DOCUMENT RESUME

ED 189 156 TM 800 327

AUTHOR Griswold, Philip A.; Cox, David L.
TITLE Perceived Classroom Climate and Cognitive Structure of Geometry Terms as a Function of Matching Students with Teachers on Field Independence.
PUB DATE Apr 80
NOTE 16p.: Paper presented at the Annual Meeting of the American Educational Research Association (64th, Boston, MA, April 7-11, 1980).

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Classroom Environment: *Cognitive Style: *Course Content: Geometry: Grade 10: High Schools: Males: *Multidimensional Scaling: *Student Teacher Relationship
IDENTIFIERS *Field Dependence Independence: *Group Embedded Figures Test

ABSTRACT

Twenty-three tenth grade male students from an urban, parochial preparatory schools participated in this study, along with two male geometry teachers. On the basis of the Group Embedded Figures Test, one teacher was assigned field dependent students, and the other teacher was assigned field independent students. The field dependent class evaluated the classroom climate more positively and closer to their teacher's perception than did the field independent class. Interpretation of individual difference multidimensional scaling suggested that the configuration of the relationships among geometry terms was similar for the two classes. These results suggest that, while FDI may be a factor in the perception of classroom climate for matched students and teachers, it makes little difference in terms of the inferred cognitive structure of the subject matter. (Author/GSK)

Perceived Classroom Climate and Cognitive Structure of Geometry Terms as a Function of Matching Students With Teachers on Field Independence

Philip A. Griswold

Rutgers--The State University

and

David L. Cox

Northeastern University

Paper presented at the American Educational Research Association annual meeting, Boston, April 7-11, 1980

Abstract

High school males were matched with their male geometry teachers on the basis of field independence. After an academic year, their perceived classroom climate and ratings of the relationship among geometry terms were examined. The field dependent class evaluated the climate more positively and closer to their teacher's perception than did the field independent class. Interpretation of individual difference multidimensional scaling suggested that the configuration of the relationships among geometry terms (i.e., cognitive structure) was similar for the two classes.

Perceived Classroom Climate and Cognitive Structure of Geometry Terms as a Function of Matching Students With Teachers on Field Independence

Much educational research has been generated by the interest in cognitive styles, but none as widespread as the field dependence-independence (FDI) dimension associated with the work of Witkin and his colleagues (Witkin, 1973; Witkin, Moore, Goodenough, & Cox, 1977). Since the acknowledged need to assign students to optional instructional techniques based on their individual characteristics (e.g., Gage & Berliner, 1975, pp. 183-188), it is not surprising to find educational researchers studying the post hoc and experimental effects of a match between students and teachers with respect to FDI.

Stasz, Shavelson, Cox, and Moore (1976) reported that the psychological structure (i.e., "interrelationship of concepts in a person's memory", p. 550) of certain concepts in social studies was partly related to the FDI of students and teachers involved in the instruction. Packer and Bain (1978) found that matching was the most beneficial for FD students on a math lesson and that students rated FD teachers more positively than FI teachers immediately after the lesson.

Illuminating as these studies are, several weaknesses in their design reduce the generalizability to the elementary and high school classroom. Specifically, atypical instructional situations fail to adequately address the natural classroom processes. For example, a class size of four is unusually small and only four consecutive, daily, 50 minute periods (Stasz, et al., 1976) is a very limited amount of teacher-student contact for high school instruction. In the second study (Packer & Bain, 1978), the 'students' were undergraduate psychology majors and the 'teachers' were final-year math education majors, a combination that does not represent true social roles of teacher and student in a school classroom. Also the lesson was unusually short and on a one-to-one basis.

Consequently, the present study was designed to assess one academic year of instruction of students by teachers matched on FDI, using cognitive structure of acquired course concepts and perceived classroom climate. Elementary geometry was selected because of the likelihood that analytic subject matter would discriminate between FD and FI students (Witkin, 1973) and because the cognitive structure, based on multidimensional scaling of dissimilarity judgments has been shown to be similar to the logical relationships among basic terms in geometry (Cox & Domeraski, 1977).

