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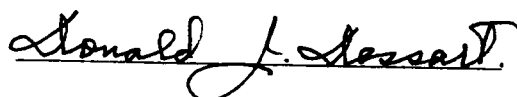
I am submitting herewith a dissertation written by Charles Larry Bouldin entitled "An Investigation of Applications of Cognitive Mapping to Instructional Strategies for College Courses in Basic Mathematics." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Education, with a major in Curriculum and Instruction.


Henry Frandsen, Major Professor

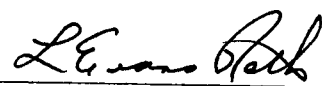
We have read this dissertation
and recommend its acceptance:







Accepted for the Council:


Vice Chancellor
Graduate Studies and Research

AN INVESTIGATION OF APPLICATIONS OF COGNITIVE MAPPING
TO INSTRUCTIONAL STRATEGIES FOR COLLEGE COURSES IN
BASIC MATHEMATICS

A Dissertation
Presented for the
Doctor of Education
Degree
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Charles Larry Bouldin

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ABSTRACT

During the fall quarter of 1979, a study was conducted at Roane State Community College in Harriman, Tennessee, in which two treatments consisting of a visual and an auditory presentation of the same material were employed for the instruction of basic arithmetic skills in the developmental studies program. The Hill Cognitive Mapping Inventory was used to classify the cognitive learning style of each subject as either visual or auditory, and after randomly assigning each subject to a treatment, some subjects' cognitive styles and treatments were matched and others' were mismatched. A total of 74 subjects participated in the study.

Of concern in this study was whether this matching and mismatching resulted in differences in the acquisition of basic arithmetic skills or changes in attitudes toward mathematics. Gain scores acquired from the pre- and posttreatment uses of the Basic Skills Test (SK/1) of the Mathematical Association of America and the Aiken Attitude Scale were used to evaluate effects on the subjects' arithmetic skills and attitudes toward mathematics.

Statistical analysis of the data detected no significant differences in basic skills acquisition or changes in attitude toward mathematics for subjects with matched treatments and styles as opposed to those with mismatched treatments and styles. No significant differences were noted concerning skills acquisition and attitude changes of subjects having a visual treatment versus subjects having an

auditory treatment. The analysis did not show any significant differences in skills acquisition and attitude changes among the four groups: auditory style-auditory treatment, visual style-visual treatment, auditory style-visual treatment, and visual style-auditory treatment. However, a slight tendency was detected for subjects with auditory cognitive style to find the visual treatment unacceptable as evidenced by the rate of transfer of these subjects from this treatment.

The relatively small gains for basic skills and attitudes reported in this study perhaps indicated that the developmental studies course was ineffective and/or that the use of the Hill Inventory in this environment was suspect.

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CHAPTER I

INTRODUCTION

Background and Motivation for This Study

In recent years educators at the college level, especially community colleges, have been confronted with students who lack the basic skills and information necessary for success in college courses. Concern has been expressed that these persons cannot benefit from higher education until they acquire prerequisite skills and knowledge.

The existence of this problem was acknowledged in the 1965 report from the Committee on the Undergraduate Program in Mathematics of the Mathematical Association of America when it addressed the question of what to do with students whose mathematical backgrounds were insufficient for precalculus courses. Of the report's three general recommendations (not teaching mathematics to these students, offering an appreciation or cultural course about mathematics, and providing remediation for these students), the two-year colleges have chosen the last. Recent surveys (Lindberg, 1976; Beckwith, 1979) report that remedial mathematics courses (arithmetic, prealgebra, algebra, geometry) are now offered in over 95% of America's two-year colleges.

Since these courses are remedial and do not carry credit which will transfer, and since the backgrounds and varying degrees of motivation among the students are quite diverse, such mathematics courses can be the most difficult and challenging to teach. In many schools, special

programs have been designed to help the student gain the required elementary information and skills in nontraditional ways. Designated by a variety of names, such as learning lab, developmental studies, and supplemental studies, these programs attempt to aid the student in achieving specific low-level goals in as short a time as possible. Various types of instruction, ranging from a pure lecture format to purely individualized study, and an astounding array of electronic and audiovisual devices, are being utilized with varying degrees of success (Gemignani, 1977; Gray, 1977; Fernando, 1977).

At the same time, some educators and psychologists (among them Cronbach and Bloom) have suggested that the set of precepts, perceptions, and assumptions that students bring into the learning situation may be as important in determining how much is learned as the method of instruction being employed. They suggest that if it were possible to determine a person's preferences for perceiving and assimilating incoming information and match those preferences to appropriate forms of communication, the learning process would be improved. Consequently, the student's attitude toward the subject, as well as knowledge and skills, might be more effectively improved.

The December, 1980 issue of Practical Applications of Research of Phi Delta Kappa and the collection of monographs published in 1979 by the National Association of Secondary School Principals under the title Student Learning Styles are evidence of a continuing interest in the study of whether cognitive styles may predispose one to certain methods of instruction. Prominent among the efforts to investigate and apply

models of perceptual patterns are the field dependence-independence studies of Witkin (1954), the reflective versus impulsive conceptual tempo work of Kagan (1966), and the learning style inventory work of Hill (1971) and Rita and Kenneth Dunn (1978).

Current efforts to explain the underlying process of learning and teaching include widely differing approaches. One is based on a model developed in 1974 by McKenney at the Harvard Business School and rooted primarily in the work of Witkin and Bruner (Keefe, 1979, p. 16). It has two dimensions: information gathering (preceptive versus receptive) and information evaluating (systematic versus intuitive). Another approach uses a model of learning developed in 1964 by Hill. It is a multi-dimensional model based on characteristic traits determined by a 224-item interest inventory. The responses are supposed to generate a picture or "map" of the way a person receives and processes various stimuli. This cognitive style map process has been studied by several researchers, notably the Dunns (Keefe, 1979, p. 16).

Developmental mathematics courses are concerned with conveying a specific quantity of subject matter in the most efficient and economical manner possible. In view of the claims made by Hill and his associates concerning the potential of the cognitive mapping process coupled with an individualized instructional format (Reece, 1976), the environment of developmental studies was chosen as an area for further investigation and application of the Hill inventory.

Purpose of the Study

The purpose of this study is twofold. One purpose is to determine whether the achievement of mathematical skills of college students taught for one quarter by instructional modes matching their cognitive style differs from the achievement of students taught by modes contrasting with their cognitive styles. The other purpose is to determine if the attitudes toward mathematics of these students differ or are affected by this matching and mismatching of cognitive style and instructional mode.

Procedures of the Study

Subjects for this study were selected from students enrolled in the Basic Mathematics course, DVS 0710, at Roane State Community College in Harriman, Tennessee, during the Fall Quarter, 1979.

Instruments used in the study were: (1) a pretest and posttest on basic mathematics skills (SK/1) developed by the Mathematical Association of America (1978), (2) the Hill Cognitive Mapping Inventory (Hill, 1976), and (3) the Aiken Attitude Scale (Shaw and Wright, 1967, p. 242).

At the first class meeting the mathematics skills test and the Aiken attitude survey were given. Some subjects, who had participated in Roane State's orientation and preregistration sessions, had taken the test previously and were excused from the skills testing at this session. During the second class meeting, each subject completed the 224-item Hill questionnaire. Classification of each subject as either visual or auditory was based on responses to the Hill inventory.

Subjects were randomly assigned to one of two treatments, each of which was designed to conform to one of Hill's primary cognitive styles. At the conclusion of the study, 44 subjects had experienced treatments which matched their cognitive style, and 30 subjects had experienced treatments which contrasted with their cognitive style.

Each of the two treatments, termed auditory and visual, consisted of five programmed basic mathematics modules published by Educulture, Inc., and were identical except for the means used to disseminate the information. Each subject worked alone.

In the auditory treatment, an audio tape produced by Educulture for use with the modules was utilized. This tape contained detailed instructions designed to carry the subject through the modules step-by-step. A study table equipped with a cassette tape player and headphones was available to each subject. A subject could stop a tape at any time, rewind it, and play back any part as often as desired. From time to time, the voice on the tape would instruct the subject to stop the tape, work in the programmed module, and then restart the tape to receive correct answers. After checking results, the subject either reviewed or proceeded to new material as indicated by his performance on the problem set. Each subject progressed at his own pace and could take the module test at any time.

In the visual treatment, a verbatim type-written transcript of the tape was used instead of the tape. Each time the module instructed the subject to turn on the tape, the visual treatment subject was instructed to resume reading the transcript.

Progression to each succeeding module for all subjects followed the passing of a module test. If the subject failed on the first try, additional auditory or visual review materials were made available. The basic skills and Aiken attitude posttests were administered upon successful completion of the fifth module or at the last class meeting of the quarter, whichever came first.

Importance of the Study

At Roane State, as at most other schools offering developmental courses, concern for the student is coupled with a need to accomplish results in the most efficient manner possible. If learning is improved by matching a student's cognitive style to a particular style of instruction, the goals of the developmental studies program may be more efficiently achieved. In addition, this more efficient utilization of student time and effort may more effectively promote positive attitudes toward mathematics.

If, indeed, these procedures result in an improvement of the developmental mathematics instructional program, they can be adapted relatively easily to any school, as the materials and equipment are not out of the ordinary for any developmental mathematics laboratory.

Basic Assumptions and Limitations

Assumptions for this study include: (1) the subjects' responses to the instruments were honest and accurate, (2) the instruments provide valid measures of student skills, attitudes, and cognitive style,

(3) the daily interaction between individual subjects and different classroom instructors did not alter the differential effect between the treatments as measured by group scores.

This study was limited to those students who enrolled in and completed the basic skills program of a developmental mathematics course. All conclusions should be made in this context.

Definitions

COGNITIVE STYLE: For the purposes of this study, cognitive style is denoted as either visual or auditory using the Hill inventory. Major classifications of cognitive style according to the Hill inventory are: (1) Auditory Linguistic T(AL) — prefers to acquire meaning through hearing spoken words, (2) Auditory Quantitative T(AQ) — prefers to find meaning in terms of spoken numerical symbols, relationships, and measurements, (3) Visual Linguistic T(VL) — prefers to find meaning from words that are seen, (4) Visual Quantitative T(VQ) — prefers to acquire meaning in terms of numerical symbols, relationships, and measurements that are written (Hill, 1976).

The Hill inventory is made up of eight pages of 28 statements each. The three possible responses of "usually, sometimes, and rarely" are assigned values of 5, 3, and 1 points respectively. The first four questions of each page deal directly with one of the four above-mentioned categories in the order listed. After the subject has responded to all the items, scores are obtained by totaling the points associated with each response. Subjects in this study were classified

as visual if they scored 27 or above on the T(VQ) and/or T(VL) portions of the Hill inventory. They were classified as auditory when scoring 27 or above on the T(AQ) and/or T(AL) portions. If the subject scored 27 or above on both visual and auditory categories, the highest score determined the group in which he was placed.

ATTITUDE TOWARD MATHEMATICS: The Aiken attitude scale contains twenty items, ten of which are negatively worded and ten positively worded. The scoring weights for the negatively-worded items range from 4 (strongly disagree) to 0 (strongly agree), and for positively-worded, the range is from 0 (strongly disagree) to 4 (strongly agree). The sum of the values of the responses was used as the score for each subject. This score was taken as indicative of each subject's attitude toward mathematics.

Organization of the Study

Chapter I includes a general overview of the study, the purpose of the study, an outline of the procedures of the study, importance of the study, assumptions and limitations of the study, and definitions pertinent to the study.

Chapter II consists of a review of literature related to the topic of cognitive styles, with prominent models being reviewed. The literature relating to the work of Hill and his cognitive mapping process is summarized, and the topic of attitude toward mathematics and the accompanying literature is investigated and discussed.

Chapter III gives the procedures and design of the study. The population and sample are described, the instruments used are discussed, and the notation, hypothesis, and statistical techniques are presented.

Chapter IV contains the data obtained and the data analysis for the study.

Chapter V summarizes the study and findings. Suggestions for further research are made.

CHAPTER II

A REVIEW OF RELATED LITERATURE

Introduction

While the term "cognitive style" has become rather widespread in educational literature, a closer look will reveal varying uses of this term. However, the general definition given by Messick seems to embrace all aspects. He refers to cognitive style as "information processing habits that represent the learner's typical mode of perceiving, thinking, problem solving, and recalling" (Keefe, 1979, p. 8).

The notion that an individual brings a unique conceptual framework to the learning experience has caught the interest of several researchers. These persons have attempted to devise their own methods of discovering, analyzing, and describing broad categories of various facets of cognitive style. Perception, age, sex, personality, intelligence, and creativity are a few of the variables that have been investigated in conjunction with cognitive style. To illustrate the diversity of these varying attempts to categorize cognitive styles, the most widely recognized models will be briefly described and any implications for mathematics instruction will be noted. The development and theoretical foundations of the cognitive mapping process will be detailed as well as pertinent research findings. Research concerning the topic of attitudes toward mathematics will be reviewed, and relevant findings will be presented at the conclusion of the chapter.

