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ABSTRACT

While previous research has demonstrated a correspondence between measures of instructional content and psychological structure due to learning, this research report examines whether individual learner differences affect this correspondence. Individuals of the field independence psychological structure were expected to impose greater structure and experience concepts as discrete and organized, while individuals of the field dependence psychological structure would not impose structure but experience the concepts and their interrelationships as global and diffuse. Ninety-six students and 24 teachers divided evenly between field-independent and field-dependent structures provided the sample group. Results indicate that the field independent subjects configures the concepts of a sample lesson identical to the model of content structure, while the field-dependent subjects did not. The implication for further research concerns the extent to which a teacher's or student's psychological structure affects his or her method of teaching or ability to understand and learn what is being taught. (Author/DE)

FIELD-INDEPENDENCE AND THE STRUCTURING OF KNOWLEDGE IN A SOCIAL STUDIES MINICOURSE

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Bruner (1966) argued that a theory of instruction should be prescriptive. It's usefulness depends on establishing rules concerning how knowledge can be effectively communicated and learned. One feature of such a theory deals with how a body of knowledge should be structured to provide optimal learning for students. Cognitive theorists have approached this problem by postulating a process of learning and remembering and suggesting that instructional material be organized to enhance this internal process (e.g., Ausubel, 1963; Ausubel & Fitzgerald, 1961; Bruner, 1966; Gagne, 1962). This approach rests on the assumption that there is some correspondence between the structure of the instructional materials (content structure) and what is represented as structure in the student's memory (psychological structure). A critical test of this assumption about structure would involve representing content and psychological structures independently and objectively, even if not completely, and examining the correspondence between the two before and after instruction. This is, in broad terms, the purpose of this study.

In assessing the correspondence between content and psychological structures, representations of both are needed. Content structure may be defined as the organization (interrelation) of concepts in a subject matter. Representations of content structure for subject matters have been obtained by establishing a model a priori (Gardner & Johnson, 1968; Johnson, Cox, & Curran, 1971; Johnson, Cox, & Lenarz, in press), by taking a frequency count of words representing concepts in a textbook (Johnson, 1967, 1969; Rothkopf & Thurner, 1972), and by mapping concepts onto directed graphs by means of a linguistic analysis of prose material (Crothers, 1972; Fredericksen, 1972; Geeslin & Shavelson, in press; Meyer & McConkie, 1974; Shavelson, 1972; Shavelson & Geeslin, 1973).

Psychological structure may be defined, roughly, as a hypothetical construct representing the organization (interrelation) of concepts in a person's memory. In order to obtain a representation of psychological structure, key concepts (words) in a subject matter are used as stimuli and subjects are typically given nonveridical tasks — e.g., word association, similarity judgments, card sorting, or essays — from which the organization of concepts in their memories is inferred. Specifically, the interpoint distances between key concepts determined from the data on these measures are assumed to represent, at least in part, the distance between concepts in memory. The validity of psychological structure interpretations of these measures has been demonstrated by, among others, Shavelson & Stanton, (in press).

Research on the correspondence between content structure and psychological structure has been successful as far as it has gone. Shavelson (1972), for example, used digraph theory to represent the content structure of a textbook chapter in Newtonian mechanics. Psychological structure was examined with word association tests prior to and following each of five days of instruction. Compared to a control group, the treatment groups': (a) achievement increased significantly from pre- to posttest; (b) psychological structure changed during instruction, such that key concepts were interrelated more closely at the end of instruction than at the beginning; and (c) psychological structure corresponded more closely to content structure at the end of instruction than at the beginning. A study by Geeslin & Shavelson (in press) has also provided evidence in support of the correspondence between content structure and psychological structure using programmed instruction on probability.

While previous research has demonstrated a co respondence between measures of content and psychological structure due to learning, the influence of individual differences between learners on this correspondence has not be examined systematically. The present study investigated the correspondence between content and psychological structure of individuals who differed with regard to a particular cognitive style — field independence (FI) -dependence (FD).

As a measure of individual differences, the FI-FD construct seemed particularly important because it is dependent upon the concept of psychological differentiation. In broad terms, differentiation refers to the complexity of structure of an individual's psychological system, with greater differentiation characterized by greater specialization and more complex integration. The behavior patterns associated with FI and FD are relatively consistent in terms of psychological functioning and pervasive throughout a person's perceptual, intellectual, motivational, defensive, and social operations (Witkin, et. al., 1962). In this study, however, of particular concern is the manifestation of these individual differences in the perceptual and intellectual domains. Research has shown that, compared to FD individuals, FI individuals are "more articulated in experiencing", generally better able to perceive items as discrete from their backgrounds, more able to reorganize an organized field or impose structure on an unorganized field. For example, FI individuals, when presented with a stimulus material that lacks internal organization (e.g. Rorschach inkblots), are likely to impose structure with the result that their percepts are organized and definite. By contrast, FD individuals tend to leave such material as is, rather than imposing structure on it. Consequently, their percepts are vague and indefinite (Witkin, et. al., 1962).

