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ABSTRACT

This study attempted to determine if there was a stable and preferred mode of perceptual organization and conceptual classification of stimuli which influenced the ability of female pre-service elementary teachers to acquire the science concepts presented in a general elementary credential preparation course. It is an example of ex post facto research where a measure of the science concepts presented in the course provided the criterion test (dependent variable) for the study. Considering the strong dependency of achievement upon intelligence, a two-way analysis of variance was performed, utilizing data from the Henmon-Nelson Test of Mental Ability for the other factor. A modified (adult) version of the Sigel Cognitive Style Test (SCST) was given to all females in the sections taught over a period of two semesters. Significant SCST contrasts occurred only with the Achievement in Science factor. For high and low achievers of science concepts, the findings indicated that a person's cognitive style influences his intellectual ability to grasp and understand new meanings. In this context, cognitive style was translated as learning style. It was concluded that the study supported much of the research involving children. (Author/EB)

COGNITIVE STYLE AS A FACTOR IN THE SCIENCE ACHIEVEMENT OF PRE-SERVICE ELEMENTARY TEACHERS

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OBJECTIVES OF THE INQUIRY

The purpose of this study was to determine if there was a "cognitive style" which influenced the ability of female pre-service elementary teachers to acquire the science concepts presented in a general elementary credential preparation course taught at San Francisco State University. In this study, cognitive style is defined as a stable and preferred mode of perceptual organization and conceptual classification of stimuli, as determined by the environmental situation and the individual.

METHODOLOGY AND DESIGN

This study is an example of ex post facto research where a measure of the science concepts presented in the course provided the criterion test (dependent variable) for the study. Since the foundation of this investigation rested on the ability of students to acquire concepts in science, a special effort was made to construct a valid measure of this concern. Because reading skills are such a contributing factor in test success, the testing materials were designed to incorporate the use of pictures with limited written directions. The rationale for this approach was patterened after two of the three levels of problem-solving proposed by Székely (1950) and further described by Krech and Crutchfield (1958).

1. Explanation - This type of problem is probably the most commonly experienced by man. In its most elemental form causal events are related to an "effect." At this level, the stimulus pattern is fairly clearly specified.

2. Prediction - Two characteristics that define this type of problem are: (1) the event (or effect) must be one that has not yet occurred; and (2) the antecedent conditions of the event must be understood. In relation to the "explanation" problem this stimulus pattern provides less information and places a greater burden upon the problem-solver.

Kagan (Kidd and Rivore, 1966) points out that in problems of this form, visual analysis is responsible to the ground, figural, and elemental components of the total stimulus pattern. It follows then, that the pictorial problem demands more of the student in identifying the problem which in turn determines his approach and expression of the solution. Each problem was constructed on the basis of selected concepts and principles presented in class but offered to the student in a form with which he had no previous experience.

The total evaluation program consisted of thirty-two explanation problems and twenty-four prediction problems, plus an additional fifty-four multiple-choice problems for balance.

Spearman-Brown reliability coefficients were than computed for each problem type as if they were separate and single tests. The inferior test questions were identified by noting their low correlation with test success. Nine of the pictoral questions were so identified in this process. When these were selected out and new test scores determined, reliability coefficients were generated for the whole and revised tests. The value produced in both cases was .87. Since these nine problems were specifically designed for the course and there was no advantage in deleting them, the original test scores were retained and incorporated into the main analysis.

When this procedure was followed for the fifty-four multiple-choice questions, the ten items that were selected out raised the original test reliability from .73 to .81. This increase was sufficient to justify the rescoring of the multiple-choice portion of the test. For a further understanding of the evaluation program, review the data listed below in Table I.

TABLE I

INTERCORRELATIONS YIELDED BY THE PICTORIAL AND MULTIPLE-CHOICE PORTIONS OF THE CONCEPTS-IN-SCIENCE TEST

		Prediction (1)	Total A (1+2)	Multiple-Choice (3)	Total B (1+2+3)
Explanation	(1)	.76	.93	.62	.91
Prediction	(2)		.94	.62	.90
Total A	(1+2)			.66	.97
Multiple-Choice	(3)				.82

Considering the strong dependency of achievement upon intelligence, a two-way analysis of varience was performed, utilizing data derived from The Henmon-Nelson Test of Mental Ability (College Edition) for the other factor. The choice of this intelligence test was jointly determined by its fine reputation and its availability at the San Francisco State University testing office. This instrument defines a quality of intelligence; that is, a "measure of those aspects of mental ability which are important for success in academic work and in similar endeavors outside the classroom." (Nelson, et. al., 1961, p. 3).

The substance of the Henmon-Nelson test is designed to measure Verbal and Quantitative abilities which are summed to provide a single total score. These two abilities are evaluated by the number of correct responses given to 100 multiple-choice items in a period of forty minutes. Since this device is reasonably short, easy to administer and score, and produces predictive results comparable to factored or multiscored tests, it was well suited to the needs of this investigation. Nelson, et. al. (1961) reports the split-half reliability of the test (Form A) to be .95.

Among other independent variables not presented here, a modified (adult) (Sigel, 1967) version of the Sigel Cognitive Style Test (SCST) was given to all sections taught over a period of two semesters. The SCST consists of thirty-five picture sets, three to a set, of people, plants, animals, and objects shown in various combinations. Given one minute to review each triad set the student was directed to select out any two of the three pictures which were similar, belong together, or were related in any way. Combinations could be repeated only if a different reason was stated.

As modified, the SCST was redefined for scoring purposes into the following major classes.