Field Independence-Field Dependence

Witkin's model of cognitive style is composed of two main categories — field independence and field dependence. Both are defined in terms of scores obtained on perceptual tasks which require the subject to differentiate either an object or himself from a surrounding field. The most commonly used tests are:

1. The Rod and Frame Test. The subject is required to align a luminous rod in a true vertical direction. The rod is set within a luminous tilted frame and the subject is either tilted in the same direction as the frame or the opposite direction.
2. The Tilting-Room-Tilting-Chair Test. This test requires the subject to adjust either his chair or the surrounding room to the true vertical while the other remains tilted.
3. The Embedded-Figures Test. This test requires the subject to find a particular simple figure within a larger complex figure.

Because of the ease of administration, the Embedded-Figures Test and the Rod and Frame Test are employed most often (Spitler, 1970, p. 16).

The field-independent person is more able than the field-dependent person to perform alignments with the true vertical and to correctly identify the simple figure within the complex design.

Other terms in the literature which describe these categories are analytic and global. Witkin (1962, p. 57-58) states,

an analytic, in contrast to a global, way of perceiving entails a tendency to experience items as discrete from their backgrounds, and reflects ability to overcome the

influence of an embedded context. People differ in the extent to which their perception is analytic. This dimension of individual differences has been called field-dependence-independence. A tendency toward an analytical or global way of perceiving characterizes a person's perception in a wide variety of situations, making for marked individual self-consistency.

Studies have been conducted in an effort to pinpoint connections between field independence/dependence and other characteristics. The following points summarize some of the findings:

1. Generally females tend to be more field dependent than males (Witkin, 1962).

2. Children tend to be relatively field dependent early in perceptual development and become more field independent as they grow older (Witkin, 1962).

3. Field independence appears to be significantly related to mathematical aptitude for both sexes (Bieri, 1956).

From her extensive review of the literature pertaining to this topic, Spitler (1970) draws the following general conclusions:

1. Field independent men and women do better on measures of quantitative intelligence than their field dependent counterparts.

2. The inductive and deductive thinking involved in concept formation appears to relate to field independence.

3. Creativity and ability to shift sets either spontaneously or rapidly were found to be weighted toward field independence for both men and women.

4. Field independent men are more able to overcome a problem solving set and cognitive interference than field dependent men.

5. Field independent women do better than field dependent women on simple recognition and recall memory tests.

What, then, are the implications for mathematics education?

Spitler proposes that the field-independent subject should progress better in mathematics for two major reasons: perception to detail in complex stimuli and ability to deal in patterned stimuli in an analytic fashion. Both are more characteristic of the field independent learner than the field dependent and both are of major importance in the learning of mathematics. Spitler (1970, p. 66) concludes by stating:

In summary, the learning of mathematics would seem to make frequent demands for field independence. This fact is substantiated by the number of studies linking mathematical aptitude and achievement with field independence. It seems to this writer that both training for field independence and the use of alternative learning materials are valid recommendations of change. Thus, curriculum designers may well consider developing field independent versus field dependent courses. Modification of methodology should be researched so that more specific recommendations based on careful studies can be made.

Conceptual Tempo

At the Fels Institute, Kagan and his colleagues were concerned with analytic styles of thinking and problem solving, and this research led to the identification of a "reflective-impulsive" dimension. The reflective person is inclined to analyze and thoroughly differentiate a complex concept; an impulsive person tends to make quick and often erroneous responses (Keefe, 1979, p. 5).

Commenting on these two poles of conceptual tempo, Kagan (1965, p. 134) has stated:

The reflective-impulsive dimension describes the subject's consistent tendency to display slow or fast response times in problem situations with high response uncertainty. The results are persuasive in suggesting that a tendency for reflection increases with age, is stable over periods as long as 20 months, and manifests pervasive generality across varied task situations.

The Matching Familiar Figures Test (MFF) is the principal test of reflective-impulsive conceptual tempo (Kagan, 1965). The subject is shown a picture (the standard) and six similar stimuli, only one of which is identical to the standard, and told to match the correct one to the standard. The number of errors and the average response time for the first response are used as scores. A subject is rated reflective if both scores reach the appropriate level — small number of errors and longer response time.

Spitler (1970, p. 114) summarizes that reflective subjects evidence greater recall, greater memorization ability, greater susceptibility to threatening conditions, and greater reasoning ability than impulsive subjects.

Cathcart and Liedtke (1969) reason that many reflective students may be at a disadvantage in traditional classrooms. Because arriving at the answers quickly is often emphasized (by using timed tests and emphasis on computational skills in lower grades), many teachers can confuse the natural hesitancy of the reflective student as a lack of ability. On the other hand, the "be careful, take your time"

instructions that accompany most word problems may conflict with the cognitive style of the impulsive student.

In her summary, Spitler (1970, p. 124) states:

The current emphasis upon the logical structure of mathematics and the interest on the discovery method place heavy demands for reflection upon the learner. . . . The preliminary findings do indicate that it may be possible to alter conceptual tempo toward increased reflectivity. . . . It may well be that particularly impulsive students are better equipped to follow a more traditional methodology which emphasizes quick response and accuracy rather than understanding.

Additional Models

A. Conceptual versus Perceptual-Motor Dominance and

Automatization: Work done by Broverman (1960) led him to construct two models of cognitive style. The first, conceptual versus perceptual deals with the capability to perform novel or difficult tasks.

Broverman (1960, p. 170) states:

Perceptual-motor tasks are those which require a coordination of sensory stimuli with motor responses, e.g., pressing a lever when a light flashes.

Conceptual tasks, on the other hand, are those which require coordination of previously learned internal schemata with sensory stimuli, other previously learned internal schemata, or motor responses for successful task performance, e.g., solving an arithmetic problem by manipulating the given data in accordance with previously learned rules of arithmetic.

The second model is strong versus weak automatization — the capacity to perform simple repetitive tasks by concentrating on the obvious properties of the task (Keefe, 1979, p. 9).

Using an extensive battery of tests — Stroop Word-Color Test, Primary Mental Abilities Reasoning, Verbal Meaning, Word Fluency and Space Subtests, Wechsler Blocks, Porter's Maze, Goodenough Draw-A-Man, Witkin-Gottschaldt Embedded Figures Test, Thurstone-Gottschaldt Figures, and some tests of his own design — Broverman categorized subjects as perceptual or conceptual motor dominant and as a strong or weak automatizer (Broverman, 1968).

Some tentative conclusions, needing further research for confirmation, that pertain to mathematics education include:

1. A strong automatizer would do well on problem sets of relatively simple problems with the same method used to solve each problem and less well on a set of diverse problems requiring different types of mathematical reasoning. A weak automatizer would do the opposite.
2. Extreme and pronounced perceptual or conceptual motor dominance would limit a student's performance in mathematics as satisfactory mathematics performance tends to need both dimensions (Spitler, 1970, p. 134).

B. Hemispheric Specialization: By observing persons who had suffered brain injury to one hemisphere, Luria (1966) noted functional differences in the left and right hemispheres. Bogen and Bogen (1969) presented summaries of lesion studies which pointed out that right hemispheric lesions resulted in loss of spatial ability whereas left hemispheric lesions resulted in loss of speech and hearing ability.

Using subjects whose two cerebral hemispheres had been surgically disconnected, Sperry (1964) was able to show that the right hemisphere could perform spatial tasks (with virtually no language capability) while the left hemisphere controlled speech, calculation, and reasoning but could not perform simple spatial tasks.

From existing evidence, Wheatly, Frankland, Mitchell, and Kraft (1978) summarized that the left hemisphere (for right-handed persons) treats stimuli serially, one at a time, making it superior at such tasks as reading, speaking, analytical reasoning, and arithmetic while the right hemisphere processes stimuli as a unit, being better at spatial tasks, recognizing faces and music. They reported that electroencephalography (EEG) seems a useful tool in determining the relative activity of the two hemispheres during certain tasks as well as giving a time-frame for the introduction of certain information and for classifying a subject as primarily a right- or left-brain thinker.

Gazzaniga (1974) assumed that a child is essentially split-brained until about the age of 8, when the specialization process begins. From this point on, cerebral lateralization is a continuous process whereby the shift from right to left hemispheres occur, with the shift being more pronounced for some persons than for others.

That some students' poor performance in problem solving and higher ordered thinking may result, in part, from an emphasis on left hemisphere tasks is theorized by Wheatly et al. (1978, p. 27, 28):

Early and continued emphasis on rules and algorithms may inhibit development of creativity, problem solving and spatial ability. Programs that provide significant oppor-

tunities for exploration, nonverbal expression, laboratory activities, and multisensory learning may enable students to reach new levels of mathematics performance. . . . If a student relies more on right-hemispheric processing, he may be more successful in a curriculum stressing spatial presentations and multisensory learning. It may also be productive to match the mode of presentation with the student's mode of learning.

C. Gregorc's Model (1977) uses two dimensions for perception, called concrete and abstract, crossed with two dimensions of processing, called random and sequential, giving four styles or patterns of learning:

1. Concrete Sequential learners are characterized by the tendency to derive information through direct hands-on experience. They look for and follow orders, appreciate logical ordered presentations and a quiet atmosphere.

2. Concrete Random learners have an experimental attitude and learn by trial and error. Making intuitive leaps in problem solving, they work well alone or in small groups and do not respond well to teacher intervention.

3. Abstract Sequential learners have excellent decoding abilities with written, verbal, and image symbols. They prefer a rational presentation, learn well from authorities, and like vicarious experiences.

4. Abstract Random learners are attuned to nuances of atmosphere and mood and are attentive to human behavior. Associating the medium with the message, they evaluate a learning experience as a whole. They

prefer to receive information in an unstructured manner, free from rules and guidelines, and to organize material through reflection.

While all persons exhibit all four patterns to some degree, Gregorc believes most show a definite "tilt" or preference toward one pattern. Gregorc recommends the matching of the style of the teacher with the style of the pupil whenever possible, in order to avoid stressful and frustrating experiences, but admits that this is not always practical (or even desirable). He believes short periods of mismatch may even give the student new and varied experiences and avoid the comfortable rut and boredom that can result from long periods of matching style to style (Gregorc, 1979).

D. McCarthy (1981) has created a teaching model called the 4 Mat System that combines the learning styles of Gregorc with right/left brain processing. However conclusions concerning its effectiveness cannot be drawn from the scant data now available.

E. Cognitive Controls according to Gardner (1959, p. 245) are developmentally stabilized structures or organizing principles which are relatively invariant over a class of situations and intentions and which guide behavior toward a goal. Six principles have been defined by Gardner: leveling-sharpening, tolerance for unrealistic experiences, scanning, field articulation, constricted-flexible, and conceptual differentiation. However only the first two seem to have any connection with mathematics learning.

Sharpeners differ from levelers in the degree of articulation of recall. When a sequence of similar stimuli is experienced, each new stimulus affects the memory of the preceding stimuli. Sharpeners are less susceptible to this influence while levelers are more susceptible. Thus sharpeners exhibit more precise recall of previous stimuli.

Spitler (1970) believes that the demands for the precise recall of definitions, notation, axioms, and theorems of mathematics places the leveler at a disadvantage in a logical, rigorous mathematics program.

The test most often used to differentiate sharpeners and levelers is the Schematizing Test of Hollingsworth (Spitler, 1970, p. 69).

The other principle, tolerance for unrealistic experiences, as defined by Gardner and Moriarty (1960, p. 107), involves the subject's tolerance for instability as well as individual differences in willingness to experience or produce organization of stimuli which are at variance with what the subject "knows" to be true in the conventional sense. One of the various measures of this control involves the readiness of the subject to perceive apparent motion, in spite of knowledge that there is no motion, in a sequence of images projected by a tachistoscope. Another test uses aniseikonic lenses which distort shape and size but not the focus of the image.

Spitler advances the theory that several areas of mathematics call upon the student to exercise this tolerance for unrealistic experiences. She mentions the idea of indirect proof and word problems that do not reflect reality as examples.

Hill's Model of Cognitive Mapping

Hill's theory of cognitive style (1970) is somewhat different from the psychological positions previously discussed. These sought to examine cognitive style by studying performances in a few specific situations and correlating them with other behaviors. Hill developed a concept of cognitive style by first examining the entire educational field in an effort to design a conceptual framework and language for education. He devised a diagnostic tool purporting to determine a profile of the student as a thinker, learner, and performer.

According to Hill, there are seven aspects or strata of education involving the interconnections of persons, processes, and properties. Hill referred to these strata as Educational Sciences. They are: (1) Symbols and Their Meanings, (2) Cultural Determinants, (3) Modalities of Inference, (4) Educational Memory, (5) Educational Styles of Individuals, (6) Teaching, Administrative, and Counseling Styles, and (7) Systemic Analysis Decision Making.