Method

Subjects

Twenty three male, 10th graders and 2 male teachers from the geometry classes of an inner-city, parochial preparatory school participated in the study. On the basis of the Group Embedded Figures Test (GEFT - Oltman, Raskin, & Witkin, 1971) administered the previous semester, one teacher (GEFT score = 6) was assigned 13 students (GEFT mean score = 6.4; range = 3-9). This was designated the FD class. The other teacher (GEFT = 18) was assigned to 10 students (GEFT mean score = 14; range = 10-18). The result was the FI class.

Students were unaware of any experimental manipulation. The teachers were informed, after their testing, of the general nature of the cognitive style construct and that the study was designed to evaluate student-teacher relationships and the effect on achievement.

At a later date and beyond the experimenter's control six new students were added to the classrooms. Four were assigned to the FI class (GEFT mean score = 3.8; range = 1-8) and two to the FD class (GEFT Scores of 10 and 15). All analyses included these students, since it was felt that their exclusion would distort the true social context of the class. Furthermore, all findings would be biased against the experimenter, creating a conservative basis for statistical inference.

Procedure

Near the end of the academic year, both classes--students and teachers--were given an abbreviated version of the Classroom Environment Scale (CES - Trickett & Moos, 1973). The CES measures distinct, though moderately correlated aspects of the classroom environment. The abbreviated version maintained the nine subscales (i.e., involvement, affiliation, support, task orientation, competition, order and organization, rule clarity, teacher control, and innovation), but used only 16 of the 90 items. These 16 were example items reported by Trickett and Moos. In scoring the scale, a positive response constituted answering true to the occurrence of positive events or false to the occurrence of negative events in the classroom.

Immediately following, a measure of psychological structure of geometry terms was administered. It consisted of two sets of all 36 possible pairs of nine terms from elementary geometry (i.e., point, length, line, segment, area, plane, triangle, volume, tetrahedron) used by Cox and Domeraski (1977).

A photographic slide of each pair, and beneath it a Likert scale from 1-7 (1 = alike; 7 = different), was projected on a screen, one at a time for seven seconds with an approximate one second interstimulus interval. The instructions were to judge how alike or different the words were as terms in geometry and then to circle the number of the choice on the answer sheet. Two trials were administered, but for the purposes of reliability, only the second was used for analysis.

The Chang and Carroll (1972) program for individual differences in multidimensional scaling (INDSCAL) was used to analyze the dissimilarity judgment data. The input consisted of a 9 x 9 half-matrix of scaled scores for all possible combinations of paired stimuli for each of 31 subjects (teachers, matched and unmatched students).

Results and Discussion

A score on the abbreviated CES was the sum of the positive responses (i.e., the greater the score, the better the perceived climate). Inspection of this data showed that the normality assumption was not justified. All perceived climate scores were then ranked and replaced in their appropriate FD or FI grouping. The Wilcoxon test was used to analyze the difference between ranks in the two classes (Marascuilo & McSweeney, 1977, p. 274). The expected average rank for the FI class was significantly different than the FD class, $\underline{Z} = -11.04$, $\underline{p} < .001$. These results suggest that the FD class perceives their classroom to be a generally more positive environment than does the FI class.

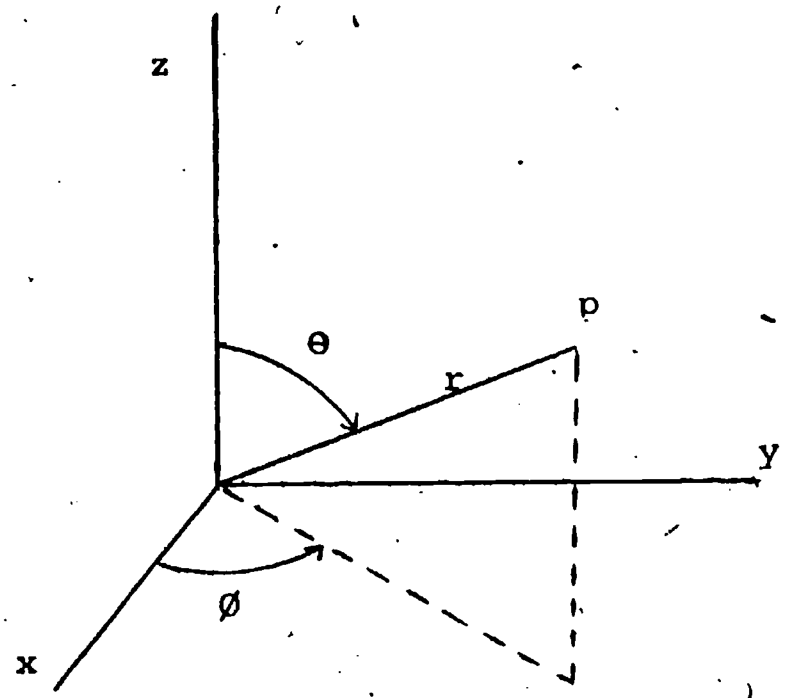
The CES has been divided into three subareas: personal development (student competition and effort), system maintenance (degree of ruler and organization by teacher), and teacher-student relationship (Trickett & Quinlan, 1979). In the abbreviated scale, questions pertaining to these three areas were separated out and ranked according to frequency of positive responses. Spearman rank-order correlations between FDI score ranks and positive responses revealed a significant negative correlation for personal development, $r = -.40$, $p < .025$, but not for the other categories. Thus, the perception of class-wide personal development appears to be inversely related to field independence.

