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EFFECTS OF TEACHING APPROACH ON ACHIEVEMENT OF AGRICULTURAL EDUCATION STUDENTS WITH VARYING LEARNING STYLES

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Abstract

The purpose of this study was to compare the effectiveness of the problem solving approach to the subject matter approach in teaching given units of instructions to students of varying learning styles. Results indicated that three distinct learning styles were present in high school agriculture classes (field-independent, field-dependent, field-neutral). The majority of students was field-independent. As the treatment, neither the problem solving nor subject matter approach produced significantly higher achievement scores in classes taught by the respective approach. Likewise, the learning style of the student did not result in significantly higher scores. However, when teaching approach was analyzed across learning styles, field-neutral learners were found to score significantly higher on achievement tests when taught in classes using the problem solving approach.

The selection of an appropriate teaching approach is important to the success of the teaching and learning process. To be successful, teachers should select and use a wide variety of teaching strategies (Joyce & Harootunian, 1967). Research on learning and teaching styles can serve as a basis for this selection (Canfield & Canfield, 1976).

Joyce and Weil (1986) proposed that students react differently to different teaching methods, and that the selection of the proper method is critical to the learning style of those being served by the instruction. They further contended that some students may possess a style of learning which promotes the effectiveness of the problem solving approach. On the other hand, some students possess a learning style which is not complimentary to the solution of problems (Witkin, Moore, Goodenough, & Cox, 1977). For these students the problem solving approach to teaching agriculture would have little effect on improvement in learning.

An adaptation of the Mitzel model presented by Dunkin and Biddle (1974) provided the theoretical framework for this study. Adapted to this study, the Mitzel model suggests that with teacher effects (presage variables) held constant, the effectiveness of a teaching approach (process variable) on student achievement (product variable) is moderated by the learning styles of the students (context variable). It is therefore necessary to determine and address differing learning styles in evaluating the effectiveness of a teaching approach.

Research on the learning styles of students enrolled in agriculture generally portray them as concrete learners (Cano & Garton, 1994; Cox, Sproles, & Sproles, 1988; Howard & Yoder, 1987; Raven, Wright, & Shelhamer, 1994; Rollins, 1990; Witkin et al., 1977). As such, these students usually prefer more action-oriented, practical classes (Cox et al.). However, other learning styles do exist (Gregorc, 1982).

Witkin, Oltman, Raskin, and Karp (1971) depicted learning styles in a linear dimension. Whereas extreme scores are common, Witkin et al. noted that the world is not peopled by two distinctly different

types of individuals, but rather that learning styles are distributed on a intermittent plane somewhere between and inclusive of abstract and concrete. Their Group Embedded Figures Test (GEFT) enumerates the degree of abstractness/concreteness on a scale of 0-18. Witkin et al. respectively classified these learners as field-dependent and field-independent.

According to Dyer (1995) and Garton and Raven (1994), a third category of learners exists. These individuals score somewhere in the middle of the bipolar scale (Figure 1). For high school students this category appears to be just below the GEFT national norm score of 11.3 as established by Witkin et al. (1971).

Research on the use of the problem solving approach can best be described as limited in scope with inconclusive results as to its effectiveness. A review of literature in research pertaining to the use of the problem solving approach produced few studies which proclaim its methodological superiority. However, no studies have shown the problem solving approach to be inferior to other approaches.

Of those studies which measured the effects of teaching approach on student achievement, mixed results have been reported. Dawson (1956) and Flowers (1986) reported no significant differences in achievement. Thompson and Tom (1957), however, reported increased achievement scores of students using the problem solving approach. Dormody (1990) observed more student-teacher interaction as a result of the use of group teaching using the problem solving approach. Selassie (1990) and Garton and Cano (1993) reported that teachers are less likely to use varying teaching techniques when using the problem solving approach. A void in the literature exists, however, when learning styles are considered in relation to teaching approaches used. Specifically, no study was found which empirically measured the effects of the problem solving approach across learning styles on the performance of secondary agricultural education students.

Purpose

The primary purpose of this study was to compare the 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 study, stated as research questions, were as follows:

1. What were the effects of the problem solving and subject matter approaches on the achievement of high school agricultural education students in Illinois?

2. What were the effects of individual learning styles of students on achievement utilizing the problem solving and subject matter approaches to instruction?