The responses a person makes to a formalized set of 224 self-descriptive statements are supposed to present a quick, graphic view of the person's "learning terrain." This profile of the person is referred to as his "Cognitive Map," and the questionnaire is called the "Inventory." The student is assigned to various descriptive categories by the means of the Inventory. These descriptive categories are expressed in the form of the Cartesian product of three sets — the first three of the so-called Educational Sciences: Symbolic Mediation,

Cultural Determinants, and Modalities of Inference. Hence these three strata will be discussed more fully than the other four, which in themselves are not pertinent to the present study.

The first set, Symbols and Their Meanings, indicates a student's tendency and ability to understand words, numbers, sensory symbols, programmatic symbols, and codes. Since mathematics is a unique symbolic language, this set is quite relevant to mathematics.

Hill (1970, p. 26) has defined two major categories of symbols, each with subcategories:

(1) The theoretical symbol is that symbol which presents to the awareness of the individual something different from that which the symbol itself is.

(2) The qualitative symbol is that symbol which presents and then represents to the awareness of the individual that which the symbol itself is to that individual.

For example, most of the time, a theoretical symbol has a commonly agreed upon connotation while a qualitative symbol is personal and subjective. Hence the word "flower" is theoretical because the word is not in reality a flower, while the color "red" of the flower is qualitative. Furthermore, theoretical symbols are of two types — visual and auditory — with each of these being further divided into linguistic and quantitative. Table 2.1 should serve to clarify this issue.

These categories in Table 2.1 are most important to this study. The scores on these categories pertaining to this portion of the Hill Inventory serve as the basis for grouping of the subjects. [When using the Hill Inventory, if a subject scores 27 or above on these topics (or any of the following), he is said to possess a Major orientation and the

TABLE 2.1
TYPES OF THEORETICAL SYMBOLS

Category	Class of Examples	Specific Example
Visual Linguistic – T(VL)	Written Words	fraction
Visual Quantitative – T(VQ)	Written Numbers	one half or 1/2
Auditory Linguistic – T(AL)	Spoken Words	the actual sound uttered as in "frak'-shun"
Auditory Quantitative – T(AQ)	Spoken Numbers	the actual sound uttered as in "wun-haf"

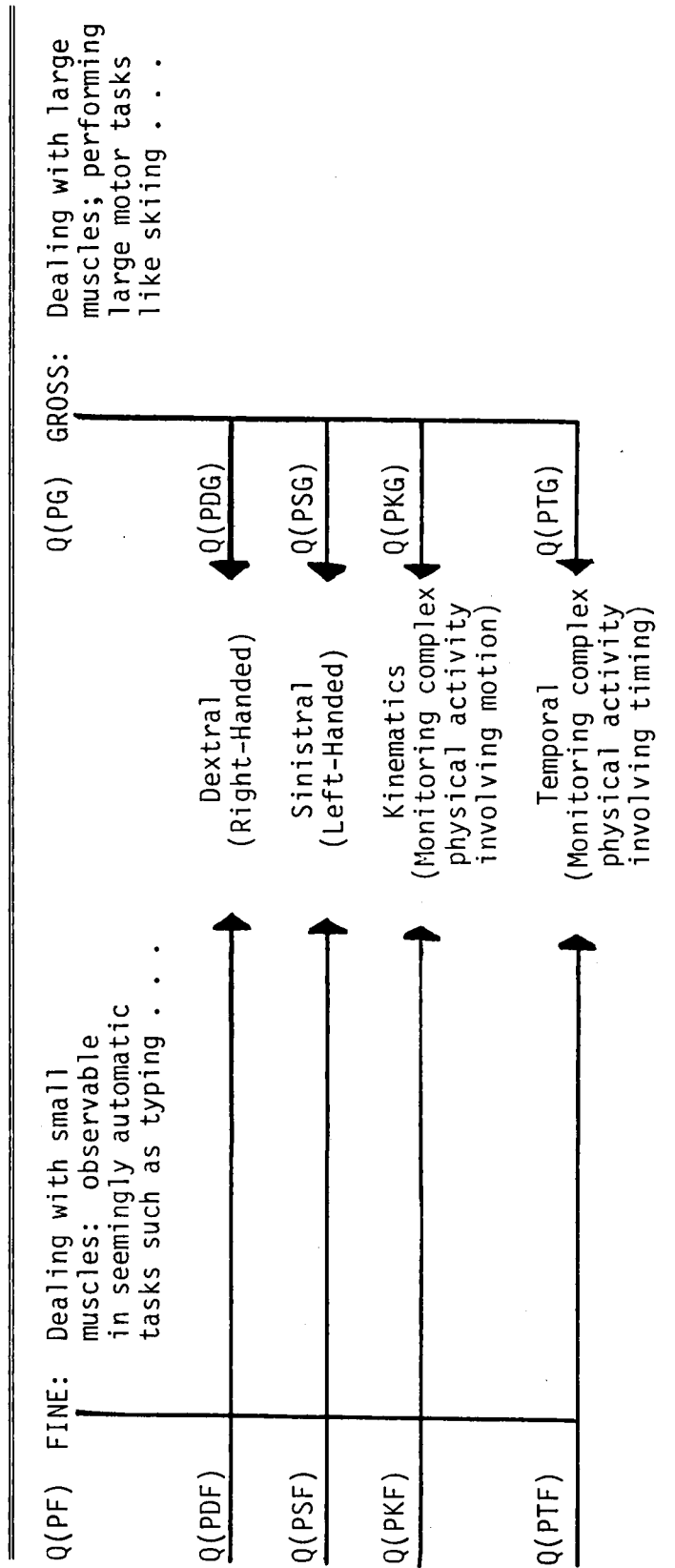
symbol T(VL), etc., is used in describing the subject's profile or map. If the subject scores between 16-26 on any item of the inventory, he is said to have a minor orientation and the symbol T'(VL), T'(AQ), etc., is used. A score less than 16 is referred to as negligible and no mention is made of it in a person's profile or map.]

The qualitative symbols not utilized in this study include the five symbols associated with the senses: Q(A) auditory – ability to distinguish tones and other sonic sensations; Q(O) olfactory; Q(S) savory; Q(T) tactile; Q(V) visual – ability to perceive variation of form, color, hues, etc., and ten symbols that are programmatic in nature and are called proprioceptive. Proprioception is defined as the ability to utilize symbols in combination with motor skills, and Table 2.2 summarizes these categories.

The remaining ten qualitative symbols are associated with cultural symbols and are summarized in Table 2.3.

TABLE 2.2

CATEGORIES OF QUALITATIVE PROPRIOCEPTIVE SYMBOLS



Source: Hill, 1970.

TABLE 2.3
QUALITATIVE CULTURAL SYMBOLS

Q(CEM)	— EMPATHIC—Sensitivity to others
Q(CES)	— ESTHETIC—Capacity to enjoy beauty
Q(CET)	— ETHIC—Commitment to a set of values
Q(CH)	— HISTORIONIC—Knowing how to fulfill role expectations
Q(CP)	— PROXIMICS—Capacity to judge correct social or physical distance between persons
Q(CS)	— SYNNOETICS—Knowing oneself
Q(CT)	— TRANSACTIONAL—Positive communication interaction between persons
Q(CTM)	— TEMPORAL—Capacity to behave according to imposed time expectations
Q(CKH)	— KINESTHETIC—Ability to perform motor skills according to acceptable form

Source: Hill, 1971, p. 3.

The second set of criteria is called Cultural Determinants. According to Hill (1970, p. 5), the meaning of symbols can be interpreted in the light of three cultural influences — I-Individuality, A-Associates, and F-Family. The Individuality aspect is evidenced by a person's need to quote definitions or explain situations in his own words, and he frequently prefers to work alone. The Associates' influence is reflected by the person explaining or discussing matters in terms of the input of peers or friends, and such a person probably does better in group situations. The Family determinant shows itself in the person's using family examples to explain things or consulting members of his family before making decisions. Such a person usually performs better when an authority figure is present in the learning situation (Reece, 1976).

The third set in the Cartesian product of cognitive style indicates the form of inference one tends to use. Called Modalities of Inference, these styles are:

1. M-Magnitude — using norms or classifications as the basis for decisions. Such reasoning needs a definition of terms before understanding develops.
 2. D-Difference — a tendency to reason in terms of a one-to-one contrasts.
 3. R-Relationship — the ability to synthesize dimensions or incidents into unified meaning, or through analysis of a situation discover its component parts.
 4. L-Appraisal — using all three of the above to analyze, or question, toward the process of drawing a probability conclusion.
 5. K-Deductive — using logical proofs or syllogistic reasoning.
- (Hill, 1970, p. 6).

The remaining four strata or "Educational Sciences" will be only briefly described as they play no part in this project.

Educational memory is concerned with long and short-term memory functions. Using findings from biochemistry, selected biochemical and electrophysiological measurements provide information concerning memory activity as it interacts with the Piagetian conditions of assimilation, accommodation, attendance, and repression in conjunction with remembering persons, processes, and properties. Further research in this area might include using chemical injections to increase attention span or affect the memory function (Hill, 1970, p. 7).

Educational style is defined by Hill as a Cartesian product of the first four sets. Instruments for collecting information relative to this last stratum are under construction (Hill, 1971).

Teaching, Administrative and Counseling Styles are represented by a Cartesian product of three sets of information pertaining to demeanor, emphasis, and communication aspects of a person in one of these positions. A person may be process oriented or person oriented and this orientation may determine how he interacts with others. Dominant/permissive, situational, cooperative, and custodial are subcategories describing styles of people in this area.

Regarding the final stratum, Hill (1970, p. 8) states,

the Systemic Analysis Decision-Making Stratum concerns itself with using the elements, and their interconnections, of any system to find a choice of options available to the decision maker and then deriving the optimal or best decision for all elements concerned in the system. This stratum is especially useful in management and administrative areas.

An extension of cognitive style mapping led to an effort by Rita Dunn, Kenneth Dunn, and Gary Price to devise a new questionnaire that would tell more about the respondent than the Hill Inventory. The result has been named the Learning Style Inventory (LSI), and studies are now being conducted using this instrument (Cavanaugh, 1981).

This Learning Style Inventory is based on research data that has yielded 18 categories which suggest that learners are affected by their:

1. Immediate environment (sound, temperature, light, and design);
2. Emotional state (motivation, responsibility, persistence, and structure);

3. Sociological needs (self, pairs, peers, teams, adult, and/or varied); and
4. Physical needs (perceptual strengths and/or weaknesses, intake of food and fluids, and mobility).

For instruction to be effective, the Dunns claim that all of these areas must be considered (Dunn and Dunn, 1975).

From responses to the LSI questionnaire, individual teaching prescriptions are developed for each student. The method of prescribing is described fully in The Learning Style Manual written by Price (1979). Optimum benefit can only be achieved by adhering strictly to this manual.

Criticisms have been leveled toward the uses of a differentiated learning environment (Davidman, 1981), but the Dunns and Price are quick to defend their strategies, citing studies supporting their claims (Dunn, Dunn, and Price, 1981).

Research on the Hill Method

Applications of Hill's Inventory and efforts to research the cognitive mapping process are numerous and fairly widespread. Some schools have chosen to structure their curriculum and instructional strategies around the use of the Hill Inventory. Examples are Oakland Community College in Michigan, Spartanburg State Technical Community College in South Carolina, Mountain View Community College in Texas, and Polk Community College in Florida. Wayne State University in Michigan has served as a center for experimenting with the use of the Hill

Inventory in various instructional settings. Numerous doctoral dissertations that incorporate some aspect of cognitive mapping have been written. However, most of the research centers on various facets of one of the following four questions, and the ensuing discussion will focus on research findings pertinent to them and in the same order as they are presented. These questions are:

1. What are the effects when a student's cognitive style and that of his teacher are similar?
2. Can a student's cognitive style be matched by certain teaching methods?
3. Are there cognitive style elements that predispose a person to high achievement in particular content areas?
4. Does a unique collective cognitive style exist for students who learn well from a specific instructional strategy?

Ort (1971) found no significance between the degree to which successful and unsuccessful students shared "like" cognitive styles with that of the instructor in a first year high school French course. However, using cognitive mapping to match social science students with various instructional media, Frever (1975) concluded that cognitive mapping was more successful for prescribing treatments than any other pretest used. Seventy-two percent of the mapped students, as opposed to 52 percent of the unmapped students, received a grade of C or better, with the number of A grades more than double for the former group than for the latter.

Wasser (1969) found that when the cognitive style of the student closely matched that of the teacher, the likelihood of higher grades increased. In particular, teachers of spelling, health, reading, mathematics, science, language, and social studies tended to accord higher grades to students whose cognitive styles most resembled their own. Shroeder (1969) and Blanz (1970) reached similar conclusions.

In addition, Wasser and Shroeder concluded that those students whose styles matched the teacher evaluated the teacher as more effective than did those students with disjunct styles. That similarity of cognitive styles is significant to the faculty evaluation process was further corroborated by DeLoach (1969) who concluded that similarity in cognitive styles between school administrators and instructors led to higher ratings of the instructors by the administrators than those teachers with styles dissimilar to the administrators.

