

EFFECTS OF APPROACH TO TEACHING ON STUDENT ACHIEVEMENT, RETENTION AND ATTITUDE

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Many people equate the learning process with schools, instruction, and teachers; however, people learn everyday without the help of formal instruction. What educational processes do people use as they face everyday problems, situations, questions, and obstacles?

John Dewey, an educational philosopher, defined a scientific method of teaching which combined processes people use in everyday problem situations. Dewey's Steps in Reflective Thinking, also known as The Chain of Reasoning, The Method of Science, and The Scientific Method, have been recommended by agricultural educators as the problem solving approach to teaching (Binkley and Tulloch, 1981; Crunkilton and Krebs, 1982; Hammonds, 1950; Krebs, 1967; Lancelot, 1944; Newcomb, McCracken, and Warmbrod, 1986; Stewart, 1950).

The problem solving approach has been widely accepted as the way to teach vocational agriculture. A review of literature produced little evidence to support the use of the problem solving approach to teaching secondary vocational agriculture students. Kirts (1983) found that student teachers of vocational agriculture using the problem solving approach asked more higher level questions, more lower level questions, and fewer procedural questions than teachers and student teachers not using the problem solving approach. Chuatong (1986) concluded that most junior and senior horticulture students do not demonstrate a very high level of problem solving ability. Flowers (1986) discovered no significant difference between students taught by the problem solving approach and students taught by the subject matter approach on student achievement, retention scores, and attitudes toward the teaching method.

Education has been criticized for its reliance upon "soft" research and traditions. To overcome this criticism, education must establish sound scientific evidence for the practices commonly used in teaching students. Agricultural education and the problem solving approach to teaching cannot be an exception. The effectiveness of the problem solving approach of teaching vocational agriculture, a) must be established and the profession continue to recommend its use, or b) proven ineffective and discarded or modified to meet the needs of vocational agriculture teachers and students.

Purpose and Objectives

The purpose of this study was to determine which approach, problem solving or subject matter, was the most effective in teaching high school vocational agriculture students as measured by which approach produces higher levels of student achievement test scores, better retention of student learning, and better student attitudes toward instruction upon completion of the instructional unit. The problem solving approach is a student-centered approach to teaching where the central and essential characteristic is solving problems (Binkley and Tulloch, 1981). Students participate in the learning process by contributing problems, analyzing the factors associated with the problems, developing possible solutions to the problems, placing the solution(s) into action, and evaluating the results of the solution. The subject matter approach is a teacher-centered approach to teaching where students are more passive participants in the learning process. Students listen to the information, participate in limited discussion, take notes, and retrieve or recall the information for evaluation purposes. With the subject matter approach the focus is more on acquisition of information than on group driven problem solving.

The objectives of this study were reflected by the following research questions:

1. Which approach to teaching (problem solving or subject matter) results in higher student achievement on a given unit of instruction in vocational agriculture?
2. To what extent does student retention of knowledge differ between students taught with a subject matter approach and students taught with a problem solving approach?

3. Which of the two approaches to teaching requires the greater amount of instructional time to complete a given unit of instruction?
4. To what extent is there a difference in attitudes toward instruction for students receiving the varying forms of the treatment?

Procedures

The data for this study were collected using a quasi-experimental counterbalance design (Campbell and Stanley, 1963). Teachers were purposefully selected for their ability to use the problem solving approach to teaching by a panel of experts consisting of three faculty members from The Ohio State University's Agricultural Education Department and nine staff members from the Supervisors of the Ohio Department of Education, Vocational Agriculture Service. The panel of experts was selected on the basis of their knowledge of the teaching ability of Ohio's vocational agriculture teachers. Twenty-two teachers were identified by the panel of experts, eight teachers agreed to participate in the study, seven teachers provided usable data to the researcher, and six teachers provided audio tapes of their instruction. The accessible population was 121 freshmen students enrolled in production agriculture in seven Ohio comprehensive high schools.

Each teacher taught two instructional units. One unit was taught using a problem solving approach and a second unit was taught using a subject matter approach. The unit plans contained an equal amount of instructional material; the only differences were related to the two teaching approaches used in the study. The problem solving approach unit plans were prepared for each of the instructional units. Equivalent unit plans were prepared for the subject matter approach to teaching including identical information used in the problem solving unit plans. The instructional unit plans were then submitted to a panel of experts consisting of four faculty members and six graduate students from The Ohio State University's Department of Agricultural Education to establish content validity and equality. The panel of experts was selected on the basis of their experience teaching high school vocational agriculture. The topic of the unit (Preparing Beef Cattle for Show and Controlling Weeds in Corn), the timing of the unit (first or second in the instructional series), and the approach to teaching (subject matter or problem solving) were randomly assigned to each teacher. Instruction on all units was audio taped to verify the administration of the experimental levels of the treatment.

