EFFECTS OF STUDENT LEARNING STYLES ON SHORT AND LONG TERM RETENTION OF SUBJECT MATTER USING VARIOUS TEACHING APPROACHES

James E. Dyer, Assistant Professor
University of Missouri

Edward W. Osborne, Professor and Head of Agricultural Education and Communications
University of Florida

Abstract

The primary purpose of this study was to compare the retentive effectiveness of the problem solving approach to the subject matter approach in teaching given agricultural education problem areas to students of different learning styles. Specifically, the study measured the effects of delivery systems on short- and long-term retention of subject matter. Results indicated no significant differences on either the short-term or long-term retention between the problem solving approach or subject matter approach across student learning styles. Student learning styles do not influence the effectiveness of either teaching approach. The implications for this finding is that teachers may use whichever teaching approach (of the two) with which they are most comfortable.

Introduction

The teaching approach used by educators is very important to the success of the learning process. With the onset of the MTV era, teachers have found themselves in daily competition with professional entertainers to motivate and hold students' interest. As a result, students have come to expect that classes and classrooms be more student-centered and that teachers employ varying teaching techniques, methods, and/or approaches to accomplish their educational objectives. Since no one method of instruction will work all of the time and under every circumstance (Bartz & Miller, 1991), teachers should master several different teaching approaches and strategies (Joyce & Harootunian, 1967). According to Joyce and Weil (1986) teachers should select appropriate teaching methods based upon the learning style of those being taught.

For the past three-quarters of a century one teaching approach has been recommended by agricultural educators as the one best method of teaching agriculture (Phipps & Osborne, 1988). Today, that approach remains the primary method of teaching offered to pre-service agriculture teachers in many teacher education programs. However, some educators question its validity as a superior approach to instruction. Likewise, many teachers view the problem solving approach as archaic--tied to the farm backgrounds and supervised agricultural experience programs of the learners (Moore & Moore, 1984). Critics of the problem solving approach also accuse that while the approach has a sound theoretical base, it has been accepted with very little empirical evidence to either defend or reject its usefulness in the classroom. Reviews of literature from prior studies have produced little evidence to refute this claim.

Ronning, McCurdy, and Ballinger (1984) reported that some students may possess a style of learning which is not complimentary to the use of problem solving instruction. Their inability to solve problems interacts with their inability to use past knowledge and experiences to help in the solution to the problem. Dyer (1995) noted that field-dependent (abstract) learners do not recognize problems as such when presented to them. Canfield and Canfield (1976) noted that

research on learning and teaching styles can serve as a basis for selecting appropriate teaching approaches.

The theoretical framework for this study was provided by Mitzel's "Conceptual Model for the Study of Classroom Teaching," as adapted by Dunkin and Biddle (1974). Mitzel contended that changes in product variables (short-term and long-term retention) result from the combined effects of those things which students bring to the setting (context variables), those which teachers bring (presage variables) and those which happen in the classroom (process variables). Adapted to this study, the model suggests that the effectiveness of a teaching approach (process variable) on the short- and long-term retention of subject matter by students (product variables) is moderated by the learning styles of those students (context variable) when teacher effects (pressage variables) are held constant. According to Flowers (1986), researchers must address each of the variables in the model in studies involving classroom teaching. Therefore, consideration of the moderating effects of student learning styles is a necessity in determining the effectiveness of a teaching approach on the short- and long-term retention of subject matter by students.

A review of literature revealed only one study that addressed these variables in measuring the effects of the problem solving approach on short-term subject matter retention by secondary agricultural education students. Flowers (1986) reported no significant differences in the short-term retention of subject matter when the problem solving approach was compared to the subject matter approach. Flowers did note, however, that the problem solving approach proved significantly more effective in reducing achievement loss. No study could be found which addressed the effects of the problem solving approach on long-term retention of subject matter by secondary agricultural education students.

