

EFFECTS OF TEACHING APPROACH ON PROBLEM SOLVING ABILITY 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 producing increased problem solving ability in students of varying learning styles. Results indicated that the majority of males were field-independent learners, whereas slightly less than half of the female students were field-independent (48.8%). Results also indicated that students in classes taught by the problem solving approach produced significantly higher problem solving ability test scores than did students in classes taught by the subject matter approach. When teaching approach was analyzed across learning styles, field-independent learners taught by the problem solving approach exhibited significantly higher scores between pretests and posttests. No differences were found between the pretest and posttest scores of either field-dependent or field-neutral learners. Also, no differences across learning styles for the subject matter approach groups were detected.

Over the past decade a new commitment to quality instruction and student learning has emerged in the educational community. As a part of that community, agricultural educators are reassessing past educational practices in an effort to determine the effectiveness and validity of methods which have for years been practiced and proclaimed with almost religious fervor (Dyer, 1995). One of those methods is the problem solving approach to teaching agricultural education. The problem solving approach has been widely accepted and recommended by agricultural educators as the best method of teaching agriculture (Phipps & Osborne, 1988). Today, that approach remains the primary method of teaching offered to preservice agriculture teachers in many teacher education programs. However, critics of the problem solving approach accuse that while the approach has a sound theoretical base, it has been accepted with little empirical evidence to either defend or reject its usefulness in the classroom (Moore & Moore, 1984).

Joyce and Weil (1986) noted that the selection of a teaching method is critical to the learning style of those being served by the instruction. Ronning, McCurdy, and Ballinger (1984) contended that some students may possess a style of learning which is not complimentary to the use of problem solving instruction.

The theoretical framework for this study was founded in Mitzel's conceptual model for the study of classroom teaching (Dunkin & Biddle, 1974). Adapted to this study, the Mitzel model suggests that the effectiveness of a teaching approach (process variable) on the problem solving ability of students (product variable) is moderated by the learning styles of the students (context variable) when teacher effects (presage variables) are held constant. Therefore, consideration of student learning styles is a necessity in determining the effectiveness of a particular teaching approach on the problem solving ability of students.

Of the few studies which have attempted to address these variables in measuring the effects of teaching approach on problem solving ability, mixed results have been reported. Whereas Dawson (1956) reported an increase in problem solving ability, Thompson and Tom (1957) found no differences. Chuatong (1987) reported that, generally, students did not demonstrate a very high level of problem solving ability. No study could be found which addressed the effects on problem solving ability across learning styles.

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, & Shelmamer, 1994; Rollins, 1990; Witkin, Moore, Goodenough, & Cox, 1977). As such, these students usually prefer more action-oriented, practical classes (Cox et al.).

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 an 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. Dyer (1995), however, identified a third category of learners referred to by Garton and Raven (1994) as "field-neutral" learners. These individuals consistently score in the middle of the GEFT bipolar scale (Figure 1).

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 problem solving ability of high school agricultural education students in Illinois?
2. What were the effects of students' individual learning styles on the problem solving ability of students taught using the two approaches?

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

HO₁: There is no difference in the problem solving ability of students taught by the problem solving approach and the problem solving ability of students taught by the subject matter approach.

HO₂: There is no difference in the problem solving ability of students with varying learning styles taught by the problem solving approach and the problem solving ability of students taught by the subject matter approach.

Methods and Procedures

The population of this study consisted of all Illinois secondary agricultural education students. 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

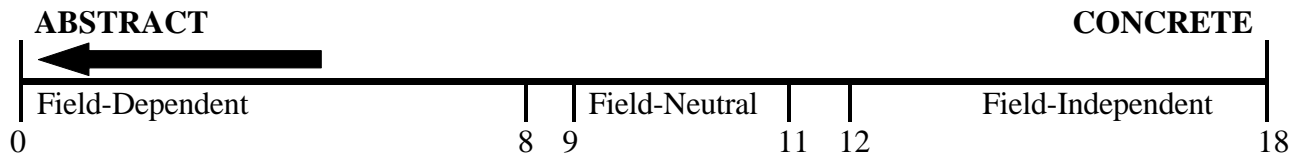


Figure 1. Interpreting GEFT Scores for High School Age Students.

in that the subject matter approach to instruction was used as the control.

Students were administered a pretest designed to measure pre-treatment problem solving ability. Normal curve equivalent (NCE) scores were also obtained 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. Two units of instruction were taught to each group. At the conclusion of all instruction, a problem solving ability posttest and the GEFT instrument were administered to all participants. Each problem solving ability test was scored using an analysis form constructed by the researcher. Inter-rater reliability was established at $r = .97$.