Descriptive Part (Dp)

Groupings in this category are based on the similarities in specific, objective, physical attributes seen as singular parts of separate stimuli. The concrete attributes are shared by all members and can be perceived by any of the senses. "People with something in their hands." would be an example.

Descriptive Whole (Dw)

The only difference between this class and the previous one is that the similarities perceived by the subject are of a global nature, i.e., they define a characteristic held by the entire stimulus. A tomato and an apple both classified as "red" or "round" would fall into this class.

Categorical (C)

Membership in this class is determined on the basis of a common set of descriptive stimuli. Each particular attribute defining the set is not limited to a specific example, but may exhibit a range of physical characteristics. For example, the biological class mammalia is defined as having hair, giving birth to live young, etc. Thus, a cat and a dog while quite different in many ways are similar enough in others to justify being placed in the class mammalia. Other examples would be "fruit" or "modes" of transportation."

Inferential (I)

Here the defining relationship is again based upon a common characteristic shared by all members, but which excludes all inherent references to the physical nature of the stimuli. Membership in this category indicates interdependence expressed by functional or thematic labels. For example, a dog and a cat may be seen as "both capable of running." Or a policeman and fireman "both protect."

Relational (R)

The interdependence of the members of this group depends upon a particular and singular situation which is not generalizable. The meaning of any one stimulus in the grouping is defined by its relationship to other stimuli. For example, a horse and a carriage go togehter because the "horse pulls the carriage."

In the final analysis of the student responses, the total number generated within each class was not considered as important as the proportion they occupied within the individual's overall labeling (cognitive) disposition. Therefore, each class total was reduced to a percentage of the entire set of responses given by each student. This procedure was repeated for just the first responses given to each of the picture triads. In this case the percentages would be determined with a demominator of thirty-five.

DATA AND ITS SOURCES

Because of the limited number of men enrolled in the course (22), only the data from the ninety-five women were used in the study. The average age of this group was 23.7 years.

The following tables report some of the particulars of a two-factor analysis of variance involving three levels of achievement in science and two levels of intelligence. Note that significant SCST contrasts occur only with the Achievement in Science factor.

Every independent variable described has been selected for an alpha level of significance of less than .05. Cell and marginal means are reported, as are "p"

values, while the population of this analysis is defined by the ten replications found in each of the sex cells. A single statement summarizes the result of a Tukey (main effect) post-hoc comparison made at the .05 level.

Main Effect A
ACHIEVEMENT IN SCIENCE

With two and fifty-four degrees of freedom the F ratio at the .05 level of confidence must exceed 3.17 to be considered significant for this source of variation.

TABLE II

(SCST)[1] Sub Total A[2] as a Function of Achievement in Science

F = 3.347

p = .043

The simple pair-wise contrast between Low and High means of Achievement in Science is significant.

Achievement in Science	Intelligence: High	Intelligence: Low	
High	59.72	71.15	65.435
Average	58.43	55.70	57.065
Low	54.57	53.82	54.195
	57.573	60.223	

[1]Analysis of first responses.

[2]Sum of Descriptive Part, Descriptive Whole, and Categorical labels.

TABLE III

(SCST)[1] Inferential as a Function of Achievement in Science

F = 3.558

p = .37

The simple pair-wise contrast between High and Average means of Achievement in Science is significant.

Achievement in Science	Intelligence: High	Intelligence: Low	
High	13.44	11.15	12.295
Average	17.48	18.28	17.88
Low	14.30	17.05	15.675
	15.073	15.493	

[1]Analysis of first responses.

TABLE IV

(SCST)[1] Sub Total B[2] as a Function of Achievement in Science

$F = 3.347$

$p = .043$

The simple pair-wise contrast between Low and High means of Achievement in Science is significant.

Achievement in Science	Intelligence: High	Intelligence: Low	
High	40.28	28.85	34.565
Average	41.57	44.30	42.935
Low	45.43	46.18	45.805
	42.427	39.777	

[1] Analysis of first responses.

[2] Sum of Inferential and Relational Labels.

RESULTS AND CONCLUSIONS

When presented with a classification task, high achievers of concepts-in-science preferred simple objective labels such as "round" or "both are girls". These labels represented a composite Descriptive-Categorical or analytical cognitive style, as defined by the Sigel Cognitive Styles Task. Those who did not perform as well on the concepts-in-science achievement tests typically preferred memory-oriented Inferential class labels. These would include references to men in uniform "protecting", which would exclude all inherent references to the physical nature of the stimuli. Consider this to be of major importance, because in combination with labels of the Relational class the grander distinction of "analytical" versus "non-analytical" styles may be noted. It also determines the mirror image relationship between Tables II and IV.

Another interesting result to note is the fact that only the analyses of the first responses to each of the picture tirads produced significant differences. It would appear that a person's first impression or first perception of the problem dictates the path he will reason to a resolution of the problem.

SIGNIFICANCE

For high and low achievers of concepts in science the findings indicate that a person's cognitive style mediates his intellectual ability to grasp and understand new meanings. For most educators it would seem logical to consider training students to modify their style to match the demands of an information-processing curriculum. Earlier efforts have been made to influence style (Scott and Sigel, 1965 and Scott 1964), in children when they were involved in an inquiry science program that encouraged the asking of questions, the formation of hypotheses, and the making of inferences. Sigel and Coop (1974) now suggest that the question of inducing change may also be an issue of ethics if there are personality or related side effects.

For the adults of this study, cognitive style may be translated as a "learning style". This study is also one of the few that has focused on (female) adult behavior, which in turn supports much of the research involving children. It also raised the question of the desirability of matching a "teaching" style to the student's style of learning.

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