When student learning styles were introduced as a variable, no study could be found which measured the effects of student learning styles on either the short-term or long-term retention of subject matter by secondary agricultural education students taught in classes using the problem solving approach. Clearly, a need existed to determine the effects of the problem solving approach on both the short- and long-term retention of subject matter in students of all learning styles.

Purpose and Objectives

The primary purpose of this study was to compare the retentive effectiveness of the problem solving approach to the subject matter approach in teaching given agricultural education problem areas to students with varying learning styles. The specific objectives of the research, stated as research questions, were as follows:

1. What were the effects of the problem solving and subject matter approaches on the short-term retention of subject matter by high school agricultural education students in Illinois?
2. What were the effects of the problem solving and subject matter approaches on the long-term retention of subject matter by high school agricultural education students in Illinois?
3. What were the effects of students' individual learning styles on the short-term retention of subject matter by students taught using problem solving and subject matter approaches?
4. What were the effects of students' individual learning styles on the long-term retention of subject matter by students taught using problem solving and subject matter approaches?

For purpose of statistical analysis, the research questions were posed as null hypotheses. Each null hypothesis was tested at the .05 level of significance.

HO_1: There is no difference in the short-term retention of subject matter by students taught by the problem solving approach and the short-term retention of subject matter by students taught by the subject matter approach.

HO_2: There is no difference in the long-term retention of subject matter by students taught by the problem solving approach and the long-term retention of subject matter by students taught by the subject matter approach.

HO_3: There is no difference in the short-term retention of subject matter across learning styles of students when taught using either the problem solving or subject matter approach.

HO_4: There is no difference in the long-term retention of subject matter across learning styles of students when taught using either the problem solving or subject matter approach.

Procedures

Teachers were selected from the 311 Agricultural Education Departments listed in the 1994-95 Annual Directory (Illinois Association of Vocational Agriculture Teachers, 1994) based upon their ability to use both the problem solving and subject matter approaches. The level of proficiency of the teachers to use the two approaches was determined from interviews conducted with University of Illinois Agricultural Education staff members, members of the Facilitating Coordination in Agricultural Education (FCAE) staff, and the teachers themselves. Once identified, teachers and their programs were visited by the researcher, and participation confirmed. Since random selection and assignment of teachers and students was an impossibility, it was believed that the best measurement of treatment effects could be attained by purposively selecting teachers who were capable of demonstrating both teaching approaches and randomly assigning treatments to intact classes.

Student enrollment numbers were obtained from participating teachers so that adequate numbers of students were available to conduct the study using the above criteria. Once selected, classes were randomly assigned to either the problem solving approach or the subject matter approach by coin toss. The study followed a variation of the nonequivalent control group design described by Campbell and Stanley (1963), but differed in that the subject matter approach to instruction was used as the control.

Six teachers, 16 classes, and 258 students were selected using a cluster sampling technique. Both Flowers (1986) and Boone (1988) reported mortality rates ranging from 50% to 100% in their respective earlier studies examining the effects of the two approaches on achievement. The high rates were largely due to teachers' inability to correctly use each approach or in their inability to separate the two approaches, resulting in elevated mortality rates. To compensate for the expected loss of students, Hays' (1973) formula for determining sample size was used with a mortality allowance of 50%.

To control for existing knowledge of subject matter, students were administered a pretest in each unit of instruction. Normal curve equivalent (NCE) scores were also obtained from guidance counselors to statistically control for existing ability levels. One treatment group received instruction in classes taught by the problem solving approach, the other group received instruction in classes taught by the subject matter approach. To control for teacher differences, each instructor taught one class using the problem solving approach and another using the subject matter approach.

Two units of instruction were taught to each group. One unit consisted of factually based subject matter which did not lend itself well to the identification of problems (Unit I: Applying Principles of Plant Science), the other unit possessed content which could readily be divided

into logical and solvable problems (Unit II: Germinating Seeds). At the conclusion of each unit of instruction, a multiple choice test was administered to measure differences in achievement levels. Approximately two weeks later a parallel achievement test was administered to measure differences in short-term retention. A second retention test was administered approximately five months later to measure differences in long-term retention. At the conclusion of all instruction, the Group Embedded Figures Test (GEFT) was completed by all participants.