Face, content, and construct validity of the researcher-constructed instruments were determined by an expert panel from the University of Illinois College of Agriculture and high school agricultural education teachers prior to administration. All instruments were pilot tested and appropriately adjusted. The GEFT instrument is considered to be a standardized instrument. Its validity 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). To ensure that the

proper teaching approach was used, instructors were provided inservice workshops of 2-6 hours in length concerning the proper use of both teaching approaches and all class sessions were audio recorded and analyzed using a 10-point 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 $r = .95$.

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 the SPSS[®] for Windows[™] statistical package. 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 had likely not adequately received the treatment and 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 (Table 1). Forty students possessed field-dependent learning styles. Twenty students were field-neutral learners. Male students were predominately field-independent learners whereas slightly 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 (problem solving ability). Follow-up univariate ANCOVA procedures were used to test the null hypotheses pertaining to the effects of teaching approach on problem solving ability.

Hypothesis One

The problem solving ability of students was measured by the numerical score obtained from an analysis of the problem solving ability posttest completed by each student. All tests were scored according to the 10-point Problem Solving Ability Analysis Form developed by the researcher. Scores on the problem solving ability pretest were used as a covariate measure to adjust for pre-existing group differences.

Results of the univariate analysis of covariance (Table 2) testing the effects of the treatment on the problem solving ability of students indicated that the

scores of students in classes taught by the problem solving approach were significantly higher ($p = .046$) on the posttest than were scores of students assigned to classes using the subject matter approach.

As a result, the null hypothesis of no difference between treatment groups was rejected. Figure 2 graphically displays summary statistics of student performance on the 10-point problem solving ability pretest and posttest.

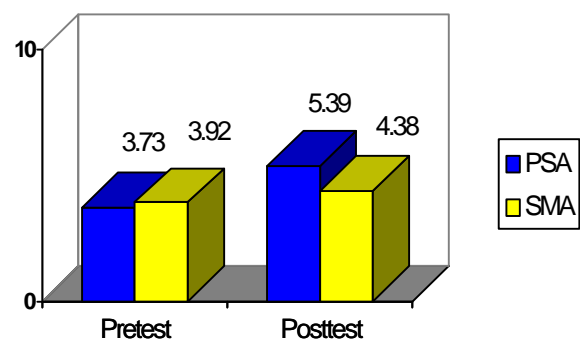


Figure 2. Mean Problem Solving Ability Scores by Treatment (10-points maximum).

Hypothesis Two

Exploratory analysis indicated differences in problem solving ability within learning style categories in the treatment group assigned to the problem solving approach. As indicated in Figure 3, students in classes taught by the problem solving approach exhibited higher problem solving test scores on posttests than on pretests. For field-independent learners this difference was significant ($p = .003$), indicating that field-independent learners respond to the use of the problem solving approach more positively than do students of the other learning styles. By contrast, all students in classes taught by the subject matter approach exhibited little improvement between posttest and pretest scores (Figure 4).

Table 1. Numbers and Percentages of Students Across Learning Styles by Gender and Teaching Approach

Learning Style	<u>n</u>	Gender		Teaching Approach	
		Male <u>n</u> = 92	Female <u>n</u> = 41	PSA <u>n</u> = 72	SMA <u>n</u> = 61
Field-Dependent	40 (30.1)	28 (30.4)	12 (29.3)	20 (27.8)	20 (32.8)
Field-Neutral	20 (15.0)	11 (12.0)	9 (22.0)	11 (15.3)	9 (14.8)
Field-Independent	73 (54.9)	53 (56.6)	20 (48.8)	41 (56.9)	32 (52.5)

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

Table 2. Univariate Analysis of Covariance for Problem Solving Ability of Students

Source	<u>SS</u>	<u>MS</u>	<u>F</u>	<u>p</u>
Problem Solving Ability Test	24.77	6.09	4.07	.046

Note. df = 1, 123.