Just as this ability to analyze and structure experience has been demonstrated with an immediate stimulus configuration (perception) so it may influence remembering and thinking about written or symbolic material. Specifically, the correspondence between content structure and psychological structure might be closer for FI individuals than for FD individuals. Given the task of assigning similarity judgments to pairs of concept words and thereby imposing structure, it seems likely that FI and FD individuals will perform differently, and that their representations of psychological structure in memory will be correspondingly different. That is, FI individuals would be expected to impose greater structure, and experience concepts as discrete and the relationships among concepts as organized; FD individuals will not impose structure, but experience the concepts and their interrelationships as global and diffuse.

This study examined the correspondence between an a priori model of content structure and psychological structure as inferred from similarity judgments for individuals who differed in cognitive style. Research on the correspondence of content and psychological structure and on the construct of FI-FD led to the following predictions: (1) after instruction, the perceived relationships among concepts (psychological structure) would correspond closely to a hypothetical model of subject-matter organization (content structure), and (2) the psychological structure of FI subjects, due to their greater ability to differentiate, would correspond more closely to content structure than would the psychological structure of FD subjects.

The design of this study corresponded with Shavelson's (1974) model for examining the communication of subject-matter structure in the classroom (Figure 1). FI and FD teachers learned and taught a lesson in social studies

Insert Figure 1 about here

Figure 1. Communication flow of subject-matter structure through teacher's cognitive structure to student's cognitive structure removed to conform with copyright laws.

NOTE: From "Methods for examining representations of a subject-matter structure in a student's memory," by R. J. Shavelson, Journal of Research in Science Teaching, 1974, 11, 231-249.

(content structure) to FI and FD students. The lesson was communicated to students through verbal discourse over five, one-hour periods. The communication of content structure was influenced by the teachers' (a) psychological structure which, in turn, was influenced by their aptitudes for learning including FI-FD, and (b) their aptitudes for teaching, including FI - FD. The students' learning depended upon the teaching and its correspondence with their aptitudes for learning, including FI-FD.

METHOD

Content Structure: The Logical Model

Instructional material. The instructional material, "The Development of Mayan Civilization," was a social studies minicourse prepared especially for this study. It focussed on the development of societal patterns of the Mayan civilization, with the aim of helping students understand how and why this civilization developed and recognize some of the distinctive features and accomplishments of the Mayan people. Teachers were provided with instructional goals and objectives (e.g., To explain how relig[illegible], economic, social and political factors interacted to shape Mayan society at the height of the Mayan civilization) ; they were not instructed as to how to teach.

Logical model. For the purpose of identifying content structure, six independent judges selected 10 key concepts from a list of statements which described the course. These 10 concepts, serving as a basis of analysis of content structure, were: CULTURE, CULTURE AREA, CIVILIZATION, CULTURAL EVOLUTION, CULTURAL DIFFERENTIATION, CULTURE TRAIT, SOCIETY, CULTURE REGION, CULTURE PATTERN, CULTURAL DIFFUSION.

From the definitions of these concepts, cluster of similar concepts were formed such that there was high similarity among concepts in a cluster and low similarity between clusters (this was possible even though the concepts

overlapped a great deal in meaning). Figure 2 shows the four clusters of concepts which emerged — General concepts (cluster A), Geographical concepts (B),

Insert Figure 2 about here

Characteristics (C), and Processes of Change (D). The concepts in clusters B, C, and D all refer to the central cluster of general concepts — culture, society, and civilization. Specifically, culture area (e.g., Mesoamerica) and culture region (e.g., Yucatan) are geographical terms describing the location of a specific culture, society, or civilization. A culture pattern is a global characteristic (e.g., art styles, class structures) that may apply to many cultures, while culture trait is a specific characteristic that refers to a particular culture (e.g., corn as food). As a group, cultural evolution (progressive development within a culture), cultural differentiation (changes of greater specificity within a culture), and cultural diffusion (spreading out of beliefs, etc., to other cultures) refer to processes of change that occure over a long period of time.

Psychological Structure

A representation of psychological structure was obtained from data collected in a similarity judgments task. The 10 key concepts served as stimuli on that task. Each subject received a test booklet beginning with a statement about the purpose of the task. Subjects were told that the task showed how people thought about words that represented concepts in social studies, but that it did not measure achievement in social studies. They were asked to treat each pair of words carefully, making quick, yet accurate judgments, and to record the first response which occurred to them.