Instructional units were prepared using the problem solving approach model presented in Newcomb, McCracken, and Warmbrod (1993) and the subject matter approach model described by Rosenshine and Stevens (1986). To ensure that instructors could effectively use each teaching approach, all instructors were provided inservice workshops ranging from 2-6 hours in length. To verify that instructors had adhered to the assigned treatment, all class sessions were audio recorded and analyzed using a researcher-developed analysis instrument. The instrument was evaluated for content validity by University of Illinois Agricultural Education staff members and inter-rater reliability established at $\underline{r} = .95$.

All instruments were pilot tested and appropriately adjusted. The face, content, and construct validity of all researcher-constructed tests were determined prior to administration. Kuder-Richardson 20 reliability coefficients ranged from .77 to .92. The validity of the GEFT instrument was established and reported by Witkin, Oltman, Raskin, and Karp (1971) based on its parent test, the Embedded Figures Test. Witkin et al. reported a Spearman-Brown reliability coefficient of .82.

Analysis of Data

Hypotheses were tested using multivariate analysis of covariance (MANCOVA). Hotelling's $\underline{T}^2$ was calculated for the effects of the treatment (teaching approach), effects of student learning style, and interaction effects of the treatment and student learning styles on the dependent variables (short-term retention, long-term retention). In addition, other measures of variance and central tendency were used in analyzing data.

Results

Four of the six teachers correctly completed the study. It was determined from an analysis of the audio tapes that one teacher had blended approaches (centered instruction in both treatment groups around solvable problems) whereas a second teacher failed to audio-record each class session. Therefore, data collected from students in classes taught by those teachers were not included in the study. Likewise, it was determined a priori that data from students who had been absent from class 20% or more of the treatment time would likely fail to accurately reflect the assigned treatment and were not included. As a result, data from 112 students in 12 classes were analyzed. Of these, 60 students were in classes using the problem solving approach whereas 52 students were in the subject matter approach treatment groups.

The mean class time needed to complete instructional units was 18.2 periods for the problem solving approach (range = 16 - 22) and 17.8 classes for the subject matter approach (range = 15 - 21). The majority of students who completed the study were male (65.2%) and Caucasian (97.3%). The majority of learners were field-independent (54.5%). Thirty-four students possessed field-dependent learning styles. Seventeen students were field-neutral learners (Table 1). Teachers who completed the study had GEFT scores of 12, 13, 17, and 17.

A total of 73 male students and 39 female students completed the study. A majority of male students was field-independent learners. Likewise, the largest category of female students

Table 1. Numbers and Percentages of Students With Varying Learning Styles by Teaching Approach

Learning Style	Total		Teaching Approach			
			PSA		SMA	
	n	%	n	%	n	%
Field-dependent	34	30.4	18	30.0	16	30.8
Field-neutral	17	15.1	8	13.3	9	17.3
Field-independent	61	54.5	34	56.7	27	51.9

Note. PSA = Problem Solving Approach, SMA = Subject Matter Approach.

was also field-independent learners, though not a majority (Table 2).

As indicated in Table 3, students in classes assigned to the problem solving approach entered the study with higher ability (NCE) scores and greater pretreatment knowledge of subject matter, as exhibited by higher pretest scores. Covariate adjustments using NCE scores and pretests for each of the two units of instruction were made in group mean scores to control for these initial between-group differences.

Table 2. Numbers and Percentages of Students With Varying Learning Styles by Gender

Learning style	Gender			
	Male		Female	
	n	%	n	%
Field-dependent	21	28.8	13	33.3
Field-neutral	10	13.7	7	17.9
Field-independent	42	57.5	19	48.8

Hypotheses One and Two

Students in classes taught by the problem solving approach exhibited higher observed mean scores on both short- and long-term retention tests for the problem area which begat real and identifiable problems (Unit II). However, when those scores were adjusted for student ability level and prior knowledge, means were found to be similar (Table 4).

