TEACHING APPLIED BIOLOGY IN SECONDARY AGRICULTURE: EFFECTS ON STUDENT ACHIEVEMENT AND ATTITUDES

Chris A. Roegge, Visiting Assistant Professor
Earl B. Russell, Associate Professor
University of Illinois

Secondary school agricultural education may well be in its most tenuous position since its inception more than half a century ago. For example, total secondary vocational agriculture enrollment in Illinois has gone from 29,502 in 1979 to 15,385 in 19% (Witt, 1987). The educational reform movement of the 1980s has received much of the blame for this situation. A tangible result has been the increased requirement for academic credit for high school graduation and college entrance in many states (Burton, 1986; Case, 19%). Underlying factors, such as the questionable contribution of vocational education to job success (Warmbrod, 1983) and the perceived inadequacies of the traditional agriculture curriculum (Russell, 1986), may also be contributing to the decline. One strategy for solving this curricular dilemma is summarized by the National Commission on Secondary Vocational Education (1984):

> What is really required today are programs and experiences that bridge the gap between the so-called "academic" and 'vocational" courses. The theoretical and empirical bases as well as the practical and applicative aspects of academic courses and vocational courses must be made explicit and meaningful. (p. 14)

The benefits of this strategy may reach beyond vocational education. The National Science Board Commission on Precollege Education in Mathematics, Science, and Technology (1983) reported an urgent need for curricula which utilize science and mathematics applied in practical situations to improve learning and stimulate interest. Truxal (1984) advocated a more relevant curricular focus for science education to help improve student interest and achievement.

Purpose of the Study

The purpose was to determine how well two areas of study, agriculture and biology, may be integrated in a high school agriculture setting. This purpose was accomplished by testing the effect of incorporating biological principles into a unit of instruction in vocational agriculture on student achievement and attitudes. Specifically, the following null hpyotheses were tested:

HO_1: No significant difference in overall achievement will exist between students taught using the integrated approach and those taught using the traditional approach.

HO_2: No significant difference in applied biology achievement will exist between students taught using the integrated approach and those taught using the traditional approach.

HO_3: No significant difference in attitude toward the learning experience will exist between students taught using the integrated approach and those taught using the traditional approach.

Methodology

Twelve agriculture programs were randomly selected from the population of all schools offering comprehensive production agriculture programs in Illinois. Three schools (two experimental and one control) dropped out during the course of the study. Therefore, the final sample consisted of 104 students in 9 schools, 57 (five classes) in the control group and 47 (four classes) in the experimental group.

A pretest-posttest control group design was used. The experimental treatment was the use of experimental teaching plans and materials for the selected problem areas. The treatment was assigned randomly to one-half of the selected sample classes. The dependent variables measured were overall student achievement, student achievement in applied biology, and student attitude toward the learning experience. In addition, student demographic variables were selected, based on the findings of Starling (1965) and Peterson (1969), to be analyzed for their effect on the dependent variables.

A literature review produced a list of 24 principles of biology for incorporation into secondary agriculture programs (Peterson, 1969; Starling, 1965; Sutherland & Sams, 1963). Two instructional problem areas were selected for use, one on corn production and the other on soybean production. The teacher's guides for the experimental group for these two problem areas were altered slightly by the researcher to reflect the integration of biological principles into the lesson, and additional information on biological concepts was also provided. The control group teachers used the unaltered teacher's guides to teach the two problem areas.

Instrumentation and Data Collection

The student achievement instruments were adapted from instruments used by Starling (1965), Peterson (1969), and Plowers (1986). Content validity of the instruments was determined by a panel of experts from the University of Illinois. The instruments were pilot tested for clarity and reliability and item analysis was performed. RR-20 coefficients of .82 were calculated for both instruments Fifteen items were included in the pretest and 24 items in the posttest. Ten items in the posttest were identified as measures of applied biology achievement and were analyzed separately after the overall analysis. A RR-20 coefficient of .84 was calculated for the IO-item subset. University of Illinois agricultural education faculty used the following criteria to review the applicative items: a) required an application of knowledge to a problem; b) included some form of action; and, c) applied knowledge based on biological principles.

The attitude instruments were adapted from instruments used by Arrington (1984), Arrington and Price (1983), Flowers (1986), Iverson and Brown (1979), and Peterson (1969). Content validity was established by a panel of experts. Both instruments were pilot tested for clarity and reliability, and Cronbach's Alpha coefficients of .85 and .87 were calculated for the attitude toward agriculture and the attitude toward the learning experience instruments, respectively.