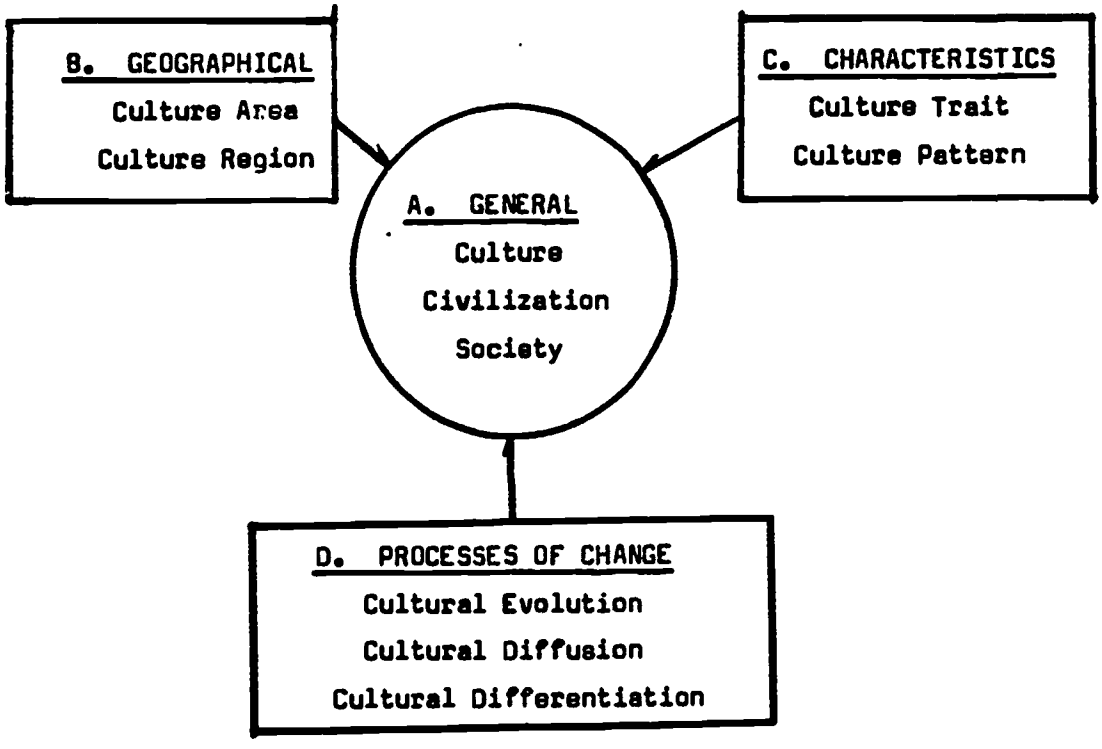


Figure 2. The organization of concepts in social studies.

Each of the 45 pairs of words (concepts) was followed by an 11-point rating scale, anchored by the words similar (1) and dissimilar (11). Two different random orders of the 45 pairs of words were constructed with restrictions that (a) no pair of words be adjacent to the same pair of words in the two random orders, (b) no adjacent pair in a given order contain the same concept, and (c) each word appear equally often on the left and right side in the pair. One pair of words was printed on each page of the test booklet and subjects were randomly assigned to one of the two orders.

The following instructions on how to respond on the similarity judgments task were given to each subject:

> On the following pages you will find pairs of words which represent concepts in social studies. Each pair of words is followed by a rating scale. Your task is to judge how similar (alike) or dissimilar (not alike) you feel the concepts represented by words are to one another. If you feel the concepts represented by a particular pair of words are similar in some degree, place an "X" in a blank near the "SIMILAR" end of the rating scale. If, on the other hand, you feel that the concepts represented by the words are dissimilar in some degree, place an "X" in a blank near the "DISSIMILAR" end of the scale. The degree of similarity or dissimilarity is indicated by how far you place your "X" from either end of the scale. Work as quickly as possible, Are there any questions?

Subjects

Subjects were 96 suburban, high school students, 14-16 years of age, and 24 social studies teachers, with a least three years of teaching experience. Half of each group were field-independent (FI) and half were field-dependent (FD); half of each group were male and half were female. All subjects were screened using the Group Embedded Figures Test (GEFT), the Portable Rod-Frame Test (PRFT) and the Human Figure

Drawing Test to determine their field-dependence-independence (Witkin, et. al., 1962). Final FI and FD groups were comparable on verbal ability as estimated by the Extended Range Vocabulary Test (French, Ekstrom, & Price, 1963). Mean scores on these tests are presented in Table 1.

Insert Table 1 about here

Procedure

This study, while conceptually distinct, was operationally embedded in a larger study investigating the effects of match and mismatch in cognitive style between teacher and students on teacher-student interaction and student achievement. The study was carried out over a five-day period. The first day was devoted to subject orientation and pretesting. At that time, all subjects were told that this was a study of classroom learning processes and the effects of different combinations of teachers' and students' teaching and learning styles on student achievement. Following orientation, subjects took the similarity judgments task, followed by various cognitive tests (not reported here). In addition, students were given a subject-matter achievement pretest. Subjects were allowed to proceed at their own speed on the similarity judgments task, and all finished the booklet in 20 minutes.

The 24 teachers then taught the social studies minicourse. The classes consisted of one teacher and four students who did not know each other. They were held for 50 minutes on four consecutive days. As an introduction, students and teachers were shown a film about early Mesoamerican civilizations. Teachers taught four "practice" students (intermediate on the FI-FD dimension), two boys and two girls, the first week, and a class of

TABLE 1

Means and Standard Deviations[a] on Cognitive Style and Vocabulary Tests for All Subjects

Subjects	GEFT[b]	PRFT[c]	Vocabulary
Field Independent Teachers (N = 12)	15.9 (1.9)	19.6 (11.4)	35.6 (5.8)
Field Dependent Teachers (N = 12)	5.0 (2.8)	98.1 (58.6)	34.6 (5.4)
Field Independent Students (taking pre and post tests) (N = 23)	16.3 (1.6)	14.4 (5.9)	20.5 (6.4)
Field Dependent Students (taking pre and post tests) (N = 24)	7.4 (3.2)	57.0 (27.9)	21.0 (7.1)
Field Independent Students (taking post test only) (N = 24)	16.9 (1.2)	17.7 (8.5)	22.2 (4.8)
Field Dependent Students (taking post test only) (N = 24)	7.2 (4.1)	69.0 (23.3)	21.6 (7.1)

[a] Means are presented first, with standard deviations in parentheses.