Hotelling's T^2 statistic was .038 ($p = .436$) for the effects of teaching approach on the dependent variables, indicating no significant differences at the .05 alpha level in either the short- or long-term retention of subject matter by students in classes taught by either the problem solving or subject matter approaches. As a result, both null hypotheses one and two were not rejected.

Table 3. Mean Covariate Scores by Teaching Approach

Covariate	PSA (n = 60)		SMA (n = 52)	
	M	SD	M	SD
NCE	62.18	16.60	55.31	18.45
Achievement pretest I	58.95	12.43	53.27	12.60
Achievement pretest II	58.83	14.34	53.69	14.03

Note. PSA = Problem Solving Approach, SMA = Subject Matter Approach.

Table 4. Observed and Adjusted Mean Scores by Teaching Approach

Instrument	Observed Means		Adjusted Means	
	PSA	SMA	PSA	SMA
Retention test I	72.85	72.93	71.46	74.32
Retention test II	67.24	62.64	65.43	64.44
Long-term retention test I	67.51	65.14	66.34	66.25
Long-term retention test II	65.36	59.04	63.67	60.73

Note. PSA = Problem Solving Approach, SMA = Subject Matter Approach.

Hypotheses Three and Four: Effects of Learning Style

Field-independent learners exhibited higher observed mean scores on both the short-term and long-term retention tests than did field-neutral or field-dependent learners, regardless of the teaching approach used. However, field-independent learners possessed higher ability levels than did either field-neutral or field-dependent learners (Table 5).

Table 5. Mean NCE Scores Across Learning Styles

Learning style	n	M	SD
Field-dependent	35	52.17	18.04
Field-neutral	18	54.72	18.33
Field-independent	61	63.95	15.28

The coefficient of determination using Pearson's product-moment revealed a moderate, positive relationship ($r = .30$) between learning styles and NCE scores. As a result, when scores were adjusted for student ability level and prior knowledge, means were found to be similar across learning styles for both teaching approaches (Table 6).

Hotelling's T^2 statistic was .074 for the effects of learning style on the dependent variables, which was not significant at the .05 alpha level ($p = .504$). Therefore, no significant differences based upon student learning style were found between the treatment groups when the dependent variables were considered simultaneously.

To determine if significant differences existed between the treatment groups across learning styles, a multivariate analysis of covariance was performed, testing the effects of learning style on the dependent variables and the interaction effects of learning style by treatment.

Interaction effects

Hotelling's T^2 statistic was .087 for the effects of the interaction on the dependent variables of student learning styles and the teaching approach used, which was not significant at the .05 alpha level ($p = .379$). As a result, both null hypotheses three and four were not rejected.

Conclusions and/or Recommendations

For all clinical studies care should be taken in generalizing findings to the target population. With this limitation in mind, and based upon the findings of this study, the following conclusions and recommendations were noted.

In this study the problem solving approach was found to be neither more nor less effective than the subject matter approach in producing higher short-term retention scores. Likewise, the problem solving approach was found to be neither

Table 6. Observed and Adjusted Mean Scores by Teaching Approach and Learning Style

Instrument	Field-dependent		Field-neutral		Field-independent	
	Observed Mean	Adjusted Mean	Observed Mean	Adjusted Mean	Observed Mean	Adjusted Mean
Retention test I						
PSA	72.83	75.07	66.25	69.20	79.47	74.28
SMA	67.17	70.16	73.33	73.49	77.59	75.15
Retention test II						
PSA	65.72	68.42	64.37	67.28	71.62	66.00
SMA	56.69	59.22	62.44	63.99	68.78	64.70
Long-term retention test I						
PSA	64.33	66.23	64.62	66.72	73.56	69.56
SMA	59.19	61.58	67.33	66.61	68.89	67.22
Long-term retention test II						
PSA	63.17	65.25	63.62	66.34	69.29	64.49
SMA	58.94	62.38	52.22	53.10	65.96	61.64

Note. PSA = Problem Solving Approach, SMA = Subject Matter Approach.

more nor less effective than the subject matter approach in producing higher long-term retention scores. Therefore, if the purpose of instruction is to increase retention scores, teachers may use either the problem solving or subject matter approach with equal effectiveness.