McAdam (1971) found that persons having an educational cognitive style match with the instructor viewed their learning experience with a more positive attitude than those students with styles dissimilar to the teacher. Using two groups of students and instructors whose styles matched and two mismatched groups, Lange (1972) concurred with McAdam and also showed that there was a significantly smaller failure-withdrawal rate for the matched groups than for the nonmatched groups. Berke (1976) found that a mathematics program incorporating cognitive mapping was more successful than a similarly designed reading program and that cognitive mapping was seen as a positive factor in the course completion rate.

In investigating the third question, Shuert (1970) found the following elements of cognitive style to be unique to a group of successful mathematics students:

1. Major Theoretical Visual Quantitative — T(VQ)
2. Major Theoretical Auditory Quantitative — T(AQ)
3. Minor Auditory Linguistic — T'(AL)
4. Minor Associate Determinant — A'
5. Appraisal Inference — L
6. Deductive Inference — K

Investigating the relationship of cognitive style to success in a college statistics course, Ribley (1977) concluded the following:

1. There exist separate, distinct, collective educational cognitive styles for both successful and unsuccessful students which yield profiles to differentiate between these groups.
2. T(VL), T(VQ), T(AQ), and K and A modality of inference appear to be useful in predicting potential achievement. These were stronger for the successful than for the unsuccessful students.

With a group of students involved in a computer programming course, Beleutz (1976) found that the cultural determinants played no part in the success or nonsuccess of the student. However the items of T(AQ), Q(CEM), Q(CET), Q(CP), Q(CS), and K were notable for being present in the most successful students while at the same time not appearing as characteristics of the least successful.

In his analysis of the relationship of cognitive style elements to certain factors associated with students enrolled in an elementary algebra course, Grasser (1973) concluded the following:

1. Educational Cognitive Style elements tend to be positively correlated with measures of aptitude rather than achievement.
2. Standardized achievement test scores more closely related to cognitive measures than course averages.
3. Characteristics of students making grades of A, B, or C were more closely related to theoretical measures of cognitive style, while traits of nonsuccessful students tended to relate to particular elements of qualitative and cultural determinants.

Fragale (1969) found that of a group of community college students enrolled in industrial technology courses, the high achievers exhibited majors in T(VL), T(AL), Q(V), Q(CEM), Q(CS), A, L, D, and M, while DeNike (1973) concluded that students excelling in the use of simulation games had majors in T(AL), Q(A), Q(CEM), and A.

Hoogasian (1970) claimed that it is possible to isolate collective style profiles and relate them to various grades in a first year college English course, and the study of Dehnke (1966) indicated a common style pattern among successful English teachers (Theoretical Linguistic and Inference-Appraisal oriented). Wright (1976), when studying students majoring in science, mathematics, and engineering, even theorized from the results of his study that cognitive preferences may influence the students' choice of major and that these preferences become more congruent to the field of study the longer they stay in the particular

major. Cotter (1970) discerned a trend for students with a major Individuality determinant to choose a curriculum stressing fundamental disciplines (liberal arts and sciences) as opposed to applied areas. Finally, Zussman (1968) discovered certain cognitive style elements to be common to persons choosing to work in the field of educational administration. Of the two groups studied, public school administrators and community college administrators, both displayed theoretical orientations T(VL), T(VQ), T(AL), and T(AQ), shared the same cultural determinant — Individuality, and exhibited the qualitative codes Empathetic and Kinesthetic.

Concerning the fourth major area of inquiry, Hand (1972) attempted to use cognitive mapping as a means of matching certain student characteristics to an instructional strategy and setting. Fifty-six community college students enrolled in a developmental science course were divided into three groups according to the degree of match between the mode of understanding required by a programmed instruction package and the setting in which the package was implemented. He found no significant difference between mean gain scores on skills tests among the highest, middle-range, or lowest degrees of match with respect to package or setting.

On the other hand, Hauser (1975) in investigating the effects of teaching an environmental education concept using an audio-tutorial method, a printed self-instructional package, and cognitive mapping, made the following observations:

1. Practically all (98 percent) of the subjects in both groups exhibited a major or minor in Visual Linguistic T(VL).
2. All high achievers in both groups had a major Associate determinant.
3. Q(V) was the only other element exhibited by a majority (70 percent) of high achievers in the audio-tutorial program.
4. Cognitive style elements unique to low achievers in the audio-tutorial program were majors in T(VL), Q(CH), and Q(CT).
5. Factors common to high achievers using the printed package were majors Q(CS) and L with minors Q'(O), Q'(CT), and D'.
6. Low achievers in the printed package group exhibited no common elements of style.

Warner (1970) concluded that when a group of community college freshmen was taught a life science course by either the lecture-discussion method or a multimedia approach, T(VL), qualitative code Esthetic and the cultural determinants of Family and Individuality were needed for high achievement in the lecture-discussion group, while Appraisal as a modality of inference was helpful to the students involved in the multimedia approach.

Blanz (1970), using cognitive mapping as input while designing a mathematics curriculum, found when utilizing programmed materials, the set of students who possessed majors T(VL) and I had a greater achievement gain than students who did not possess both or either of these elements.

Strother (1973) found that majors T(AL) and R and minor M' were useful in predicting achievement when the mode of presentation of information was a didactic film. Major T(VL), D, and minor R' appeared to be incompatible with learning from this didactic film.

In summary, application of the cognitive mapping process has been addressed by numerous researchers in efforts to gain useful information for various aspects of the teaching and learning process. Results often have been inconclusive, but the researchers considered this a method that has merit and is deserving of more investigation and use. Results often implied that improved attitudes, grades, and retention rates occur when cognitive styles of student, teacher, and/or mode of instruction are matched; other frequent conclusions indicate that the use of certain student profiles is a tool for predicting success in certain subject or vocational areas using particular teaching methods.

Attitude Toward Mathematics

In examining the literature concerning the role of attitude in mathematics instruction, one cannot fail but be impressed at the volume of work that has been done in this area. However, findings are often inconclusive and even contradictory. Indeed, the word "attitude" has been defined in many different ways because of the different viewpoints researchers have adopted. Mealy (1970, p. 4) seems to summarize well the prevailing ideas when he asserts that attitude is to be considered as an intervening variable, and as a predisposition to respond in a certain way toward the object of the attitude. In interaction with

situational and other dispositional variables, an attitude can guide and direct the behavior of the individual.

Several types of instruments have been employed to assess the degree of and/or gain in attitude due to some particular treatment. Most prominent among them are Thurstone's technique, Likert's method, and Osgood's semantic differential (Kirkpatrick, 1978, p. 41). The Thurstone technique employs a series of statements expressing different degrees of negative and positive attitudes toward something. Each response is given a scale value with the subject's score being either the sum or mean of the scale values of the answers given.

Osgood's semantic differential combines controlled association with scaling as the subject is given a concept to be differentiated and a set of bipolar adjectives scales to use, allowing the subject to indicate both direction and intensity of feeling. Employed extensively in psychological studies, the crux of the method lies in the selection of a meaningful set of polar terms.

Likert's method requires the respondent to indicate whether he strongly agrees, agrees, is undecided, disagrees, or strongly disagrees with statements expressing varied positive and negative attitudes toward something. The individual's score is then the sum of the weights associated with the particular responses.

In reviews of the literature pertaining to the topic of attitude toward mathematics, several researchers and their findings are frequently cited. The study of Poffenberger and Norton (1959) is of interest in that it states important factors affecting the origins of

attitude toward mathematics. Factors relating to the student's attitude toward mathematics include: (1) the father's attitude toward mathematics, (2) the parents' grade expectations in mathematics, (3) the parents' encouragement in mathematics, (4) siblings' attitudes toward mathematics, (5) difficulty with elementary arithmetic, (6) grades in fractions and decimals, (7) grades in algebra, and (8) the algebra teacher.

The conclusions of Poffenberger and Norton seem to conform to the generally recognized idea that adults' attitudes toward mathematics can be traced to childhood (Morrisett and Vinsonhaler, 1965, p. 132). The late elementary and early junior high school grades are viewed as being particularly important to the development of attitudes toward mathematics (Callahan, 1971; Taylor, 1970). There is evidence that very definite attitudes toward arithmetic may be formed as early as the third grade (Fedon, 1958; Stright, 1960). Dutton (1951), Smith (1974), and White (1963) found that college students regarded the intermediate grades (4-6) as most influential. McDermott (1961), using case studies of college students, reported that the majority pointed to the elementary grades as the place where they began developing negative attitudes toward mathematics with the remainder stating that they began exemplifying negative attitudes in the secondary level when attempting algebra. Dutton (1968) reported that junior high school seems to be a critical point in the determination of attitudes toward mathematics.

Bleyer (1978) found in her study of college students that 57 percent held significant negative attitudes toward mathematics.

McMillan (1976) in an analysis of 124 dissertation abstracts (including 43 on mathematics) indicated that attitudes toward various subjects among elementary through college age students may be affected more by teacher attitudes and enthusiasm toward the subject, or by student related variables such as previous attitude, parents, and self concept, than by instructional variables. In fact, Phillips (1973) found that the type of teacher attitude experienced by a student for two of the three past years of his instruction, and especially the most-recent-teacher attitude, was significantly related to student attitude toward arithmetic. However, Aiken and Dreger (1961) reported that students who do not do well in mathematics may develop negative attitudes, despite having conscientious and enthusiastic teachers.

Aiken (1963) in a study on positive attitude and factors related with mathematics, found that attitude toward this subject is the result of personality variables that are highly demonstrative of interest and adjustment, that high (positive attitude) scorers in math-attitude scales were more socially and intellectually mature and self-controlled, and that they put more value on theoretical matters than did low (negative attitude) scorers.

Moore (1971) found that important factors in fifth grade students' attitudes toward mathematics include the personality and self-concept of the student, while Swafford (1970) concluded that in general positive attitudes toward mathematics at the elementary and junior high levels

are significantly related to a number of personality variables indicative of good adjustment. They include a high sense of personal worth, greater sense of responsibility, high social standards, high academic motivation, perseverance, and self-confidence (Aiken, 1976).

While it is a popular and widespread belief that attitude and learning are related, researchers differ on which aspect is influenced by the other. Neale (1969) and to a lesser degree Aiken (1970) propose that learning affects attitudes and that persons bring their attitude in line with behavior, rather than vice versa. However, Aiken (1970) also reports that when attitude scores are used as predictors of achievement in mathematics, a low but positive significant correlation is usually found, and he cites some of the data from Neale (1969). This assertion is further backed up by studies at the elementary level (Moore, 1971), secondary level (Crosswhite, 1972), college undergraduate level (Fenneman, 1974) and graduate level (Webb, 1972). The correlation between attitude and achievement varies not only with grade level (Jacobs, 1974), but is generally somewhat higher for females than for males (Behr, 1973; Aiken, 1961).

In an effort to affect a change of more positive attitudes toward mathematics, differing instructional strategies and devices, including behavioral modification techniques, have been utilized.

In an effort showing some promise, Natkins (1967) experimented on modifying anxiety toward mathematics by a mediated transfer procedure and was followed by Robbins (1973) employing verbal and physical positive reinforcements to obtain positive improvements in attitude

shown toward mathematics. Dil and Gotts (1971) achieved similar positive changes by using positive reinforcement at an individual and group level. Gee (1962) showed that attitudes toward mathematics of prospective teachers were improved by taking a course designed specifically for them.

An individualized approach to instruction in elementary and junior high school sometimes has had a more positive effect on attitudes than a traditional approach (Malcom, 1973), but at other times, no difference has been found (Corbin, 1974; Horvath, 1975). In general, no real differences in attitude change can be claimed using traditional or "modern" mathematics (Joyner, 1974), or the discovery versus expository methods (Struder, 1972). However, certain units or topics in mathematics, such as history of mathematics, seem to have a positive effect on attitudes (McBride, 1974; Rollins, 1977).

Aiken (1976) in a review of educational research relating to attitudes summarizes results by concluding that changes in attitude toward mathematics involve a complex interaction among student and teacher characteristics, course content, method of instruction, instructional materials, and parental and peer support. Other summary conclusions relative to the studies cited in this section seem to indicate that parents, siblings and teachers exert influence on the formation of attitudes, that negative attitudes are frequently formed before high school, that attitude toward mathematics is at least reciprocal with achievement in mathematics, and that alteration of negative attitudes is possible.

CHAPTER III

DESIGN AND PROCEDURES

Overview of This Chapter

This chapter presents the design of the study and the procedures followed in conducting it. Included are descriptions of the population and the sample used in the study. The instruments used to obtain data are described, and details of the methods used to administer the instruments are given. The hypotheses tested in the study are presented. The chapter concludes with a description of the data obtained and the statistical methods used in the analysis of the data.