[b] A higher score represents greater field independence.

[c] A higher score represents greater field dependence.

four students (two boys, two girls, divided on FI and FD) the following week. To make certain all students had equal exposure time to the curriculum, reading or homework assignments were not given. Students could not take notes in class.

Teachers received a curriculum packet, "Development of Mayan Civilization," which included a listing of course goals, specific objectives, statements about the course content, and possible test questions. In addition, teachers received a required reading list which gave specific readings for each of the teaching goals. A copy of each book listed as required reading was loaned to each teacher. Teachers were encouraged to try to meet all the course objectives, although emphasis upon one objective over another was permitted. Additional references and instructional materials were provided, with the stipulation that they be used only at the research site (Educational Testing Service). Teachers were not permitted to bring in additional teaching materials of their own.

Design

A pretest-posttest design was used for the teachers. They were pretested before receiving information about the course and received the posttest after teaching the course. Classes were randomly assigned to receive tests either at pretest and posttest or at posttest only. In the former, students were given the similarity judgments task before receiving instruction. All students received the posttest at the end of instruction and before taking the final achievement test. Sex and cognitive style were balanced in the design.

RESULTS AND DISCUSSION

Data were examined to determine whether the psychological structure of FI teachers and students corresponded more closely to the content structure than that of FD teachers and students. A positive finding would support the hypothesis that teachers and students of different cognitive style organize these concepts differently psychologically. In order to justify this investigation of psychological structure, a methodological check on knowledge of subject matter is presented.

Knowledge of Subject Matter

If a subject were merely guessing, he or she would be expected to answer approximately 17 questions (out of 68) correctly on the achievement posttest. On the average, all students scored above this level ($\bar{X} = 37.4$). A within classroom analysis, testing for differences by type of student (FI or FD, male or female) and type of teacher, was also not significant (Moore, personal communication). These results imply that students had some structure of the subject-matter, and support an interpretation of the scaling data as representing something other than error.

Correspondence between Content Structure and Psychological Structure

Similarity ratings were averaged across subjects for each of the 45 pairs in each of the two teacher groups (FI and FD) and for each of the four student groups (FI and FD in the pre-posttest design and FI and FD in the posttest-only design). Pre- and posttest means (for each group by cognitive style) were placed in half matrices and submitted separately to multidimensional scaling analysis (Kruskal, 1964b). Scaling was attempted in 2, 3, and 4 dimensions using the city block metric. An "elbow"

occurred in the stress function at three dimensions for each of the ten analyses. These three-dimensional representations were interpreted as representing psychological structure and were used in further analyses reported below.

In order to get a visual representation of of subjects' psychological structure, clusters were formed in the following manner. The interpoint distances between all possible concept pairs were computed using the coordinates of the points obtained from the three dimensional solutions.[1] Since a judgment was made between all possible pairs of the 10 concepts, each concept had 9 interpoint distances related to it. For each concept, these distances were ranked in order of increasing distance. Those concept pairs which differed by an absolute value of 1.5 or less were retained for further analysis.