All tests and attitude instruments were administered by the vocational agriculture teachers and sent to the researcher for scoring and analysis. Pretests were administered immediately prior to the beginning of instruction. Completion of the problem area took approximately two weeks (10 instructional days). Posttests were administered upon completion of instruction.

Results

Selection of Covariate Measures: Demographic data were collected on the students (Table 1). Equality of proportion tests revealed that the control group was more farm-oriented than the experimental group, with the experimental group having a significantly higher percentage of students with nonfarm backgrounds ($p = .04$), and-a significantly higher percentage of town students ($p < .003$). A significantlv higher percentage of the experimental group had also completed a biology course prior to the study ($p = .03$). Also, a significantly higher-percentage of control group students planned on immediate employment after high school ($p = .03$).

Table 1
Equality of Proportion Test Results on Student Demographic Variables

Variable	% of Treatment	% of Control	p
Farm Background	40	54	.10
Rural non farm background	11	28	.04
Town background	49	18	.003
No previous ag courses	28	**26**	.43
1 - 2 previous ag courses	60	**51**	.23
3+ previous ag courses	12	23	.12
Previous biology course	**60**	37	.03
Concurrent biology course	**32**	14	.04
Further educational plans	49	35	.12
Immediate employment plans	17	37	.03

Due to the significance of the pretreatment differences, these variables (background, previous biology experience, concurrent biology experience, and postgraduation plans) were then tentatively selected

for use as covariates. As a second step in the selection process, correlation coefficients were calculated to determine the strength of relationship behveen the student demographic characteristics and overall achievement. Table 2 reveals that achievement correlated most significantly with background, previous biology experience, postgraduation plans, and attitude toward agriculture.

Tabk 2
Relationships Between Achievement and Demographic Variables

Variabk	r	p
Background	-.15*	.06
Previous agriculture participation	.08	.22
Previous biology participation	-.41*	.01
Concurrent biology participation	-.07*	.25
Self-perceived interest in ag.	-.09*	.17
Self-perceived interest in science	-.06*	.28
Postgraduation plans	-.21*	.02
Attitude toward agriculture	.28	.01

Note. Negative correlations occured as a result of the way in which each variable was entered for analysis. In the case of previous biology participation, for example, achievement scores increased with the number of hours of previous biology taken.

Student attitude toward agriculture was measured by an attitude instrument. Al-test of group means revealed that students assigned to the experimental group had a significantly more positive attitude toward agriculture than those assigned to the control group ($t = 2.16$, $p < .05$). The significance of preexisting differences between treatment and control group students in background, previous biology experience, postgraduation plans and attitude toward agriculture, combined with the significance of the correlation of those variables with student achievement, led to the decision to utilize these variables as covariate measures in the final analysis of covariance.

Analysis of Student Achievement: Summary data for student achievement are presented in Table 3. Overall student-achievement was measured by student scores on the 24-item posttest. A test of hypothesis HO, was performed on the test score means. Analysis of covariance using pretest score, background, previous biology participation, postgraduation plans, and attitude toward agriculture as multipk covariate measures was used to perform the analysis. The analysis of covariance F value of 25.58 was significant ($p < .01$). Therefore, the hypothesis of no difference in overall achievement between treatment and control groups was rejected.

Tabk 3
ANCOVA Summaries: Student Achievement by Group Adjusted for Covariates

	X (observed)	X (adjusted	F	p
Overall Achievement				
Integrated Approach Group	13.63	13.13	2.558	<.01
Traditional Approach Group	9.25	9.76		
Applied Biology Achievement				
Integrated Approach Group	4.84	4.66	9.00	<.01
Traditional Approach Group	3.45	3.63		

Applied biology achievement was measured by student scores on the subset of 10 applicative items within the 24-item posttest. A test of hypothesis HO_2 was performed using the aforementioned variables as covariate measures. The ANCOVA F value of 9.00 was significant ($p < .01$); therefore, the hypothesis of no difference in applied biology achievement between treatment and control groups was rejected.

Analysis of Student Attitude Toward the Learning Experience: Student attitude toward the learning experience was measured by a 20-item attitude instrument. As a preliminary analysis, correlation coefficients were calculated to determine which independent variables were most related to student attitude. Self-perceived interest in agriculture (r = .56), self-perceived interest in science (r = .20), and postgraduation plans (r = .17) were most related to attitude. They were used as covariate measures in the analysis of covariance F test for hypothesis HO_3. Mean attitude scores and results of the analysis of covariance are presented in Table 4. The F value of 17.44 was significant ($p < .01$); therefore, the hypothesis of no difference in attitude toward the curricular approach used between treatment and control groups was rejected.