Introduction

During one quarter of a community college remedial mathematics course, a program that employed two distinct instructional strategies was implemented. One portion of the students enrolled in this course was taught by instructional modes that matched their cognitive styles while the other portion of the group was taught by modes that contrasted with their cognitive styles. The cognitive styles were called visual and auditory and were determined and defined by using the Hill Cognitive Mapping Inventory.

The study attempted to determine whether the achievement of basic arithmetic skills of those students whose cognitive styles and instructional modes were matched would differ from those whose styles

and modes were mismatched. A second goal of the study was to determine whether this matching and mismatching would have any effect on the students' attitudes toward mathematics.

The Population

The course entitled Basic Mathematics and designated Developmental Mathematics 0710 at Roane State Community College is designed to present remedial mathematics on an individualized, self-paced basis. Students do not receive transfer credit for this course, nor does it substitute for any mathematics course that may be required by the college.

The population for the study consisted of students enrolled in Developmental Mathematics 0710 courses on the Harriman, Tennessee, campus of Roane State Community College during the Fall Quarter of 1979.

The decision to enroll in Developmental Mathematics is made by the student when he decides — using high school grades, test results, counselling interviews, or previous experience — that he lacks the prerequisite background for success in the higher-level mathematics courses of the college. Students voluntarily enroll in this course, although many times it is at the urging of counsellors or faculty advisors. Since incoming students are tested for advisement and placement purposes by the college's advisement center, many of those enrolled in the course have been advised to do so because of their performance on an arithmetic skills placement test (SK/1 of the Mathematical Association of America) taken during an orientation and preregistration session at the college.

The Sample

After a student has enrolled in a developmental mathematics course, the staff of the developmental studies department must determine if the student should work toward improving fundamental algebraic skills or first focus on basic arithmetic skills. The results from the mathematics placement test are used in making this decision. Thus in each class there are students who are working on algebraic skills and students who are working on basic arithmetic skills.

Of the students enrolled in Developmental Mathematics 0710 at Roane State during the Fall Quarter of 1979, 126 were assigned to work in a program of basic arithmetic skills. All of these 126 students were invited to participate as subjects in the study, and the 120 who agreed to do so were selected as subjects.

Instruments Used in the Study

A. Hill Cognitive Mapping Inventory: Designed in 1971 by Joseph Hill and his associates at Oakland Community College in Bloomfield Hills, Michigan, the Hill Cognitive Mapping Inventory (see Appendix A) consists of 224 statements that describe various personality, physical, and emotional preferences. The subject responds to each statement by marking a "usually," "sometimes," or "rarely" category as he perceives each statement applying to himself. These responses are supposed to reflect the total pattern of how a person perceives and assimilates incoming stimuli.

The first four questions on each page of the eight-page Hill Inventory pertain specifically to the two categories that were used in this study. These categories, referred to by Hill as Theoretical Symbols, reflect how a person prefers to perceive information, that is, his preferred style of learning. The classifications of visual or auditory that are used to categorize each subject's primary cognitive style result from the subject's responses to these thirty-two questions.

Information concerning the reliability and validity of the Hill Inventory was released in a memorandum (see Appendix B) by Oakland Community College and has been further corroborated by several doctoral dissertations. Ribley (1977) concluded that "the suitability of this data-gathering instrument for community college students has been confirmed by studies conducted by Blanzky, Grasser, Shuert, and others who have worked with post-high-school students in two-year colleges" (p. 94).

The Theoretical Symbols have four subcategories: Visual Linguistic — T(VL), Auditory Linguistic — T(AL), Visual Quantitative — T(VQ), and Auditory Quantitative — T(AQ). They pertain to the tendency of an individual to depend on visual versus auditory perceptions of words and numbers in order to learn. Validity coefficients associated with these four categories were supplied by Oakland Community College and are shown in Table 3.1.

Reliability coefficients were derived by means of the Kuder Richardson formula, based upon the concept of domain sampling. Table 3.2 summarizes the data for the Theoretical Symbols.

TABLE 3.1
VALIDITY COEFFICIENTS

T(VL) Females = .80 Males = .72	T(AL) Females = .75 Males = .70
T(VQ) Females = .72 Males = .73	T(AQ) Females = .66 Males = .61

TABLE 3.2
RELIABILITY COEFFICIENTS

T(VL) Females = .93 Males = .92	T(AL) Females = .89 Males = .87
T(VQ) Females = .92 Males = .93	T(AQ) Females = .85 Males = .82

The memorandum from Oakland Community College further states (p. 2):

The validity and reliability coefficients associated with these elements of cognitive style mapping have been derived from subtests of the Differential Aptitude Tests (Fourth Edition — Form L and M — The Psychological Corporation — 1966), the Nelson-Denny Reading Test, the Carlsen-Brown Listening Test, and the quantitative section of the "Wechsler." Point biserial correlation coefficients for the qualitative symbolic elements; the cultural determinant elements of individuality, associates, and family; and the modalities of inference elements of magnitude, difference, relationship, and appraisal show the range of values in biserial correlation coefficients indicated below:

$$\text{low } r_{\text{bis}} = .54 \quad \text{to} \quad r_{\text{bis}} = .93 .$$

The average biserial coefficient value for all these elements is:

$$r_{\text{bis}} = .783 .$$

The reliability for the inventories that provide results for the mapping of these elements of style is a Kuder Richardson:
 $r = .81$.

B. Aiken Attitude Scale: Developed by Aiken in 1961 and revised in 1963, the Attitude Scale (see Appendix C) has become widely known and used. According to Aiken (1974, p. 4), "it has subsequently been employed with hundreds of elementary, secondary, and college students." The ten negatively worded and ten positively worded comments are responded to by the subject using a "strongly disagree," "disagree," "undecided," "agree," or "strongly agree" format. The scale had a reported test-retest reliability coefficient of .94 (Shaw and Wright, 1967, p. 242), while Aiken (1974) has reported the reliability to be "in the .80s or .90s, depending on the particular group tested" (p. 5).

C. Basic Skills Test: According to the Mathematical Association of America (1980, p. 3):

As a result of a widespread and increasing concern with placement problems in the mathematical community, the Placement Test Program (PTP) was established in 1977 to assist colleges and universities with the development of local placement test programs.

The PTP tests are written by panels of college mathematics teachers who are directly involved in teaching students in the courses served by the PTP tests. Each panel writes a preliminary version of a new test, pretests that version at selected institutions, and prepares a revised version. This version is submitted to the committee (on Placement Examinations — COPE) for final approval and then the test is sent to the MAA for distribution to its subscribers.

For the academic year 1978-1979, five tests were available from PTP:

- SK/1 Basic Skills in Arithmetic
- BA/1 Basic Algebraic Skills
- AA/1 Advanced Algebra
- A/3 Algebra, Basic and Advanced
- T/2 Trigonometry and Elementary Functions

The SK/1 test on basic skills was used at Roane State for advisement purposes and scores from this test were used in this study. Topics covered in this test include: the arithmetic of whole numbers, integers, fractions, and decimals; percents; ratio and proportion; positive integral exponents and square roots; order relations on numbers; areas, perimeters, and volumes; elementary linear equations and formula evaluations; and graph and table interpretations.

Pretesting of items for SK/1 was carried out at an urban two-year college, a suburban two-year college, a large state university, and a regional state university. The pretest population, several hundred students, consisted of three categories of student — arithmetic, basic algebra, and intermediate algebra. Percentage mean scores were 32, 48, and 64 respectively (Kenelly, 1978, p. 2).

Hassett (1981) reported that in 1979 a study was conducted by the American Mathematical Association of Two-Year Colleges (AMATYC) using the SK/1 in conjunction with the developmental studies programs at several colleges. Pretreatment and posttreatment skills scores were obtained from 124 students enrolled in the arithmetic portions of developmental studies programs. The percentage mean score on the pretest was 34.8 and on the posttest was 58.8.

Data that pertained to the use of SK/1 for placement purposes was released by PTP in its Spring, 1981 Newsletter. It showed that for 2893 students at nine institutions, the percentage mean score was 52.8 with a range from 20.8 to 78.0 and a range of standard deviations from 15.6 to 22.0. PTP is continuing to collect information and data on the use of SK/1 and to address more formally the questions concerning reliability and validity, with results to be published in future Newsletter issues. However, as indicated at the present time by reports in the Newsletter, the test appears to measure what it is supposed to measure in a consistent fashion, since subscribers to the PTP program are expressing a high level of satisfaction with this test and the number of institutions using it is on the increase.

Testing Procedures

At Roane State, incoming students are tested for advisement and placement purposes. The basic mathematics skills test (SK/1) of the Mathematical Association of America (see Appendix D) is administered as a part of this program. On the basis of these scores, students are advised to go into the developmental studies courses or the regular college courses. The grades from the SK/1 test were made available for use in the study.

There were some students who had not participated in the advisement program or who were taking developmental mathematics because they had already attempted other mathematics courses and found them too difficult. No scores on the SK/1 test were available for them, so the

battery of testing instruments was administered to them during the first two class meetings in the following manner:

1. At the first class meeting, the project and procedures to be employed were explained to all the students. Students were informed that they were not required to participate in the study, and signed consent forms (Appendix E) were then obtained from all students who choose to participate.

2. Those students who had not taken the SK/1 test were given this test, and a determination was then made concerning whether or not they would work on basic skills and be invited to become part of the study. Students already having mathematics skills scores on file were excused from this testing session. If they had been assigned to basic arithmetic and had agreed to participate in the study, they continued with the procedures outlined in the next step.

3. Working alone at individual carrels, each subject took approximately 25 minutes to respond to the Hill Inventory. The responses of usually, sometimes, and rarely were assigned weights of 5, 3, and 1 points, respectively. The points from the responses made to the 32 statements that pertained to the major categories in this study were totaled, and each subject was classified as visual if he scored 27 or above on the T(VQ) or T(VL) portions or as auditory if he scored 27 or above on the T(AQ) or T(AL) portions. If the subject scored 27 or above on both visual and auditory categories, the highest score determined his classification. Subjects were then randomly assigned to one of the two treatment groups. Determination scores for each subject are furnished in Appendix F.

4. Each subject took approximately ten minutes to respond to the Aiken Attitude Scale.

By the third class meeting, each subject had been assigned his treatment and course of study. Each of the subjects then began to work at his own pace on the assigned modules, moving to the next module upon scoring 80% or above on a module test.

To receive a grade of A in the developmental studies course each subject must complete five modules successfully. If this is not achieved, the student's grade for the quarter is determined by how many modules are successfully completed (four modules completed earn a B, three modules earn a C, etc.) (The syllabus for DVS 0710 is furnished in Appendix G.) The developmental studies course is designed so that most students who apply themselves can make an A. The self-pacing allows some to finish earlier than others, and these will continue on in algebra, but by the end of the quarter, the majority of the students will have completed the five modules of the basic skills course.

Since the completion rates for the basic skills course vary, each subject was given the posttest battery consisting of basic skills test and attitude scale at different times during the quarter. Posttesting occurred as soon as the subject had completed the fifth module or during the last class meeting, whichever came first. Each subject took the posttests in the same amount of time and in the same manner as he had taken the pretests. Of the 74 subjects in this study, eleven had not completed the fifth module at the time of posttesting, but they were not excluded from the study.

Hypothesis

The following abbreviations and definitions are used in this section:

A/A -- The group of subjects having auditory cognitive style and auditory treatment.

A/V -- The group of subjects having auditory cognitive style and visual treatment.

V/V -- The group of subjects having visual cognitive style and visual treatment.

V/A -- The group of subjects having visual cognitive style and auditory treatment.

Achievement gain score -- Posttreatment skills score minus pretreatment skills score.

Attitude gain score -- Posttreatment attitude scale score minus pretreatment attitude score.

The following hypotheses were tested at the .05 level of significance:

A. Pretest Hypotheses:

1. There is no significant difference in mean basic skills scores, as measured by the SK/1 basic mathematical skills pretest, among the four treatment groups, A/A, A/V, V/V, and V/A.

2. There is no significant difference in the mean attitude scores, as measured by the Aiken Attitude Scale, among the four treatment groups, A/A, A/V, V/V, and V/A.

B. Experimental Hypotheses:

1. There is no significant difference in the means of achievement gain scores between the group of subjects whose instructional and cognitive styles are matched and the group of subjects whose instructional and cognitive styles are mismatched.

2. There is no significant difference in the means of attitude gain scores between the group of subjects whose instructional and cognitive styles are matched and the group of subjects whose instructional and cognitive styles are mismatched.

3. There is no significant difference in the means of achievement gain scores between the group of subjects participating in an auditory treatment and the group of subjects participating in a visual treatment.

4. There is no significant difference in the means of attitude gain scores between the group of subjects participating in an auditory treatment and the group of subjects participating in a visual treatment.

5. There is no significant difference in the means of achievement gain scores among the four groups A/A, A/V, V/V, and V/A.