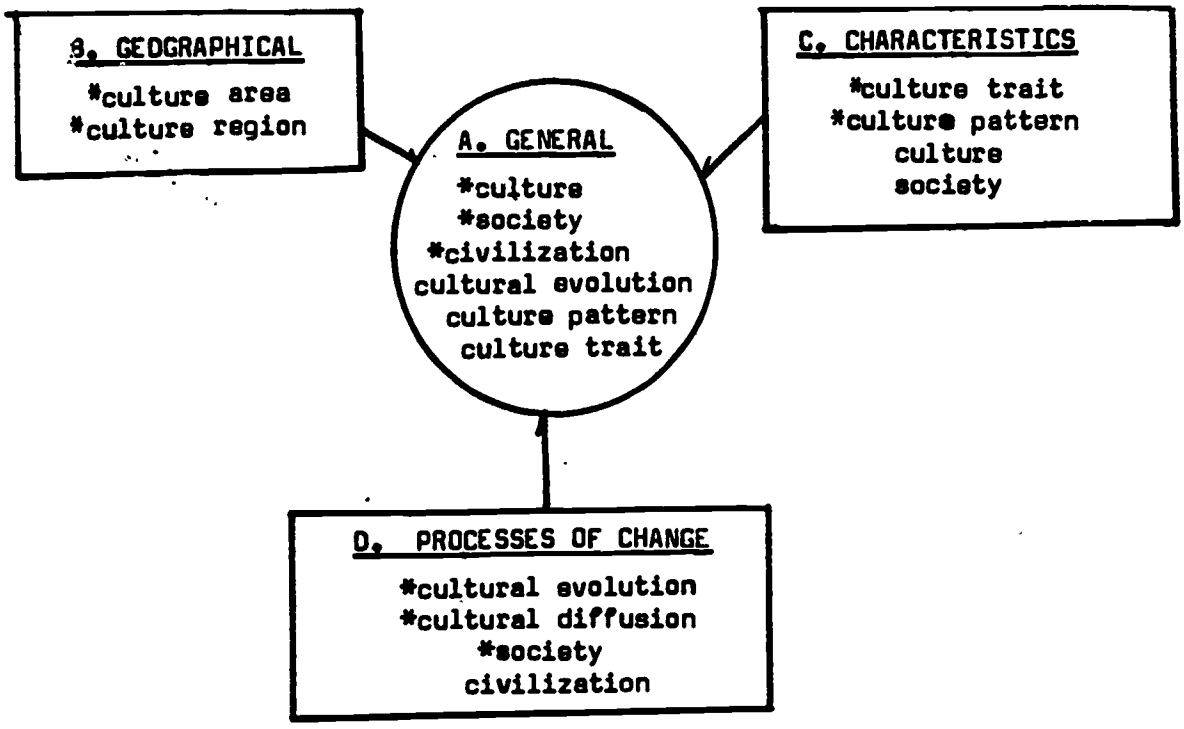
Psychological Structure of Teachers

Figure 3 presents pre- and posttest configurations of FI and FD teachers as compared with the a priori model of content structure. Differentiation

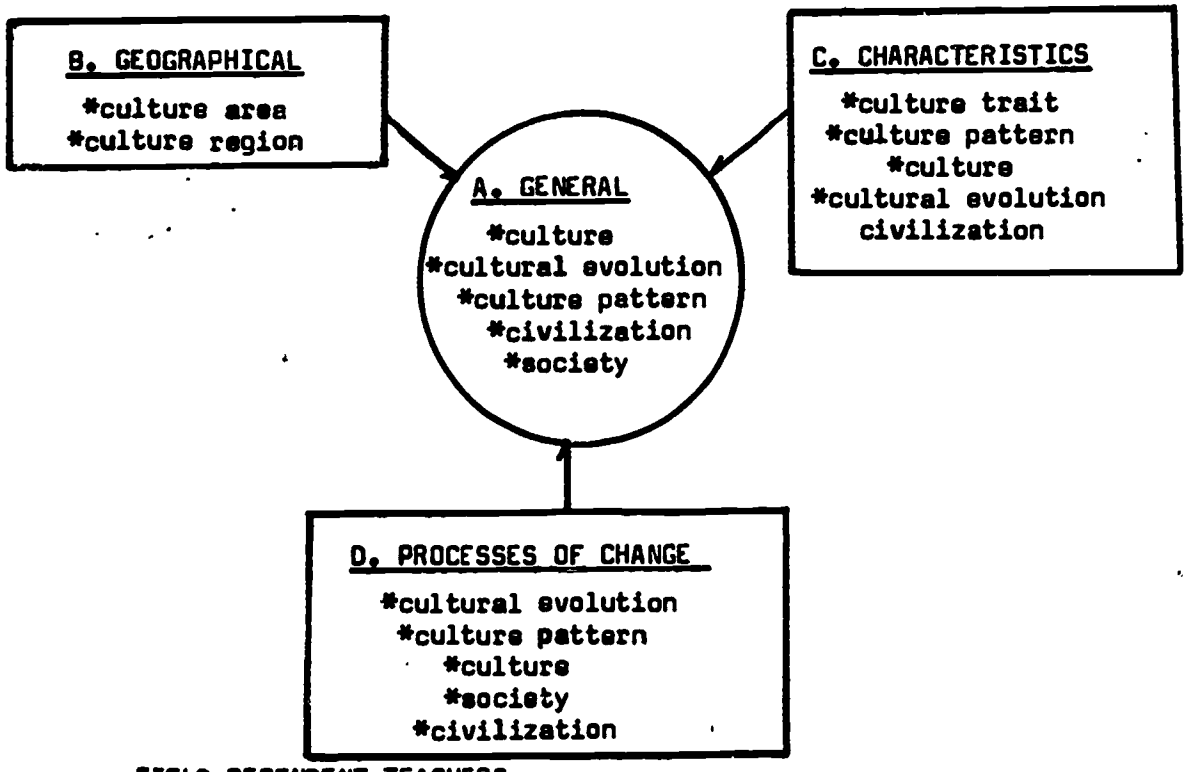
Insert Figure 3 about here

among concepts was expected to increase from pre- to posttest. For FI teachers this occurred. Their posttest configuration had fewer concepts per cluster and corresponded more closely to the model than the representation for FD teachers. In fact, pre- and posttest configurations for FD teachers were practically identical.

Inspection of each cluster revealed other differences. Generally, FI teachers' posttest configurations were identical to the model of content structure in clusters A, B, and C. For both FI and FD teachers, the concept



FIELD INDEPENDENT TEACHERS



FIELD DEPENDENT TEACHERS

Figure3 . Pretest and posttest configuration for FI and FD teachers as compared with the a priori model.