All students' responses on each question, by class, were evaluated to the extent that the proportion of positive responses was significantly greater than chance. The questions that satisfied this criterion were compared to the respective teacher's response. For all the students in the FI class, four out of the sixteen questions were answered the same by a significant majority. These responses matched the teacher's answers. In the FD class, nine of sixteen questions were answered the same by a significant majority and eight of the nine matched the teacher's answers. Although not strongly significant ($p < .075$) the frequency of student agreement with the teacher is twice as great in the FD class as in the FI class. These results suggest that there is more accurate perception of aspects of classroom environment by teacher and student when matched on FD than on FI.

Solutions to the multidimensional scaling were generated in five, four, three, two, and one dimensions. Summary statistics appear in Table 1. Choice of the appropriate dimensions cannot be made from the statistics alone, but involves interpretability. Based upon the percentage of variance accounted for and the question of interpretability of four or five dimensions, the 3-dimensional solution was determined to be the most appropriate for the subject configuration. The 3-dimensional solution was also used for the spatial configuration of the stimuli. Three dimensions have been shown to be compatible with the relationship among geometry terms (Cox & Domeraski, 1977).

No interpretable dimensions were identified for the subject space. Variables considered were FDI, a non-verbal IQ measure (Raven, 1960), perceived classroom climate, final course grades, and math achievement scores. Thus, it was not readily apparent that FD and FI classes were different in their interpretation of stimuli dissimilarities. Previous work with INDSCAL indicated that directional statistics could be used to detect spatial, positional differences (O'Hare, ~~1976,~~ 1977). Thus, to maintain the integrity of the three dimensional space, analysis in terms of angular separation was performed (Mardia, 1972).

The 3-dimensional subjects space was described, therefore, in terms of spherical location. That is, the three coordinates for each subject were transformed to directional cosines. From the mean directions (i.e., the mean directional cosine for each dimension), each class position in the spherical space was described in terms of polar coordinates. The angle (Θ) from the z-axis and the angle ($\emptyset$) from the x-axis to the class position and the spherical variance (S*) are the designated descriptive measures (Mardia, Chap. 8). Tighter clustering of the points is represented by S* approaching the value of zero. The following figure demonstrates the concept of polar coordinates. Angle Θ and angle $\emptyset$ define the spherical direction of point P; r is the resultant length.



The directions for the FD class were: $\Theta = 56.9°$, $\emptyset = 47.6°$, and S* = .111. The directions for the FI were: $\Theta = 59.1°$, $\emptyset = 38.4°$, and S* = .081. The resultant length for the FD class (R_D = 13.79) and for the FI class (R_I = 14.22) were used to test the difference between groups. Using the procedure outlined by Mardia (1972, p. 263), R_I and R_D were not found to be significantly different by the F-approximation $(2,60) < 1.0$. This suggests that the classes do not differ in the spatial configuration of their general perception of the relationships among geometry terms. The median correlations between the data and the fitted points for the two classes were not significantly different (Fisher's Z-transformation), further suggesting that the FD and FI classes were making use of the same dimensions in judging the stimuli.