6. There is no significant difference in the means of attitude gain scores among the four groups A/A, A/V, V/V, and V/A.

Description of the Data

A pretreatment and posttreatment attitude score was obtained for each subject by finding the sum of the weights associated with the responses made to the Aiken Attitude Scale. (For negatively worded statements, the scale ranged from 0 for strongly agree to 4 for strongly

disagree; for positively worded statements, the scale ranged from 4 for strongly agree to 0 for strongly disagree.) Gain scores were found by subtracting the pretreatment score from the posttreatment score of each subject.

The percentage of correct responses on the basic skills test provided the pretreatment and posttreatment measures of achievement, and gain scores were computed in the same manner as the gain score for attitude.

Techniques of Analysis of the Data

Using the results of the pretreatment skills test and attitude scores, a one-way analysis of variance for a completely randomized design was utilized to check the pretreatment hypotheses (Bryant, 1960, p. 142).

To test experimental hypotheses one through four, mean gain scores for the groups were subjected to one-tailed *t* tests.

To test experimental hypotheses five and six, a two factor analysis of variance with unequal subgroups — a variation of a randomized block design (Bryant, 1960, p. 155) — was used to check for treatment interaction among the four groups A/A, A/V, V/V, and V/A.

Findings from these tests will be presented in the next chapter.

CHAPTER IV

PRESENTATION AND ANALYSIS OF THE DATA

Introduction

In this chapter the data and the statistical analysis for the testing of the hypotheses are presented. The scores used were obtained during the Fall Quarter of 1979 at Roane State Community College in Harriman, Tennessee, and were collected from a total of 74 subjects. The results of the pretreatment basic skills test and attitude scale and of the posttreatment skills test and attitude scale are summarized in Appendix H.

Pretreatment Analysis

A one-way analysis of variance for a completely randomized design was used to check for equality of means for each treatment group with respect to the basic skills test and the attitude scale. The results are presented in Table 4.1 and Table 4.2.

Since none of the calculated F values was significant at the .05 level, there was no basis to reject the pretest hypotheses results and the following pretest hypotheses were assumed to hold:

1. There is no significant difference in mean basic skills scores, as measured by the SK/1 basic mathematical skills pretest, among the four treatment groups, A/A, A/V, V/V, and V/A.

TABLE 4.1
ANALYSIS OF VARIANCE OF PRETREATMENT SKILLS SCORES

$$\alpha = .05$$

Source of variation	Sum of squares	Degrees of freedom	Mean squares
Groups	466.98	3	155.66
Within	12477.52	71	175.74
Total	12944.5		

$$F_{(3,71)} = \frac{155.66}{175.74} = .885$$

With a table value of 2.74 for F with 3 and 71 degrees of freedom, the calculated F-value is nonsignificant.

TABLE 4.2
ANALYSIS OF VARIANCE OF PRETREATMENT ATTITUDE SCORES

$$\alpha = .05$$

Source of variation	Sum of squares	Degrees of freedom	Mean squares
Groups	819.69	3	273.23
Within	14489.67	71	204.08
Total	15309.36		

$$F_{(3,71)} = \frac{273.23}{204.08} = 1.34$$

With a table value of 2.74 for F with 3 and 71 degrees of freedom, the calculated F-value is nonsignificant.

2. There is no significant difference in the mean attitude scores, as measured by the Aiken Attitude Scale, among the four treatment groups, A/A, A/V, V/V, and V/A.

Posttreatment Analysis

Tables 4.3 and 4.4 present summaries of data for achievement and attitude gains for the various groupings that relate to experimental hypotheses 1 through 6.

In order to test experimental hypotheses 1 through 4 one-tailed t tests were used. Used for computation of the various t values and for presentation of the data was the following notation:

1. M_{AG1} = the mean of the achievement gain scores for the group whose cognitive styles matched their instructional modes.
2. M_{AG2} = the mean of the achievement gain scores for the group whose cognitive styles were mismatched with their instructional modes.
3. M_{AT1} = the mean of attitude gain scores for the group whose cognitive styles matched their instructional modes.
4. M_{AT2} = the mean of attitude gain scores for the group whose cognitive styles were mismatched with their instructional modes.
5. T_{AG1} = the mean of achievement gain scores for the group taught by an auditory method.

TABLE 4.3
SUMMARY OF ACHIEVEMENT GAIN SCORES

Group	Mean	Standard deviation
Matched	11.14	19.54
Mismatched	6.69	23.67
Auditory Treatment	9.56	21.88
Visual Treatment	8.40	20.10
V/V	10.21	16.57
A/A	11.98	22.26
V/A	7.03	21.69
A/V	5.75	30.15

TABLE 4.4
SUMMARY OF ATTITUDE GAIN SCORES

Group	Mean	Standard deviation
Matched	3.25	9.31
Mismatched	4.73	11.99
Auditory Treatment	4.16	11.32
Visual Treatment	3.16	8.54
V/V	1.86	8.59
A/A	4.52	9.95
V/A	3.77	12.98
A/V	7.38	8.57

6. T_{AG2} = the mean of achievement gain scores for the group taught by a visual method.
7. T_{AT1} = the mean of attitude gain scores for the group taught by an auditory method.
8. T_{AT2} = the mean of attitude gain scores for the group taught by a visual method.
9. S_{MG} = Standard Deviation of the means of the gains under consideration.

Formulas used in computing t-tests for the various hypotheses are listed below:

$$\text{Hypothesis 1: } \frac{M_{AG1} - M_{AG2}}{S_{MG}}$$

$$\text{Hypothesis 2: } \frac{M_{AT1} - M_{AT2}}{S_{MG}}$$

$$\text{Hypothesis 3: } \frac{T_{AG1} - T_{AG2}}{S_{MG}}$$

$$\text{Hypothesis 4: } \frac{T_{AT1} - T_{AT2}}{S_{MG}}$$

A one-tailed t test at the .05 level of significance with 1 degree of freedom has a critical value of 1.65. Table 4.5 presents a summary of the data as it related to these experimental hypotheses.

TABLE 4.5
SUMMARY OF t TEST RESULTS FOR EXPERIMENTAL
HYPOTHESES 1 THROUGH 4

$\alpha = .05$

Hypothesis	Mean	Standard deviation of the means	Calculated t	Reject (R) Fail to reject (F)
1. $M_{AG1} = M_{AG2}$	$M_{AG1} = 11.14$ $M_{AG2} = 6.69$	5.23	.852	F
2. $M_{AT1} = M_{AT2}$	$M_{AT1} = 3.25$ $M_{AT2} = 4.73$	2.60	-.571	F
3. $T_{AG1} = T_{AG2}$	$T_{AG1} = 9.56$ $T_{AG2} = 8.40$	4.87	.238	F
4. $T_{AT1} = T_{AT2}$	$T_{AT1} = 4.16$ $T_{AT2} = 3.16$	2.28	.438	F

Thus there is no basis to reject any of the following hypotheses:

1. There is no significant difference in the means of achievement gain scores between the group of subjects whose instructional and cognitive styles are matched and the group of subjects whose instructional and cognitive styles are mismatched.
2. There is no significant difference in the means of attitude gain scores between the group of subjects whose instructional and cognitive styles are matched and the group of subjects whose instructional and cognitive styles are mismatched.
3. There is no significant difference in the means of achievement gain scores between the group of subjects participating in an auditory treatment and the group of subjects participating in a visual treatment.
4. There is no significant difference in the means of attitude gain scores between the group of subjects participating in an auditory treatment and the group of subjects participating in a visual treatment.

To test experimental hypotheses 5 and 6, a two factor analysis of variance was used to check for treatment interaction among the four groups A/A, A/V, V/V, and V/A. The results are presented in Tables 4.6 and 4.7.

The analysis gives no basis to reject the following two hypotheses:

5. There is no significant difference in the means of achievement gain scores among the four groups A/A, A/V, V/V, and V/A.
6. There is no significant difference in the means of attitude gain scores among the four groups A/A, A/V, V/V, and V/A.

A part of the original participation agreement signed by each subject was the right to withdraw from the assigned treatment at any

TABLE 4.6
TWO FACTOR ANALYSIS OF VARIANCE FOR ACHIEVEMENT GAIN SCORES

$$\alpha = .05$$

Source of variation	Sum of squares	Degrees of freedom	Mean squares
Classifications	49.17	1	49.17
Treatments	5.88	1	5.88
Interaction	342.39	1	342.39
Error	32082.39	70	458.32
Total	32479.83		

$$F_{(1,70)} = \frac{49.17}{458.32} = 0.1$$

$$F_{(1,70)} = \frac{5.88}{458.32} = 0.013$$

Interaction

$$F_{(1,70)} = \frac{342.39}{458.32} = 0.75$$

With a table value of 3.98 for F with 1 and 70 degrees of freedom, none of the calculated F-values is significant.

TABLE 4.7
TWO FACTOR ANALYSIS OF VARIANCE FOR ATTITUDE GAIN SCORES

$$\alpha = .05$$

Source of variation	Sum of squares	Degrees of freedom	Mean squares
Classifications	105.57	1	105.57
Treatments	10.63	1	10.63
Interaction	77.12	1	77.12
Error	7744.04	70	110.63
Total	7937.36		

$$\text{Classification} \\ F_{(1,70)} = \frac{105.57}{110.63} = .954$$

$$\text{Treatment} \\ F_{(1,70)} = \frac{10.63}{110.63} = .096$$

$$\text{Interaction} \\ F_{(1,70)} = \frac{77.12}{110.63} = .697$$

With a table value of 3.98 for F with 1 and 70 degrees of freedom, none of the calculated F-values is significant.

time during the study. If for any reason the subject was not pleased with his mode of instruction, he simply had to request to be assigned to another treatment. When this occurred, the subject was no longer considered a part of the study. Nine subjects made such a request.

To investigate if this transfer from assigned treatment showed any significant trend, three different groupings were used: subjects matched as to cognitive style and instructional mode versus those mismatched; subjects taught by the auditory mode versus those taught by the visual mode; and subjects classified cognitively as auditory versus those classified as visual. It was found that 19% of the mismatched subjects requested a transfer, while only 4% of the matched did so; 17% of the auditory treatment subjects requested a transfer as opposed to 6% of the visual treatment subjects; and 20.5% of those classified cognitively as auditory transferred while only 2% of the visual transferred from their assigned treatments.

Chi square tests were used to further investigate this topic of transfers among the aforementioned groupings, and Tables 4.8, 4.9, and 4.10 present the results. Formulas used to compute the data are:

$$F_{\text{exp}} = \frac{\text{row total} \times \text{column total}}{\text{total}}$$

TABLE 4.8

CHI SQUARE DATA ON REQUESTED TRANSFER FROM ASSIGNED TREATMENTS,
MATCHED GROUP VERSUS MISMATCHED GROUP

$$\alpha = .05$$

<u>Observed Frequency</u>			
	<u>Transfer</u>	<u>Nontransfer</u>	<u>Total</u>
Matched	2	44	46
Mismatched	7	30	37
Total	9	74	83

<u>Expected Frequency</u>		
	<u>Transfer</u>	<u>Nontransfer</u>
Matched	4.99	41.01
Mismatched	4.01	32.99

$$\chi^2 = 3.13$$

With a table value of 3.48 for Chi square with one degree of freedom, the calculated value of 3.13 is nonsignificant.

TABLE 4.9

CHI SQUARE DATA ON REQUESTED TRANSFER FROM ASSIGNED TREATMENTS,
AUDITORY TREATMENTS VERSUS VISUAL TREATMENTS

$$\alpha = .05$$

<u>Observed Frequency</u>			
	<u>Transfer</u>	<u>Nontransfer</u>	<u>Total</u>
Auditory	3	45	48
Visual	6	29	35
Total	9	74	83

<u>Expected Frequency</u>		
	<u>Transfer</u>	<u>Nontransfer</u>
Auditory	5.20	42.80
Visual	3.78	31.20

$$\chi^2 = 1.50$$

With a table value of 3.48 for Chi square with one degree of freedom, the calculated value of 1.50 is nonsignificant.

TABLE 4.10

CHI SQUARE DATA ON REQUESTED TRANSFER FROM ASSIGNED TREATMENTS,
AUDITORY COGNITIVE STYLE VERSUS VISUAL COGNITIVE STYLE

$$\alpha = .05$$

	<u>Observed Frequency</u>		
	<u>Transfer</u>	<u>Nontransfer</u>	<u>Total</u>
Auditory	8	31	39
Visual	1	43	44
Total	9	74	83

	<u>Expected Frequency</u>	
	<u>Transfer</u>	<u>Nontransfer</u>
Auditory	4.22	34.77
Visual	4.77	39.23

$$\chi^2 = 5.37$$

With a table value of 3.48 for Chi square with one degree of freedom, the calculated value of 5.37 is significant. However, results are inconclusive as each cell of the expected frequency chart must contain values of 5.00 or above, and this is not the case in Table 4.10.

and

$$\chi^2 = \sum_{i=1}^4 \frac{(|F_{\text{obs}_i} - F_{\text{exp}_i}| - .5)^2}{F_{\text{exp}_i}}$$

where F_{obs} = observed frequency and F_{exp} = expected frequency.