NOTE. All concepts in pretest configurations are given; concepts with an asterisk (*) are those that remained in posttest configurations.

of cultural differentiation did not cluster with other concepts.

For FD teachers, however, only cluster C is identical with the model. Clusters B and A conform somewhat to the model, but add additional concepts. The same concept often appears in more than one cluster. This greater degree of "overlap" among concepts for FD teachers perhaps reflects a less differentiated perception of the concepts, in contrast to FI teachers.

Psychological Structure of Students

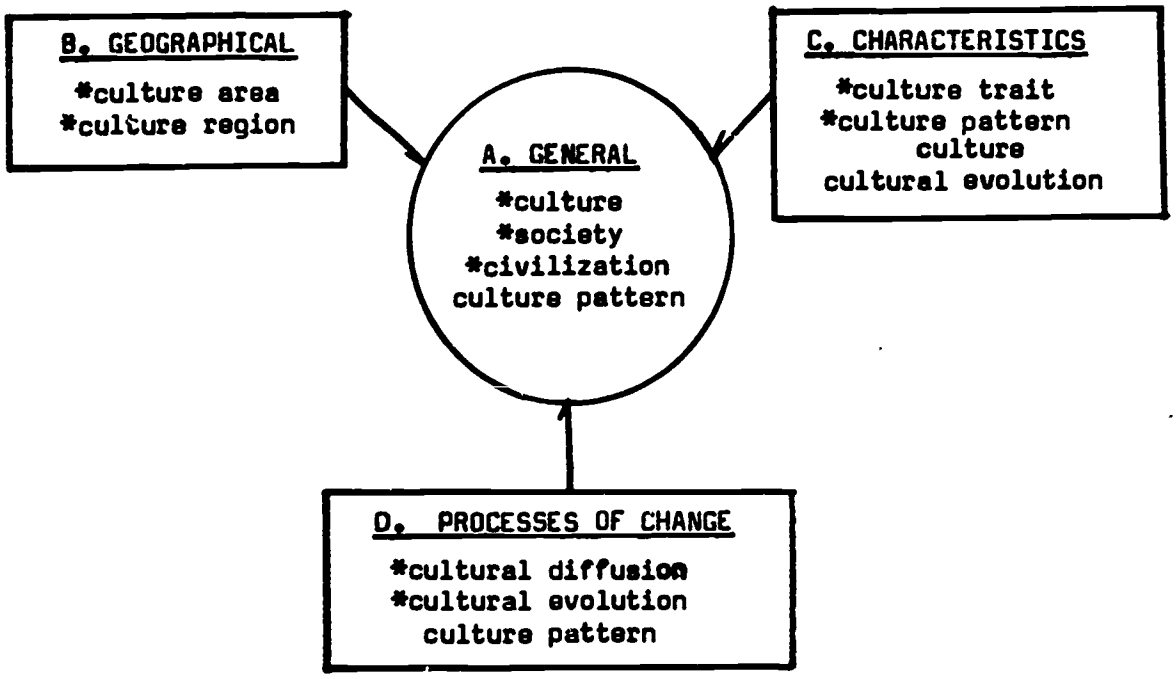
Results indicate that pretesting had some effect. Generally, students who received the pretest showed greater differentiation on the posttest than did those who did not receive the pretest. Therefore, results from the two groups will be reported separately.

For students in the pre-posttest design, results were similar to those found for teachers (see Figure 4). FI students' posttest configurations