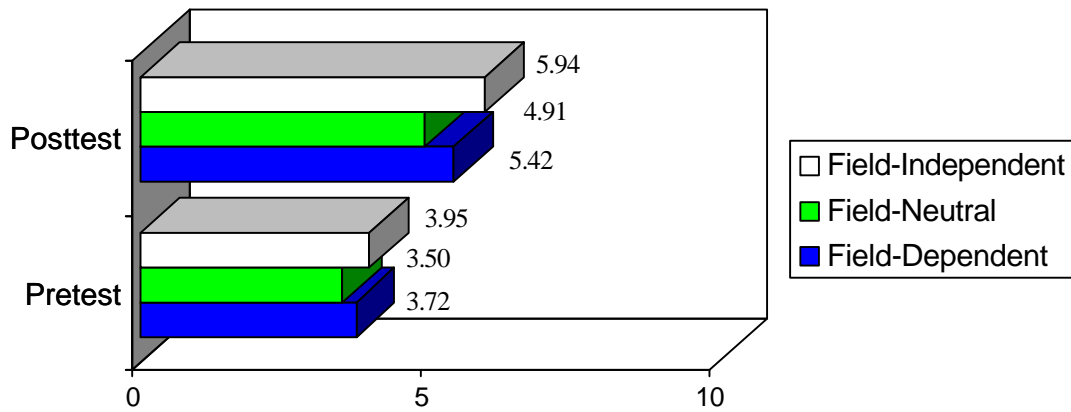


Figure 3. Mean Problem Solving Ability Pretest and Posttest Scores by Learning Style for Students in Problem Solving Approach Treatment Groups

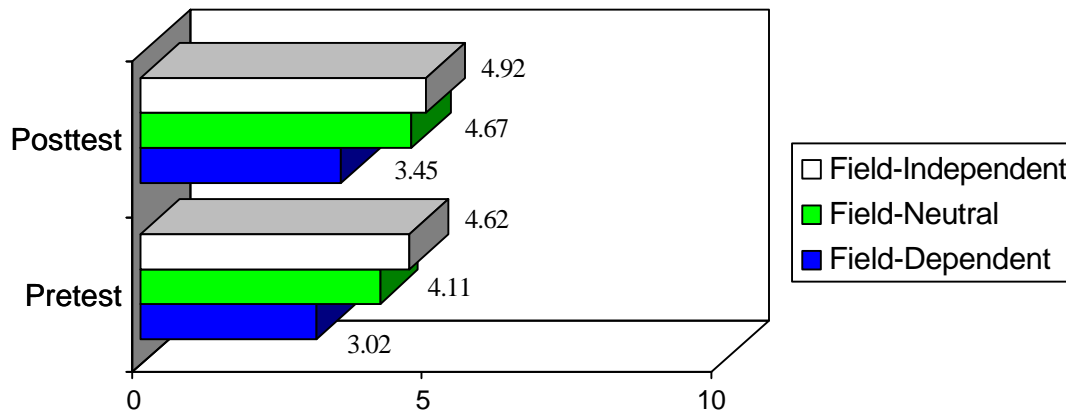


Figure 4. Mean Problem Solving Ability Pretest and Posttest Scores by Learning Style for Students in Subject Matter Approach Treatment Groups

When testing the hypothesis, however, (i.e., the effects of learning style measured on problem solving ability), the MANCOVA procedure yielded a Hotelling's T^2 statistic of .036, $F_{(2, 123)} = .421$ ($p = .936$), indicating no significant differences existed between pretest and posttest problem solving ability scores of students of the same learning style across treatment groups. Therefore, the null hypothesis of no difference between learning styles across treatment groups failed to be rejected. Student performance on the problem solving ability pretest and posttest by teaching approach and learning style is depicted in Table 3.

Conclusions, Recommendations, and Implications

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, several conclusions, recommendations, and/or implications were noted.

The problem solving approach is more effective than the subject matter approach in increasing the problem solving ability of students. This finding agreed with earlier studies reported by Dawson (1956) and Chuatong (1987). A new finding, however, was that this increase transcends learning

styles. Each type of learning style benefited from instruction using the problem solving approach. As a result, the problem solving approach to teaching should be used whenever improved problem solving ability is a desired outcome of instruction.

The ability to solve problems can be acquired if students are taught by the problem solving approach. In addition, problem solving ability can be developed in field-dependent learners to a level of effectiveness nearly equal to that possessed by field-independent learners by use of the problem solving approach. According to Witkin et al. (1977), students scoring less than 11.3 on the GEFT instrument possess little inherent ability to solve problems. They must acquire this skill. Based upon the results of this study, the problem solving approach proved to be an effective tool in this acquisition and should therefore be used as an instructional approach to enhance problem solving ability.

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. Likewise, the study should be expanded to include a larger number of minority students.

Table 3. Mean Problem Solving Ability Scores Across Learning Styles by Treatment

	PSA		SMA	
	<u>M</u>	<u>SD</u>	<u>M</u>	<u>SD</u>
Problem Solving Ability Pretest				
Field-dependent	3.72	1.52	3.02	1.31
Field-neutral	3.50	1.34	4.11	2.13
Field-independent	3.95	1.39	4.62	1.67
Problem Solving Ability Posttest				
Field-dependent	5.42	2.60	3.45	1.90
Field-neutral	4.91	2.49	4.67	1.87
Field-independent	5.94	3.00	4.92	2.51

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