Tabk 4
ANCOVA Summary: Student Achievement by Group Adjusted for Covariates

	X (observed)	X (adjusted	F	p
Integrated Approach Group	67.66	65.36	17.44	< .01
Traditional Approach Group	57.54	58.85		

Conclusions and Recommendations

The integrated approach is superior to the traditional approach in producing higher overall achievement and in producing higher applied biology achievement. Students also had a more positive attitude toward the learning experience.

The scope of the study should be expanded to include other program areas such as horticulture and animal science. This would serve to establish a basis for generalizing the effectiveness of the integrated approach to all agriculture programs. Also, expand the duration of the study to include a semester of instruction. This would provide results that are more generalizable, and would allow comparison of many different types of problem areas. Further research should compare achievement and attitudes of students taught using the integrated approach to those of students taught biology by traditional means. Studies of this nature could provide a test of the academic rigor of agricultural education programs.

Development and testing of instruments which measure achievement in applied settings should also be investigated. Measuring knowledge of a subject being applied to another subject is extremely difficult, and considerable time and effort could and should be devoted to this area.

Studies should be conducted to ascertain and to facilitate the compatibility of integrated approaches with other paramount features of agriculture programs, most notably problem solving instruction, supervised occupational experience, and FFA.

Teacher education programs should focus on developing in prospective agriculture teachers the ability and skills necessary to integrate academic and agricultural instruction. Teacher education faculty should work closely with faculty in other disciplines (e.g., science education) to prepare teachers who are well versed in integrated instruction, while agriculture teachers should work closely with science teachers in local schools to share and develop strategies for providing integrated instruction.

References

Arrington, L. (1984). Relationship of 1983 program completer attitudes about vocational agriculture and their occupational status one year after graduation. Gainesville, FL: University of Florida, Experiment Station Study. (ERIC Document Reproduction Service No. ED 251 610)

Arrington, L., & Price, W. (1983). Relationship of vocational agriculture student satisfaction to selected student, school, and program, variables. A report of research. Gainesville, FL: University of Florida, Institute of Food and Agriculture Science. (ERIC Document Reproduction Service No. ED 230 766)

Burton, L (1986, January). Falling in step with the excellence movement. The Agricultural Education Magazine, pp. 17-18.

Case, L (1986, January). Agricultural education: Striving for excellence. The Agricultural Education Magazine, pp. 10-12.

Flowers, J. (19%). Effects of the problem solving approach on achievement; retention, and attitudes of vocational agriculture students in Illinois. Unpublished doctoral dissertation, University of Illinois, Urbana-Champaign, IL

Iverson, M., & Brown, R (1979). The role of high school vocational agriculture/agribusiness programs in the occupational success of graduates. Research report of a Southern Region study in agricultural education. Atlanta: Southern Regional Education Board. (ERIC Document Reproduction Service No. ED 179 197)

National Commission on Secondary Vocational Education (1984). The unfinished agenda. Columbus, OH: The National Center for Research in Vocational Education, The Ohio State University.

National Science Board Commission on Precollege Education in Mathematics, Science, and Technology. (1983). A revised and intensified science and technology curriculum for grades K-12 urgently needed for our future. Washington, D. C.: National Science Foundation. (ERIC Document Reproduction Service No. ED 239 847)

Peterson, R (1969). An experimental evaluation of the principles approach to teaching vocational agriculture to high school students. (Doctoral dissertation, University of Nebraska, 1969). Dissertation Abstracts International, 30, 1756-1757A.

Russell, E. (1986, September). Testimony to the committee on agricultural education in secondary schools., National Academy of Sciences, National Research Council. Paper presented at the meeting of the committee, Chicago, IL. - -

Starling, J. (1965). Integrating biological principles with instruction in vocational agriculture. Unpublished doctoral dissertation, The Ohio State University, Columbus, OH.

Sutherland, S., & Sams, W. (1963). Biological principles in agriculture. Davis, CA: California State Department of Education, University of California at Davis.

Truxal, J. (1984, March). Seeing the applications makes science more exciting. VocEd, pp. 24-26.

Warmbrod, J. R (1983, November). Review of Carnegie report. In G. Santo (Ed.), The school studies: Implications for vocational education. Update. Arlington, VA: American Vocational Association.

Witt, E. (1987). (Summary of enrollment figures from the executive director, Illinois Association Unpublished raw data.