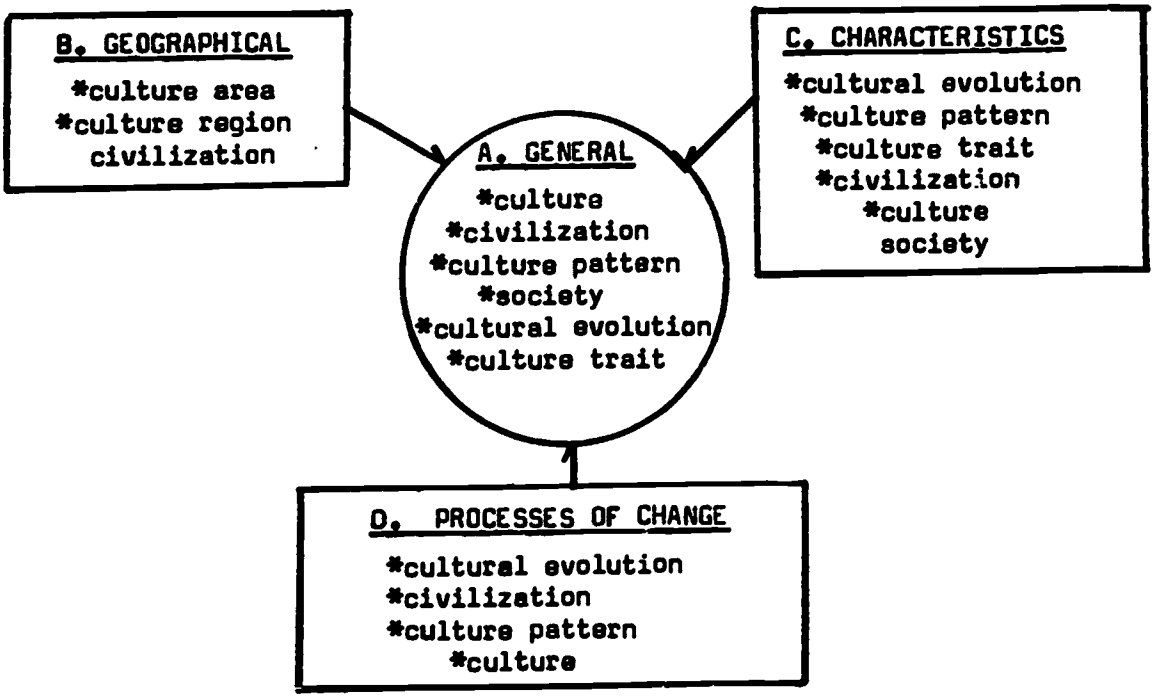
Insert Figure 4 about here

have fewer concepts per cluster than pretest configurations, indicating perceived differentiation as a result of instruction. For FD students, however, pre- and posttest configurations are nearly identical.

Again, for both FI and FD students, cultural differentiation was not perceived as closely related to other concepts. Except for that omission, the FI students' posttest configuration were identical to the model of content structure. As was the case with FD teachers, the configurations of FD students indicate that cultural diffusion was also not perceived as related to other concepts and that concepts often appeared in more than one cluster.



FIELD INDEPENDENT STUDENTS



FIELD DEPENDENT STUDENTS

Figure 4. Pretest and posttest configurations for FI and FD students as compared with the a priori model.

Note. All concepts in pretest configurations are given; concepts with an asterisk (*) are those that remained in posttest configurations.

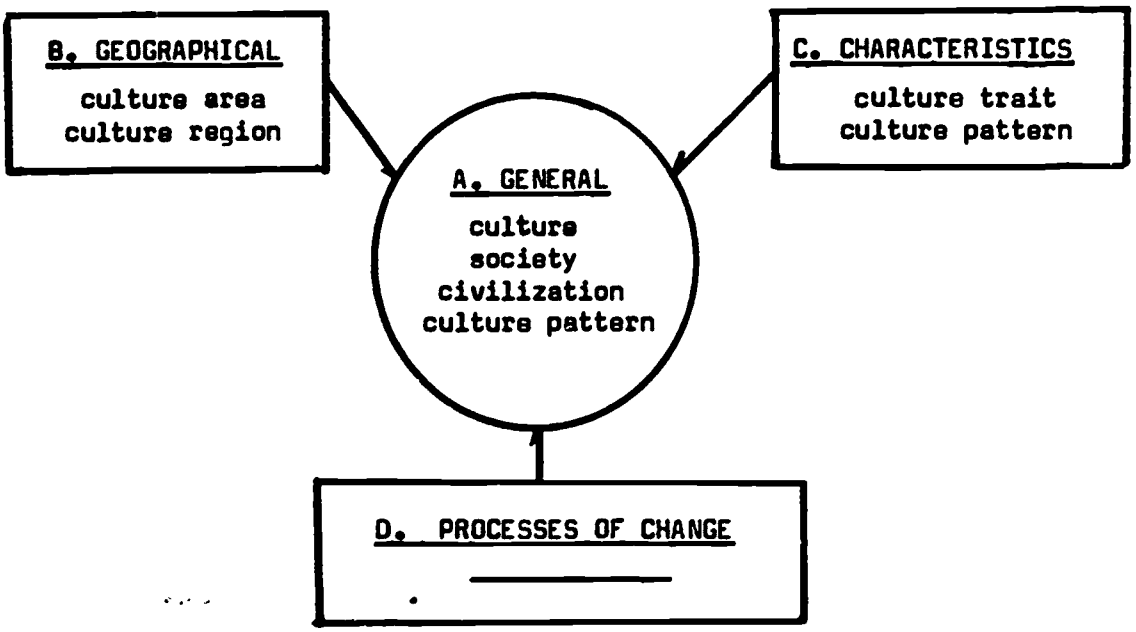
It appears, then, that FI subjects and FD subjects structure concepts differently. FI subjects have fewer concepts per cluster in posttest configurations, indicating a refinement of perceived relationships as a result of instruction. FD subjects do not exhibit this tendency. Furthermore, FI subjects' configurations are nearly identical to the a priori model. For FD subjects, however, greater overlap among concepts indicates a less differentiated view of the concepts.

These differences due to cognitive style are striking when one notes that they are consistent for both students and teachers. A number of studies have suggested that informants or experts in a particular discipline structure the subject-matter differently than novices or students, i.e., the structure of experts is presumably isomorphic to the logical structure of the discipline (Johnson, Cox, & Lenarz, in press). The teachers in this study may be regarded as informants in that they were provided with the same content material, which they then communicated to the students. In this regard, one would predict that the teachers conceptual structures would be similar to each other, yet different from that of the students. This was not the case. The findings of this study reflect differences on the basis of cognitive style, i.e., teachers and students of like cognitive style have similar structure.