Interpretation of the 3-dimensional configuration of geometry terms seemed to be based on the following: 1) a unidimensional/multidimensional aspect, 2) a difficulty of measurement dimension, and 3) a familiarity/unfamiliarity dimension. At one end of the first dimension, segment, line, length, and point were found (i.e., the unidimensional terms); at the other end were the multidimensional stimuli--volume, area, triangle, plane. Dimension 2 had terms that were "easier to measure" (i.e., length, segment, volume, triangle, area) at one end and "more difficult to measure" at the other end (i.e., point, line, plane). Dimension 3 had at one end volume, length, area, line and at the other end point, plane, and sement. These were designated as the generally more familiar and less familiar terms. The inconsistent and outlying location of the term tetrahedron infers that many of the students were unfamiliar with this term.

This heuristic study suggests that while FDI may be a factor in the perception of classroom climate for matched students and teachers, it makes little difference in terms of the inferred cognitive structure of the subject matter (i.e., the perception of the interrelationships of key content terms). Furthermore, it supports the contention that longitudinal study of teacher-student interaction generates different conclusions than short-term, laboratory study. It also points out the potential usefulness of the individual difference multidimensional scaling technique as a tool for uncovering cognitive structure of curriculum content rather than relying on tests of recall of specific facts.

References

Chang, J. J. & Carroll, J. D. How to use INDSCAL, a computer program for decomposition of N-way tables and individual differences in multidimensional scaling. Unpublished manuscript, Bell Laboratories, 1970.

Cox, D. L. & Domeraski, V. P. The use of similarity judgments to assess perceived relationships among terms in geometry. Unpublished manuscript, Rutgers, The State University, New Brunswick, N.J., 1977.

Gage, N. L. & Berliner, D. C. Educational psychology. Chicago: Rand McNally, 1975.

Marascuilo, L. A. & McSweeney, M. Nonparametric and distribution-free methods for the social sciences. Monteray, CA: Brooks/Cole, 1977.

Mardia, K. V. Statistics of directional data. NY: Academic Press, 1972.

O'Hare, D. Individual differences in perceived similarity and preference for visual art: a multidimensional scaling analysis. Perception and Psychophysics, 1976, 20, 445-452.

O'Hare, D. A note on the statistical treatment of individual differences in multidimensional scaling. Perception and Psychophysics, 1977, 21, 283-284.

Oltman, P. K., Raskin, E., & Witkin, H. A. Group embedded figures test. Palo Alto, CA: Consulting Psychologists Press, 1971.

Packer, J. & Bain, J. D. Cognitive style and teacher-student compatibility. Journal of Educational Psychology, 1978, 70, 864-871.

Raven, J. C. Standard progressive matrices. N.Y.: The Psychological Corp., 1960.

Stasz, C., Shavelson, R. J., Cox, D. L., & Moore, C. A. Field independence and the structuring of knowledge in a social studies minicourse. Journal of Educational Psychology, 1976, 68, 550-558.

Trickett, E. J. & Moos, R. H. Social environment of junior and high school classrooms. Journal of Educational Psychology, 1973, 65, 93-102.

Trickett, E. J. & Quinlan, D. M. Three domains of classroom environment: factor analysis of the classroom environment scale. American Journal of Community Psychology, 1979, 7, 279-291.

Witkin, H. A. The role of cognitive style in audience performance and in teacher-student relations (ETS RB-73-11). Princeton, N.J.: Educational Testing Service, 1973.

Witkin, H. A., Moore, C. A., Goodenough, D. R., & Cox, P. W. Field-dependent and field-independent cognitive styles and their educational implications. Review of Educational Research, 1977, 47, 1-64.

Table 1

INDSCAL Analysis of Dissimilarity Judgments:

Summary Statistics for 5 Dimensions in

FD and FI Classrooms

	5D		4D		3D		2D		1D	
	FI	FD	FI	FD	FI	FD	FI	FD	FI	FD
%Variance Accounted for	57.8	61.0	48.5	51.6	38.3	42.3	27.7	30.8	15.9	19.2
Average Correlation Across Subjects	.76	.77	.69	.71	.61	.64	.51	.53	.35	.41
Correlation Between Data and Estimated Dissimilarities	.76	.78	.70	.72	.62	.65	.53	.56	.40	.44