Data were collected using a forty question achievement test (Beef Unit Knowledge Test and Weed Unit Knowledge Test), a fifteen item attitude toward instruction instrument (Beef Attitude Instrument and Weed Attitude Instrument), and a fourteen item teaching approach evaluation instrument (Teaching Approach Instrument) developed by the researchers. The forty achievement test questions were arranged in different ways to produce three identical forms of the exam. The three forms were used as a pretest, posttest #1 and posttest #2. Reliability of the instruments used in the study was established with a Cronbach's Alpha of .86 for the Beef Attitude Instrument, .76 for the Beef Unit Knowledge Test, .79 for the Weed Attitude Instrument, .82 for the Weed Knowledge Instrument, and .96 for the Teaching Approach Instrument. Content validity of the instruments was established by a panel of experts consisting of four faculty members and six graduate students from The Ohio State University's Department of Agricultural Education with experience teaching high school vocational agriculture.

Data Analysis

Data analysis for student attitudes toward instruction and time necessary to complete an instructional unit was completed using the analysis of variance procedures. Data analysis for student achievement was completed using multivariate analysis of covariance with repeated measures.

Results

Teaching Approach: Each teacher was requested to audio tape record all instruction conducted for the study. The audio tapes verified the treatment students received in the study. Each recording was analyzed and given an adjusted teaching method score based upon the degree to which the teacher included the essential elements of problem solving. The essential elements of the problem solving approach are: 1) instruction organized around solvable problem statements, 2) problem statement explored by the students, 3) class developed a clear-cut problem statement, 4) students discovered possible solutions to the problem, 5) class established factors needed to be considered in accepting a possible solution, 6) students secured information needed to analyze potential solutions, 7) students weighed information against the problem situation, 8) class arrived at a

tentative conclusion to the problem, 9) students implemented the solution, and 10) the results of the solution were evaluated. A score of one represented the absence of problem solving in the instructional approach, while a score of seven indicated that all the essential elements of the problem solving approach were present. A score greater than four was required to establish that the problem solving approach was used to teach the instructional unit. Two of the six teachers did not teach the problem solving instructional units using the problem solving approach. Their teaching method followed a lecture format where students were given information instead of being required to inquire into the topic. Four teachers used variations of the problem solving approach while teaching their subject matter approach units. Teachers either did not use the problem solving approach or the differences between the problem solving and subject matter approaches were so small that there was limited opportunity for the teaching approach variable to have impact on adjusted student achievement scores.

Student Achievement and Retention: The data were analyzed using multivariate analysis of covariance with repeated measures. Multivariate analysis of covariance with repeated measures produced no significant main effects for timing of the unit or teaching approach used on student achievement and retention.

A significant interaction (Table 1) was found for students completing the "Preparing Beef Cattle for Show" instructional unit. Students who were taught the unit first with the problem solving approach had higher adjusted achievement scores than students who were taught the unit first with a subject matter approach. A possible explanation for this finding will be presented in the discussion section.

Table 1
Multivariate Analysis of Covariance with Repeated Measures Comparing Adjusted Student Scores on the "Preparing Beef Cattle for Show" Instructional Unit

Approach	Timing of Unit of Instruction		Total
	First	Second	
Problem Solving	39.92 $\bar{n} = 46$	32.26 $\bar{n} = 28$	36.09 $\bar{n} = 41$
Subject Matter	34.19 $\bar{n} = 13$	38.09 $\bar{n} = 28$	36.14 $\bar{n} = 41$
Average Both Approaches	37.06 $\bar{n} = 59$	35.17 $\bar{n} = 57$	

Source of Variation	<u>SS</u>	<u>df</u>	<u>MS</u>	<u>F</u>	<u>p</u>
Within Cells	4659.01	110	42.35		
Regression	851.14	1	851.14	20.10	.001
Constant	2317.42	1	2317.42	54.71	.001
Timing of Unit	82.71	1	82.71	1.95	.165
Teaching Approach	.05	1	.05	.00	.972
Timing x Approach	773.65	1	773.65	18.27	.001

Within Cells	1886.77	111	17.00		
BFTPOST	119.83	1	119.83	7.05	.009
Timing of Unit X BFTPOST	.06	1	.06	.00	.954
Approach x BFTPOST	.18	1	.18	.01	.918
Timing x Approach	.94	1	.94	.06	.815

Instruction Time: The average number of minutes necessary to complete the instructional units was 188 for the problem solving approach and 177 for the subject matter approach. There was no significant difference ($p > .05$) in the time necessary to complete an instructional unit using the

problem solving approach compared to the time necessary to complete and instructional unit using a subject matter approach.

Student Attitudes Toward Instruction: Analysis of variance was used to determine if significant differences existed between mean attitude scores for students who were taught instructional units using the problem solving approach and students who were taught an instructional unit using the subject matter approach. Results of the analysis of variance (Table 2) indicated a significant interaction between the effect of the two independent variables on student's attitude toward instruction. Students taught an instructional unit first with a problem solving approach had higher mean scores on attitude toward instruction than students taught the unit first with a subject matter approach. Students taught an instructional unit second with a problem solving approach had lower mean attitude scores than students taught the unit second with a subject matter approach.