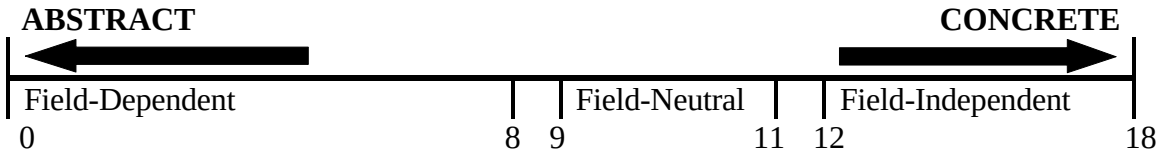


Figure 1. Interpreting Geft Scores for High School Age Students

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

HO_1: There is no difference in the achievement scores of students taught using the problem solving approach and the achievement scores of students taught by the subject matter approach.

HO_2: There is no difference in the achievement scores of students of varying learning styles taught using the problem solving approach and the achievement scores of students of varying learning styles taught using the subject matter approach.

Methods and Procedures

The population of this study consisted of all Illinois secondary agricultural education students. An ideal sample would have been randomly selected and assigned teachers and students. Practicality, however, required adjustments to the selection of subjects. Keeping in mind that the purpose of this study was to determine the effectiveness of two teaching approaches on students with differing learning styles, it was imperative to use an experimental design which would lead to the best measurement of those effects. Randomly selected students was an impossibility. A random selection of teachers would have almost assuredly produced teachers incapable of using either one or both teaching approaches, resulting in a confounded measurement of effects. By purposively selecting teachers who were capable of demonstrating both teaching approaches, and randomly assigning treatments to intact classes, it was believed that the best measurement of the treatment effects could be attained. Based upon Hays' (1973) formula for determining student sample size, 16 classes and 258 students, taught by six teachers, were selected.

The study was conducted using a quasi-experimental design. 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.

To measure pretreatment achievement, students were administered a pretest in each unit of instruction prior to treatment. Normal curve equivalent (NCE) scores were obtained from guidance counselors to statistically control for existing student ability levels.

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). One treatment group received all instruction using the problem solving approach, whereas the other group received instruction using the subject matter approach. At the conclusion of each unit of instruction, a multiple choice test was administered to measure differences in achievement levels. At the conclusion of all instruction, the GEFT instrument was administered to all participants.

The validity of the GEFT instrument was established and reported by Witkin et al. (1971) based on its parent test, the Embedded Figures Test. Witkin et al. reported a Spearman-Brown reliability coefficient of .82.

Instructional units were prepared using the problem solving approach model presented in Newcomb, McCracken, and Warmbrod (1993) and the subject matter approach model as described by Rosenshine and Stevens (1986).

Boone (1988) found that teachers blended teaching approaches and reaffirmed the need for proper training in the use of problem solving

approach. Instructors were provided inservice workshops of 2-6 hours in length concerning the proper use of both teaching approaches. To ensure that the proper teaching approach was used, 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 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.

As part of a larger study which determined the effects of teaching approach on achievement, problem solving ability, and retention, hypotheses were tested using multivariate analysis of covariance (MANCOVA) followed by univariate analysis of covariance (ANCOVA) procedures. In addition, other measures of variance and central tendency were used in analyzing data. Post hoc multiple comparisons were made using Tukey's HSD procedure. Data were analyzed using SPSS© for Windows.™ Hotelling's T^2 was calculated for the effects of the treatment, effects of student learning style, and interaction effects of the treatment and student learning styles on the dependent variable.

Findings

The mortality rate of teachers and students corresponded with the anticipated rate based upon studies completed by Flowers (1986) and Boone (1988). Two teachers failed to correctly demonstrate the two approaches and/or failed to document the teaching approach used, resulting in unusable data from 93 students. Additionally, 32 students were absent from class during some instructional periods. It was determined a priori that students missing three or more classes in either problem area would be dropped from the study. Therefore, data were analyzed only from the 133 students in the 12 classes who actually received the treatment.

The mean instructional time needed to complete the units was 18.2 class 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 (69.2%) and Caucasian (97.7%). The majority of learners were field-independent (54.9%). Forty students possessed field-dependent learning styles. Twenty students were field-neutral learners (Table 1). A majority of the male students were field-independent learners. However, less than half of the female students were classified as field-independent.