In the following chapter, findings from the study will be presented, and recommendations for further study will be considered.

CHAPTER V

FINDINGS AND RECOMMENDATIONS

Summary

Two treatments for the instruction of basic arithmetic skills were employed in the developmental studies program at Roane State Community College during the fall quarter of 1979. Within an individualized, self-paced format, one treatment consisted of a visual presentation of material and the other treatment an auditory presentation of the same material. The cognitive style of each subject was classified as either visual or auditory using the Hill Cognitive Mapping Inventory. As a result of being randomly assigned to one of the two treatments, some subjects' cognitive styles and treatments were matched; others' styles and treatments were mismatched. This process created four groups: auditory cognitive style with auditory treatment (A/A), visual cognitive style with visual treatment (V/V), visual cognitive style with auditory treatment (V/A), and auditory cognitive style with visual treatment (A/V). A total of 74 subjects participated in the study.

Of concern in this study was whether this matching and mismatching resulted in differences in the acquisition of basic skills or changes in attitudes toward mathematics of the subjects. Pre- and posttreatment measures of basic skills and attitudes were collected from the subjects by use of the SK/1 test of the MAA and the Aiken Attitude Scale. The gain scores from these two areas of interest were used in an attempt to

evaluate effects on the subjects' arithmetic skills and attitudes toward mathematics.

Findings

The findings of the study were:

1. There were no significant differences in the means of achievement gain scores between the group of subjects whose instructional and cognitive styles were matched and the group of subjects whose instructional and cognitive styles were mismatched.
2. There were no significant differences in the means of attitude gain scores between the group of subjects whose instructional and cognitive styles were matched and the group of subjects whose instructional and cognitive styles were mismatched.
3. There were no significant differences in the means of achievement gain scores between the group of subjects who participated in an auditory treatment and the group of subjects who participated in a visual treatment.
4. There were no significant differences in the means of attitude gain scores between the group of subjects who participated in an auditory treatment and the group of subjects who participated in a visual treatment.
5. There were no significant differences in the means of achievement gain scores among the four groups A/A, A/V, V/V, and V/A.
6. There were no significant differences in the means of attitude gain scores among the four groups A/A, A/V, V/V, and V/A.

7. The number of subjects who requested to be transferred from their assigned treatments indicated that subjects classified as auditory were more likely to find their assigned treatments unacceptable than the visual subjects. There is some indication that instructing those who are auditory by visual means contributes to student frustration and may therefore reduce the effectiveness of a program.

One treatment does not appear to have been any more effective than the other, but the mean achievement gain score of the subjects whose cognitive style and instruction were matched was slightly higher than that of the subjects who were mismatched. The relatively small gains indicate that perhaps the developmental program was not very effective in any of its forms.

It should be pointed out however that the subjects in this study lack mathematical skills and confidence in themselves. Any improvement in their skills can provide a valuable increase in self-esteem. Most students who start out in basic arithmetic at Roane State Community College remain in the developmental studies courses for two or three quarters before they begin the regular college mathematics courses. Some go on to succeed in these mathematics courses, possibly because of the skills gained in developmental studies. Thus in terms of the egalitarian philosophy of the community college movement and in terms of the human factor, even a slight improvement in skills of a student is of some value, and any enhancement of this process should be carefully evaluated.

Recommendations

Some recommendations that might be considered in further research include:

1. Special attention should be paid to the problem of the transfer rate from assigned treatments. If statistical verification could be provided for the implied trend of the auditory subjects finding the visual treatment unacceptable, a modification on the present visual method of instructing the Roane State's developmental studies fundamental algebra course would be indicated.
2. The problem of transfer (or drop) rate from the developmental program's treatments should be investigated. Such a study might include interviews with those students who terminate their participation in order to try to pinpoint factors contributing to this occurrence.
3. Since the basic skills achievement gains found in this study were not substantial, a comparison of the achievement gains of students in this program with a control group would be of some interest.
4. The use of the Hill Inventory does not appear to be of much value in conjunction with the current developmental studies courses at Roane State Community College. Further efforts should be made to investigate the legitimacy and efficacy of the Hill Inventory.

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APPENDICES

APPENDIX A

COGNITIVE STYLE MAPPING

INTEREST INVENTORY

ROANE STATE COMMUNITY COLLEGE

HARRIMAN, TENNESSEE

REVISED AND EDITED
BY SPARTANBURG TECH
FACULTY AND STAFF

DR. JOSEPH HILL
c 1973 OAKLAND COMMUNITY COLLEGE
BLOOMFIELD HILLS, MICHIGAN

COGNITIVE STYLE MAPPING INVENTORY

The purpose of this inventory is to give you information on how you prefer to learn. Your Cognitive Style Map will be developed from your responses to this inventory and should provide valuable information in determining the manner in which you prefer to learn. This inventory is not a test. It cannot be passed or failed and there are no right or wrong answers. Remember, your map will only be as accurate as the responses you give. The results from your map will provide a picture of how you prefer to learn. Your instructors will use this information to help you perform better in the classroom. So, relax and enjoy this adventure in self-understanding.

IN ORDER TO DETERMINE YOUR COGNITIVE STYLE
YOU WILL NEED THE FOLLOWING:

1. A cognitive style mapping inventory.
2. A tally sheet.
3. Something to write with.
4. Approximately 45-60 minutes of time.

HOW TO COMPLETE THIS INVENTORY

1. Read each statement carefully.
2. There are eight sets of statements and each set contains 28 statements.
3. After reading a statement decide how it pertains to you: "Usually," "Sometimes," or "Rarely." On the tally sheet, find the line that corresponds to the statement that you are on and place a tally mark (~~||||~~) in the column marked "Usually," "Sometimes," or "Rarely." For example, your response to statement 1 should be placed in the appropriate column on line 1 of your tally sheet. Your response to statement 2 should be placed in the appropriate column on line 2 of your tally sheet.
4. Follow this procedure until the inventory is completed. Be sure to respond to each statement.

PLEASE MARK ONLY ON THE TALLY SHEET AND NOT ON THE INVENTORY!

BEGIN AT THE TOP OF PAGE 1 AND AT THE TOP OF THE TALLY SHEET!

1. I UNDERSTAND BETTER WHAT A PERSON MEANS WHEN HE SPEAKS TO ME THAN WHEN HE WRITES TO ME.
2. I FIND IT EASY TO LISTEN TO NUMBERS AND TO ADD THEM IN MY HEAD.
3. AFTER I TELL SOMEONE HOW TO DO SOMETHING, I WOULD READ HIS NOTES TO BE CERTAIN THEY ARE CORRECT.
4. I SOLVE MATH PROBLEMS FASTER IF I USE PAPER AND PENCIL.
5. I CAN TELL IF SOMETHING IS WRONG WITH AN ENGINE BY LISTENING TO IT RUN.
6. I CAN TELL "WHAT'S FOR DINNER" BY THE SMELL WHEN I ENTER THE HOUSE.
7. I CAN EASILY TELL IF MILK IS SOUR BY TASTING IT.
8. I CAN FEEL THE DIFFERENCE BETWEEN LEATHER AND METAL BY SLIDING MY HAND OVER IT.
9. I PREFER TO READ BOOKS WHICH HAVE PICTURES OR DRAWINGS IN THEM.
10. I CAN CATCH A BALL THAT HAS BEEN HIT OR THROWN.
11. MY FRIENDS TELL ME THAT I AM UNDERSTANDING.
12. I ENJOY LOOKING AT PRETTY THINGS.
13. THE VALUES OF OUR SOCIETY ARE GOOD FOR EVERYONE.
14. I CAN IMITATE SOMEONE ELSE BEFORE A GROUP WELL ENOUGH FOR THEM TO KNOW WHO IT IS.
15. I BLUSH AT TIMES WHEN MANY OTHERS DO NOT.
16. WHEN PREPARING FOR MY DRIVERS ROAD TEST, I AM WILLING TO PRACTICE UNTIL I LEARN TO DRIVE WELL.
17. I WOULD WAIT TO BE INTRODUCED TO A FAMOUS PERSON RATHER THAN INTRODUCE MYSELF IMMEDIATELY.
18. I CAN PREDICT MY RESPONSES IN MANY SITUATIONS.
19. I CAN PERSUADE CHILDREN TO DO WHAT THEY SHOULD.
20. I KNOW HOW LONG IT WILL TAKE TO COMPLETE MOST TASKS.
21. I LEARN A SUBJECT BETTER WHEN I CAN DISCUSS IT WITH MY FRIENDS.
22. BEFORE VOTING IN A SCHOOL ELECTION, I TALK ABOUT THE CANDIDATES WITH MY FAMILY.
23. I MAKE MY OWN POLITICAL CHOICES.
24. I WORK BEST IN AN ORGANIZED SITUATION.
25. I UNDERSTAND AN IDEA BETTER IF I STUDY HOW IT DIFFERS FROM OTHER TOPICS.
26. I WOULD FIND IT INTERESTING TO DISCOVER HOW PEOPLE BEHAVE BY FIGURING OUT WHAT MAKES THEM TICK.
27. I PREFER TO KNOW ALL THE FACTS BEFORE I REACH A DECISION.
28. I ENJOY GAMES AND PUZZLES IN WHICH THE SOLUTION CAN BE FIGURED OUT FROM THE RULES.

RETURN TO THE TOP OF THE NEXT PAGE AND THE TALLY SHEET AND FOLLOW THE SAME PROCEDURE AS BEFORE!

1. I DO BETTER ON A TEST IF IT IS ABOUT INFORMATION I HAVE HEARD RATHER THAN READ.
2. I USE NUMBERS I KNOW ABOUT TO PROVE MY POINT WHEN TALKING TO OTHERS.
3. IT IS EASIER FOR ME TO EXPLAIN THINGS IN WRITING THAN BY TALKING ABOUT THEM.
4. I DO BEST ON WRITTEN MATHEMATICS TESTS.
5. THE TONE OF A SPEAKER'S VOICE ADDS MEANING TO HIS WORDS.
6. I CAN DISTINGUISH FRESH FRUIT FROM STALE FRUIT BY THE SMELL.
7. WHEN EATING, I USE DIFFERENT SPICES UNTIL THE FOOD TASTES "RIGHT."
8. I CAN EASILY BUTTON MY COAT IN THE DARK.
9. I CAN EASILY TELL IF A PICTURE HANGING ON THE WALL IS STRAIGHT.
10. I HAVE BEEN TOLD THAT I AM A GOOD FRISBEE PLAYER.
11. I "FEEL" THE EMOTIONS OF OTHERS AS THEY DO.
12. I LIKE THE OUTSIDE OF BUILDINGS TO BE AS BEAUTIFUL AS THE INSIDE.
13. I TRY TO LIVE MY LIFE AS IF THE WAY I WAS TAUGHT WERE RIGHT.
14. I AM A GOOD ACTOR OR ACTRESS.
15. I USE FACIAL EXPRESSIONS TO SHOW HOW I FEEL.
16. I AM BETTER COORDINATED THAN MOST PEOPLE.
17. I KNOW ON WHOM I CAN PLAY A PRACTICAL JOKE.
18. I KNOW HOW WELL I WILL DO WHEN I AM FACED WITH A NEW SITUATION.
19. IN GROUP DISCUSSIONS, I CAN BE THE ONE WHO PERSUADES THE GROUP TO REACH A DECISION.
20. I KNOW EXACTLY HOW MANY MINUTES IT TAKES ME TO GO PLACES THAT I GO A LOT.
21. I ENJOY AN ACTIVITY MORE IF MY FRIENDS DO IT WITH ME.
22. FAMILY VALUES SHOULD HAVE LASTING EFFECTS ON EACH OF US.
23. RELIGION IS PURELY A PERSONAL DECISION.
24. WHEN I GO SHOPPING, I TEND TO MAKE LISTS.
25. I PREFER "TRUE,FALSE" TESTS.
26. I LIKE TO FIGURES OUT THE WAY THE PARTS OF A WHOLE FIT TOGETHER.
27. WHEN I HAVE TO SOLVE A PROBLEM, I TRY TO SEE IT FROM AS MANY VIEWPOINTS AS POSSIBLE.
28. I FIND REASONING LIKE THIS STATEMENT HELPS ME UNDERSTAND: ALL DOGS BARK.
THIS ANIMAL IS A DOG.
THEREFORE, THIS ANIMAL BARKS.

RETURN TO THE TOP OF THE NEXT PAGE AND THE TALLY SHEET AND FOLLOW THE SAME PROCEDURE AS BEFORE!