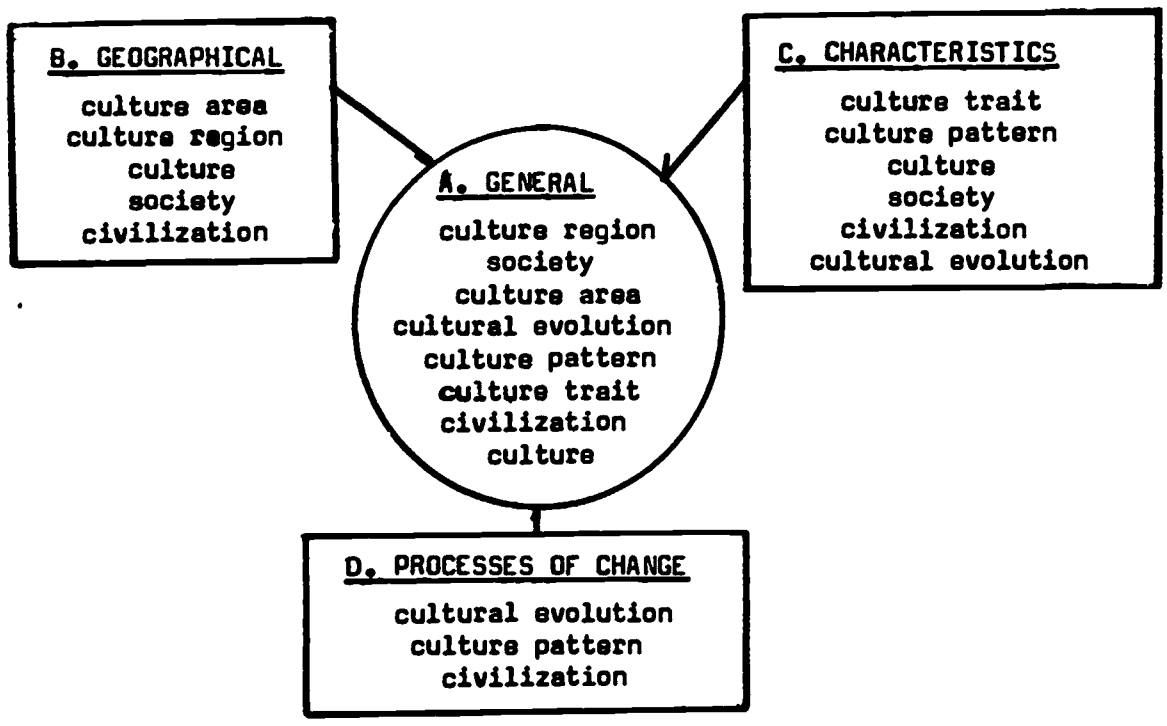
Figure 5 presents contigurations for FI and FD students in the

Insert Figure 5 about here

posttest only design. Generally, the configuration for these subjects are similar to those of FI and FD students in the pre-posttest design (see Figure 4). It appears, though, that the pretest may have aided the structuring process for both FI and FD students. For example, although FI



FIELD INDEPENDENT STUDENTS



FIELD DEPENDENT STUDENTS

Figure 5. Posttest configurations of FI and FD students in the posttest only design as compared with the a priori model.

students' configurations are well-integrated and reflect the a priori model in clusters A, B, and C, none of the concepts in cluster D were perceived as related to the other concepts. This is contrary to findings for FI students in the pre-posttest design. Furthermore, FD students configurations are even less differentiated than those of their counterparts who had taken the pretest.

CONCLUSIONS

The results of this study may be summarized as follows: (1) for FI and FD subjects, posttest configurations more closely resembled the model than did pretest configurations; (2) FD subjects, both teachers and students, exhibited greater overlap, i.e., less differentiation among concepts, in that they had more concepts per cluster and the same concepts often appeared in more than one cluster than did FI subjects; (3) FI subjects' configurations were nearly identical with those posited in the model of content structure; (4) teachers and students of like cognitive style have similar structures, and (5) sensitization with the pretest may have aided both FI and FD students in structuring concepts.

The cognitive style differences found in this study suggest a number of questions for further research. For example, to what extent does the teacher's psychological structure affect his or her method of instruction (e.g., lecture content, areas of emphasis)? In turn, how would this presentation affect the student's ability to understand and learn what is being taught? The use of cognitive style as a variable in aptitude-treatment-interaction research is also apparent. In addition to having implications for curriculum development and instruction, this study suggests that it may be important to consider individual differences, particularly cognitive style, in research on cognition and the acquisition of knowledge.

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Footnotes

[1]Computation involved using a formula for generalized distance function $AB = \left[(X_A - X_B) + (Y_A - Y_B) + (Z_A - Z_B)\right]$ with "X", "Y", and "Z" corresponding to coordinates in each of the three dimensions for concepts "A" and "B". In this way an absolute estimate of subjects' perceived distance between concepts "A" and "B" was calculated.