partners in vocational and academic education could guide efforts to integrate these programs.

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