Table 2
Analysis of Variance Comparing Average Attitude Toward Instruction Scores of Students Who Received the "Preparing Beef Cattle for Show" Instructional Unit

Approach	Timing of Unit of Instruction		Total
	First	Second	
Problem Solving	57.97 $\bar{n} = 36$	48.41 $\bar{n} = 29$	53.71 $\bar{n} = 65$
Subject Matter	40.08 $\bar{n} = 13$	49.43 $\bar{n} = 7$	43.35 $\bar{n} = 20$
Average Both Approaches	53.20 $\bar{n} = 49$	48.60 $\bar{n} = 36$	

Source of Variation	<u>SS</u>	<u>df</u>	<u>MS</u>	<u>F</u>	<u>p</u>
Main Effects:	2238.26	2	1119.13	17.42	.001
Timing of Unit	597.48	1	597.48	9.30	.003
Teaching Approach	1796.57	1	1796.57	27.96	.001
Timing x Approach	1267.87	1	1267.87	19.73	.001
Explained	3506.13	3	1168.71	18.19	.001
Residual	5204.64	81	64.26		
Total	8710.78	84	103.70		

Discussion

Verification of the treatment was conducted with the use of audio tapes. The adjusted teaching scores that were produced as a result of the verification of treatment indicated that there was little difference between the two approaches used by the teachers participating in the study. Teachers in the study performed in one of two ways. Two teachers did not use the problem solving approach to teach the instructional unit designated by the researcher to be taught using the problem solving approach. The other four teachers incorporated many features of the problem solving approach in their instructional unit designated by the researcher to be taught with a subject matter approach. The result was that variance in the levels of the independent variable, approach to teaching, was not maximized. The failure to follow prescribed levels of the independent variable could explain the significant interactions between timing of the instructional unit and teaching approach. The teachers who taught the "Preparing Beef Cattle for Show" unit second with a subject matter approach had an average teaching score of 3.72. The teachers who taught the "Preparing Beef Cattle for Show" unit second with a problem solving approach had an average teaching score of 1.14. The presence of elements of the problem solving approach in teaching the subject matter approach instructional unit and the absence of essential elements of the problem solving approach in teaching the problem solving approach instructional units could explain the interaction between timing of unit and instructional approach. A positive relationship between the degree to which a teacher used the problem solving approach and the level of student achievement was observed.

One of the real benefits of the problem solving approach to teaching may be that it is a method of learning which students can use both in and out of the classroom. Another aspect of problem solving is the transfer of knowledge from a known situation to one that is unknown. Achievement tests, such as the ones used in this study, cannot measure how the problem solving approach to teaching is used by students outside of the traditional classroom.

The teachers in this study had a difficult time using the subject matter instructional approach with which they were not familiar. The unit plans were written in such a way that the instructional approaches should have been easy to follow. Once teachers were in the classroom, they soon reverted to using their traditional style of teaching. They either used the subject matter (lecture) approach they were used to using or they incorporated portions of the problem solving approach in their subject matter approach instruction.

Even though four of the six teachers who provided audio tapes used a form of the problem solving approach to teaching, are teachers using all of the essential elements of problem solving instruction with their students? The adjusted teaching approach scores for the four teachers' problem solving approach units ranged from 4.26 to 5.68 on a seven point scale. The researcher had established a minimum score of four to be considered problem solving teaching. Does a teaching performance have to include all of the essential elements of the problem solving approach to give the students the full benefit of the teaching approach?

Conclusions

Teachers in this study did not fully use all of the essential elements of the problem solving approach to teaching.

Student achievement varied depending on timing of the unit and instructional approach. The timing of the unit and the instructional approach had a significant effect upon student achievement scores. Students taught with the problem solving approach first in an instructional series had higher achievement scores than students taught first with a subject matter approach. Students taught with a subject matter approach second in an instructional series had a higher achievement scores than did students taught second with a problem solving approach.

Student attitude toward instruction varied depending on timing of the unit and instructional approach used by teachers in the study. Students taught with the problem solving approach first in an instructional series had higher scores on attitude toward instruction than students taught first with a subject matter approach. Students taught with a subject matter approach second in an instructional series had higher scores on attitude toward instruction than did students taught second with a problem solving approach.

Problem solving teaching and subject matter teaching required the same amount of classroom time to complete an instructional unit.

Recommendations

The effectiveness of teaching approaches should continue to be studied. Every effort must be taken to maximize the variance in the levels of the independent variable. Teachers who participate in studies relating to teaching approaches should receive inservice training prior to participating in such studies. This will make it possible for researchers to communicate exactly how the units are to be taught and provide instruction in the teaching approaches to be used.

The participants in teaching approach studies should be monitored carefully. Every effort should be taken to monitor and evaluate the teaching performance of teachers participating in such studies. Audio tapes should be used to provide an effective and inexpensive way to determine the level of problem solving used by a teacher.

The problem solving approach, when used first in the instructional series, produced higher achievement and attitude toward instruction scores. Therefore, when problem solving and subject matter teaching approaches are being used, students should be taught first with the problem solving approach.

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