Multivariate analysis of covariance produced a Hotelling's T^2 statistic of .105, $F_{(1, 123)} = 2.49$, p = .035 for the effects of teaching approach on the dependent variable. Follow-up univariate ANCOVA procedures were used to test hypotheses pertaining to the effects of teaching approach on achievement.

Hypothesis One: *There is no difference in the achievement scores of students taught using the problem solving approach and the achievement scores of students taught by the subject matter approach*

Students in classes taught using the problem solving approach exhibited higher mean scores on achievement tests for both units of instruction than did students in classes taught using the subject matter approach (Table 2). However, follow-up univariate analysis of covariance indicated no significant differences in achievement as measured by either Achievement Test I (p = .187) or Achievement Test II (p = .053). Therefore, the null hypothesis of no differences in achievement between treatment groups failed to be rejected.

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

		Teaching Approach		Gender	
		PSA	SMA	Male	Female
Learning Style	n	n = 72	n = 61	n = 92	n = 41
Field-Dependent	40 (30.1)	20 (27.8)	20 (32.8)	28 (30.4)	12 (29.3)
Field-Neutral	20 (15.0)	11(15.3)	9 (14.8)	11 (12.0)	9 (22.)
Field-Independent	73 (54.9)	41 (56.9)	32 (52.5)	53 (56.6)	20 (48.8)

Note. Percentages are in parentheses. PSA = Problem Solving Approach, SMA = Subject Matter Approach.

Table 3 contains data derived from the univariate analysis of the effects of the treatment.

Hypothesis Two: *There is no difference in the achievement scores of students of varying learning styles taught using the problem solving approach and the achievement scores of students of varying learning styles taught using the subject matter approach.*

When the effects of learning style were measured on the dependent variable, the MANCOVA procedure yielded a Hotelling's T^2 statistic of .036, $F_{(2, 123)} = .421$, $p = .936$, indicating no significant differences in achievement existed based upon the learning style of the student.

When student achievement was measured across learning styles, however, differences in both observed and adjusted means were noted in students' scores on both problem area achievement tests. For both tests, students taught by the problem solving approach displayed higher mean scores across learning styles than did their respective counterparts. Summary statistics of achievement across learning styles are presented in Table 4.

As indicated by these data, interaction effects between the treatment and student learning styles occurred in both sets of achievement test scores. Figure 2 presents a graphic display of the interaction effects based upon adjusted group means for each respective achievement test.

Hotelling's T^2 statistic for the effects of the interaction on the dependent variables of student learning style and the teaching approach used was .166, $F_{(2, 123)} = 1.96$, $p = .038$. Follow-up univariate analysis of covariance (Table 5) indicated significant differences ($p = .028$) in student achievement for Achievement Test II, the unit of instruction most readily suited for use with problem solving instruction. Field-neutral learners in classes using the problem solving approach scored significantly higher than did field-neutral learners taught in classes using the subject matter approach. Based upon these results, the null hypothesis of no differences in achievement across student learning styles was rejected.

Conclusions

Based upon the findings of this study, the following conclusions were formed:

1. For field-neutral learners, the problem solving approach is more effective than the subject matter approach in increasing achievement in problem areas which beget identifiable and relative problems.

2. The problem solving approach is the superior approach for field-neutral learners only in instructional areas which possess relevant and meaningful problems. Otherwise, the problem solving approach is neither more nor less effective than the subject matter approach in

Table 2. Mean Achievement Scores by Treatment

	PSA		SMA	
Instrument	Observed Mean	Adjusted Mean	Observed Mean	Adjusted Mean
Achievement Test I	77.35	76.15	72.18	73.38
Achievement Test II	74.34	72.89	66.86	68.30

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

Table 3. Univariate Analysis of Treatment Effects

Variable	MS	MSE	F	p
Achievement Test I	185.98	105.74	1.76	.187
Achievement Test II	511.81	133.94	3.82	.053

Note. df = 1, 123.