Student learning styles do not influence the effectiveness of either the problem solving or subject matter approaches in producing higher short-term retention scores for high school agricultural education students. Likewise, student learning styles do not influence the effectiveness of either the problem solving or subject matter approaches in producing higher long-term retention scores. However, given the moderate correlation between student learning style and NCE scores, and the finding that field-independent learners possessed higher ability levels (NCE scores) than did either field-neutral or field-dependent learners, further research addressing this phenomenon is needed.

As a clinical study, this research is severely limited in its ability to be generalized to other populations. The study should be replicated to increase the level of generalizability and to validate this piece of research.

References

Bartz, D. E., & Miller, L. K. (1991). Twelve teaching methods to enhance student learning: What research says to the teacher (Report No. ISBN-0-8106-1093-0). Washington, DC: National Education Association. (ERIC Document Reproduction Service No. ED 340 686)

Boone, H. N. (1988). Effects of approach to teaching on student achievement, retention, and attitude. Dissertation Abstracts International, 49(10), 2900A. (University Microfilms No. 88-24, 463)

Campbell, D. T., & Stanley, J. C. (1963). Experimental and quasi-experimental designs for

research. Chicago: Rand McNally.

Canfield, A. A., & Canfield, J. S. (1976). Canfield instructional styles inventory manual. Los Angeles: Western Psychological Services.

Dunkin, M. J., & Biddle, B. J. (1974). The study of teaching. New York: Holt, Rinehart and Winston.

Dyer, J. E. (1995). Effects of teaching approach on achievement, retention, and problem solving ability of Illinois agricultural education students with varying learning styles. Unpublished doctoral dissertation, University of Illinois at Urbana-Champaign.

Flowers, J. L. (1986). Effects of the problem solving approach on achievement, retention, and attitudes of vocational agriculture students in Illinois. Unpublished doctoral dissertation, University of Illinois at Urbana-Champaign.

Hays, W. L. (1973). Statistics for the social sciences. New York: Holt, Rinehart, and Winston.

Illinois Association of Vocational Agriculture Teachers. (1994). 1994-95 annual directory. Roanoke, IL: Author.

Joyce B., & Weil, M. (1986). Models of teaching (3rd ed.). Englewood Cliffs, NJ: Prentice-Hall.

Joyce B. R., & Harootunian, B. (1967). The structure of teaching. Chicago: Science Research Associates.

Moore, G. E., & Moore, B. A. (1984). The problem solving approach to teaching: Has it outlived its usefulness? Journal of the American Association of Teacher Educators in Agriculture, 25(2), 3-10.

Newcomb, L. H., McCracken, J. D., & Warmbrod, J. R. (1993). Methods of teaching agriculture. Danville, IL: Interstate.

Phipps, L. J., & Osborne, E. W. (1988). Handbook on agricultural education in public schools (5th ed.). Danville, IL: Interstate.

Ronning, R. R., McCurdy, D., & Ballinger, R. (1984). Individual differences: A third component in problem-solving instruction. Journal of Research in Science Teaching, 21, 71-82.

Rosenshine, B., & Stevens, R. (1986). Teaching functions. In M. C. Wittrock (Ed.), Handbook of research on teaching (pp. 376-390). New York: MacMillan.

Witkin, H. A., Oltman, P. K., Raskin, E., & Karp, S. A. (1971). Group embedded figures test manual. Palo Alto, CA: Consulting Psychologist Press.