Table 4. Mean Achievement Score by Treatment and Learning Style for Achievement Tests

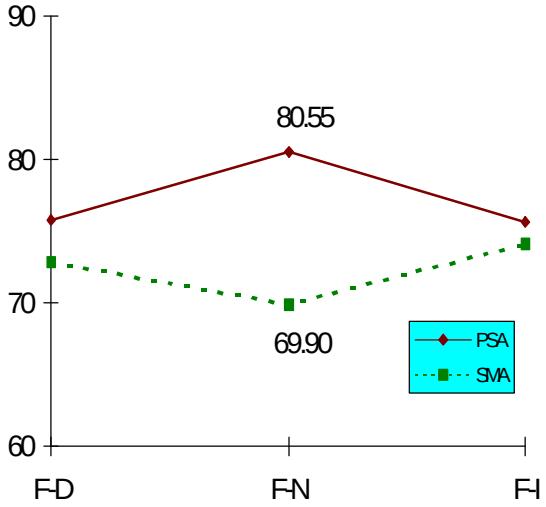
	F-D		F-N		F-I	
	Observed Mean	Adjusted Mean	Observed Mean	Adjusted Mean	Observed Mean	Adjusted Mean
Achievement Test I						
Problem Solving	74.45	75.81	79.00	80.55	78.58	75.68
Subject Matter	71.70	72.79	68.22	69.60	76.62	74.15
Achievement Test II						
Problem Solving	69.30	71.72	78.84	78.80	75.44	73.04
Subject Matter	65.50	66.51	60.22	62.88	74.84	71.17

Note. F-D = field-dependent, F-N = field-neutral, F-I = field-independent learning styles.

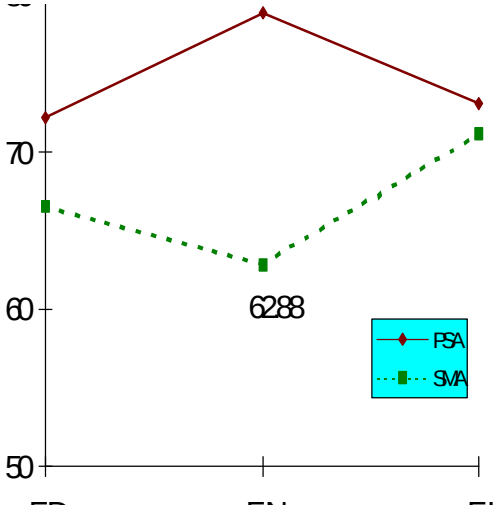
Table 5. Univariate Analysis of Interaction Effects Between Learning Style and Treatment

Variable	MS	MSE	F	p
Acheivement Test I	180.19	105.74	1.70	.186
Achievement Test II	493.13	133.94	3.68	.028

Note. df = 2, 123.



Achievement Test I (p = .186)



Achievement Test II (p = .028)

Figure 2. Interaction Effects of Treatment and Learning Style for Students Taught in Classes Using the Problem Solving Approach

producing significantly increased achievement scores.

3. Both student learning style and teaching approach are important variables which should be addressed for maximum achievement to be attained.

Recommendations and Implications

1. Since the problem solving approach proved to be effective in increasing achievement scores on problem-based topics for field-neutral learners, teachers should use this approach whenever field-neutral learners are among those being taught. To identify these individuals, all students and teachers should be evaluated for learning style upon entrance to an agricultural education program.

2. Teachers of agriculture should accept that students and teachers differ in learning styles and use that knowledge to better facilitate learning. Whereas concrete (field-independent) learners readily divide subject matter into problems to be solved and abstract (field-dependent) learners do not envision subject matter as problems, field-neutral learners are capable of improving achievement scores if the instructor provides the structure (i. e., breaks the subject matter down into solvable problems for the students).

3. Teachers of agriculture should accept that students and teachers differ in learning styles and use that knowledge to better facilitate learning. Instructional strategies involving the use of differing teaching approaches and using various teaching techniques and materials should be used. This should provide for more inclusive and effective instruction utilizing the characteristics of each student's learning style, and the teaching style of the instructor. Also, teachers may use these results to expand students' style limitations by introducing teaching techniques which aid students in enhancing their learning capabilities.

4. 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 the findings.

5. This study concentrated on the cognitive effects of the problem solving and subject matter approaches on students with varying learning styles. Future studies should also seek to determine the effects of the two approaches on psychomotor skill development in students with varying learning styles.

6. Findings of this study contain scores from only three minority students. Similar studies should be conducted using students from varied ethnic and geographical backgrounds.

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