1. I UNDERSTAND THE DAILY NEWS BETTER IF I HEAR IT ON THE RADIO THAN IF I READ IT IN THE NEWSPAPER.
2. ORAL MATHEMATICS TESTS ARE EASIER FOR ME THAN WRITTEN MATHEMATICS TESTS.
3. I PREFER CLASSES WHICH DEPEND UPON TEXTBOOKS.
4. I KEEP WRITTEN RECORDS OF THE MONEY I GET AND THE WAY I SPEND IT.
5. I CAN RECOGNIZE WHO IS ON THE PHONE JUST BY LISTENING TO THE VOICE FOR A FEW MOMENTS.
6. I CAN TELL THE DIFFERENCE BETWEEN SEVERAL KINDS OF FLOWERS BY SMELLING THEM.
7. THE TASTE OF FOOD IS MORE IMPORTANT THAN THE WAY IT LOOKS.
8. I USE MY FINGERS TO FEEL OUT THE TEXTURE OF THE WOOD.
9. I ENJOY LOOKING AT ART WORK.
10. WHEN I WALK DOWNSTAIRS, I LOOK AHEAD RATHER THAN AT MY FEET.
11. I UNDERSTAND HOW A PERSON FEELS WHEN HE IS BEING PUNISHED.
12. I ENJOY THE AUTHOR'S WRITING STYLE AS MUCH AS THE STORY HE TELLS.
13. I WOULD NOT AGREE TO CHEAT IF I WERE OFFERED A BRIBE.
14. I CAN LOOK LIKE I AM CALM AND COMFORTABLE EVEN THOUGH I AM ANGRY AND UNCOMFORTABLE.
15. I SHRUG MY SHOULDERS WHEN SAYING "I DON'T KNOW."
16. LEARNING TO THROW A BALL THE RIGHT WAY IS IMPORTANT.
17. I CAN RECOGNIZE THOSE WHO WILL BE FRIENDLY TO ME.
18. I SET GOALS THAT SUIT MY NEEDS AND ABILITIES.
19. I CAN STOP PEOPLE FROM ARGUING.
20. IT BOTHERS ME FOR A FRIEND TO BE LATE FOR AN APPOINTMENT WITH ME.
21. WHEN SHOPPING FOR CLOTHES, I PREFER HAVING A FRIEND ALONG TO HELP ME MAKE CHOICES.
22. I ENJOY OUTDOOR ACTIVITIES WHEN I AM WITH MY FAMILY.
23. I WOULD RATHER DO THINGS MY WAY EVEN IF MY FAMILY OR FRIENDS DON'T AGREE.
24. LIFE IS SIMPLE IF YOU GO BY THE RULES.
25. IN MY CHOICE OF CLOTHING, I WEAR BRIGHT STRIKING COLORS.
26. I TEND TO THINK OF ALL PARTS OF THE WORLD AS WORKING TOGETHER.
27. ONE CANNOT SOLVE A PROBLEM UNLESS HE KNOWS ALL THE FACTS.
28. I ENJOY THE WAY MATH MAKES ME THINK.

RETURN TO THE TOP OF THE NEXT PAGE AND THE TALLY SHEET AND FOLLOW THE SAME PROCEDURE AS BEFORE!

1. I WOULD RATHER TELEPHONE A FRIEND THAN WRITE HIM A NOTE.
2. WHEN TAKING A MATH CLASS, I FIND IT EASY TO TALK ABOUT THE PROBLEMS WITH MY FRIENDS AND THE TEACHER.
3. I SCORE HIGH ON TESTS WHICH DEPEND UPON READING FIRST AND THEN ANSWERING QUESTIONS ABOUT WHAT I HAVE READ.
4. WHEN I AM IN MATH CLASS TRYING TO DO WORD PROBLEMS, I AM AMONG THE FIRST TO REACH THE RIGHT ANSWER.
5. I CAN REMEMBER MUSIC WELL ENOUGH TO RECOGNIZE A "TUNE" THE NEXT TIME I HEAR IT.
6. THE SMELLS IN A ROOM TELL ME WHETHER IT IS A PLEASANT OR UNPLEASANT PLACE.
7. I CAN IDENTIFY ROOT BEER OR COKE JUST BY THE TASTE.
8. I LIKE FURNITURE THAT FEELS GOOD TO MY HAND.
9. I UNDERSTAND A BOOK BETTER IF IT HAS PICTURES AND DRAWINGS.
10. I CAN WRITE NEATLY WHILE ANOTHER PERSON IS TELLING ME WHAT TO WRITE.
11. I TRY NOT TO SAY THINGS WHICH MAY HURT THE FEELINGS OF OTHERS.
12. I ENJOY LISTENING TO MUSIC WHEN IT SOUNDS GOOD.
13. I WOULD GIVE UP SOMETHING I WANT TO DO NOW RATHER THAN SACRIFICE ONE OF MY VALUES.
14. I AM ABLE TO ACT OUT SOMETHING IF I WANT TO.
15. I "TALK WITH MY HANDS" MORE THAN OTHERS DO.
16. WHEN LEARNING A NEW DANCE, I AM WILLING TO PRACTICE THE STEPS UNTIL I CAN DO THEM PERFECTLY.
17. UNLESS SPOKEN TO FIRST, I DO NOT SPEAK TO A TEACHER.
18. I CAN ACCURATELY PREDICT IF I WILL BE ABLE TO GET MY WORK DONE.
19. I CAN CONVINCE OTHERS TO WANT TO DO THE THINGS THAT I WOULD LIKE THEM TO DO.
20. IT BOTHERS ME WHEN EVENTS DO NOT START ON TIME.
21. I LIKE TO SHARE IDEAS WITH FRIENDS.
22. I TALK WITH MY FAMILY BEFORE DOING ANYTHING THAT MIGHT AFFECT THEM.
23. WHEN GIVEN A PROBLEM TO SOLVE, I FIND THE ANSWER MYSELF.
24. I PREFER WORKING IN SITUATIONS WHERE STANDARDS AND RULES ARE STATED SPECIFICALLY.
25. WHEN I AM JUDGING OTHERS, I COMPARE WHAT THEY DO NOW WITH WHAT THEY DID BEFORE.
26. WHEN LOOKING AT SOMETHING MADE BY SOMEONE ELSE (A PAINTING, A BUILDING, FURNITURE) I LIKE TO FIGURE OUT WHY THE PERSON MADE IT AS THEY DID.
27. INFORMATION SHOULD BE STUDIED IN A NUMBER OF WAYS BEFORE A DECISION IS MADE.
28. I FIND THE TYPE OF REASONING DEMANDED BY MATHEMATICS SUITS MY WAY OF THINKING.

RETURN TO THE TOP OF THE NEXT PAGE AND THE TALLY SHEET AND FOLLOW THE SAME PROCEDURE AS BEFORE!

1. I PREFER TO FOLLOW SPOKEN DIRECTIONS RATHER THAN WRITTEN DIRECTIONS.
2. IT IS EASY FOR ME TO REMEMBER THE NUMBERS AND PRICES I HAVE HEARD DURING A CONVERSATION.
3. I PREFER TO HAVE DIRECTIONS WRITTEN ON THE BOARD WHILE THEY ARE BEING EXPLAINED.
4. I USE A WRITTEN RECORD TO SHOW FOR MONEY FOR WHICH I AM RESPONSIBLE.
5. I AM ABLE TO TELL WHICH GROUPS OF INSTRUMENTS ARE PLAYING AT DIFFERENT TIMES DURING A CONCERT.
6. I NOTICE THE WAY DIFFERENT PLACES SMELL.
7. I WOULD RETURN TO A RESTAURANT BECAUSE THE FOOD TASTED GOOD.
8. I PICK UP AND FEEL VEGETABLES AND FRUITS BEFORE EATING THEM.
9. A STORY IS EASIER TO UNDERSTAND IN A MOVIE THAN IN A BOOK.
10. WHEN I RIDE A BIKE, I LOOK AHEAD RATHER THAN AT THE HANDLEBARS.
11. I AM ABLE TO GIVE ADVICE WITHOUT OFFENDING OTHERS.
12. I WOULD GO OUT OF MY WAY TO SEE BEAUTIFUL SCENERY.
13. I DON'T LET MY FRIENDS INTERFERE WITH MY COMPLETING AN ASSIGNMENT.
14. I CAN ACT INTELLIGENT WHEN THE SITUATION DEMANDS.
15. WALKING WITH A SPRING IN YOUR STEP GIVES THE IMPRESSION THAT YOU ARE HAPPY.
16. TO BECOME A GOOD MUSICIAN, I WOULD PRACTICE CORRECT FINGER MOVEMENTS.
17. IF I NEED TO BORROW A QUARTER, I WOULD KNOW WHOM TO APPROACH.
18. I KNOW MY STRENGTHS AND WEAKNESSES.
19. I CAN PERSUADE PEOPLE TO DO THINGS MY WAY.
20. I AM AMONG THE FIRST TO COME TO A MEETING.
21. BEFORE CHOOSING A CLASS, I WOULD DISCUSS IT WITH MY FRIENDS.
22. I FIND IT IMPORTANT TO TALK THINGS OVER WITH MY FAMILY.
23. I CONSIDER MY PERSONAL GOALS BEFORE THE GOALS OF OTHERS.
24. IN SPORTS AND AT WORK, IT IS IMPORTANT TO "PLAY BY THE RULES."
25. I ASK QUESTIONS TO MAKE PEOPLE THINK ANOTHER WAY.
26. IT IS EASY FOR ME TO PUT PUZZLES TOGETHER.
27. I TAKE LONGER TO MAKE UP MY MIND BECAUSE I WANT TO KNOW MORE ABOUT AN ISSUE THAN MOST OTHER PEOPLE DO.
28. I FIND IT EASIER TO WIN AN ARGUMENT WHEN I STATE A FACT AND GIVE A LOGICAL CONCLUSION.

RETURN TO THE TOP OF THE NEXT PAGE AND THE TALLY SHEET AND FOLLOW THE SAME PROCEDURE AS BEFORE!

1. AFTER I WRITE A LETTER, I ASK SOMEONE TO READ IT TO ME SO THAT I KNOW IT SOUNDS RIGHT.
2. I CAN REMEMBER A TELEPHONE NUMBER ONCE I HAVE HEARD IT.
3. I WOULD RATHER READ A NEWSPAPER TO MYSELF THAN HAVE SOMEONE READ IT TO ME.
4. I HAVE TO WRITE DOWN A PHONE NUMBER IN ORDER TO REMEMBER IT.
5. I CAN RECOGNIZE THE DIFFERENCE BETWEEN TWO CLOSELY PITCHED SOUNDS.
6. YOU CAN TELL IF A CAR IS NEW BY ITS SMELL.
7. I CHOOSE A DRINK BY THE WAY IT TASTES.
8. I DECIDE MY HAIR NEEDS WASHING BY THE WAY IT FEELS WHEN I TOUCH IT.
9. I CAN PICTURE SOMETHING IN MY MIND FROM A DESCRIPTION.
10. I CAN DRIBBLE A BASKETBALL WITHOUT WATCHING MY HANDS.
11. WHEN SOMEONE IS FRIGHTENED, I CAN BE PATIENT AND CALM RATHER THAN ANSWER IN ANGER.
12. I ENJOY THE BEAUTY OF A WELL-DESIGNED BUILDING.
13. I BELIEVE THAT A PROMISE SHOULD BE KEPT.
14. I CAN ACT FRIENDLY IN ORDER TO GET FAVORS.
15. WHEN I SHAKE HANDS WITH SOMEONE, THE HANDSHAKE TELLS ME HOW SINCERE THE PERSON IS.
16. WHEN I ENGAGE IN SPORTS, I PRACTICE OR WARM-UP FIRST.
17. FIRST NAMES ARE GOOD IF THE OTHER PERSON LIKES FIRST NAMES.
18. I KNOW THE AMOUNT OF ENERGY IT TAKES FOR ME TO DO SOMETHING.
19. FRIENDS ASK ME TO HELP SOLVE THEIR PROBLEMS.
20. I TURN IN ASSIGNMENTS WHEN THEY ARE DUE.
21. I MAKE DECISIONS AFTER DISCUSSING THEM WITH MY FRIENDS.
22. I UNDERSTAND EVENTS BETTER AFTER DISCUSSING THEM WITH MY FAMILY.
23. I DO NOT NEED OTHERS TO HELP ME MAKE DECISIONS.
24. IF I SEE WHAT I WANT SHOPPING FOR CLOTHES, I BUY IT.
25. I AM COMFORTABLE DOING THINGS DIFFERENTLY FROM OTHER PEOPLE.
26. I TRY TO UNDERSTAND WHY PEOPLE BREAK RULES.
27. A PERSON CAN NEVER KNOW ENOUGH ABOUT THE UNIVERSE.
28. KNOWLEDGE FLOWS LOGICALLY FROM GIVEN FACTS.

RETURN TO THE TOP OF THE NEXT PAGE AND THE TALLY SHEET AND FOLLOW THE SAME PROCEDURE AS BEFORE!

1. WHEN I HAVE TO EXPLAIN SOMETHING, I CAN SAY IT BETTER THAN I CAN WRITE IT.
2. I DISCUSS "SALE" PRICES WITH OTHERS BEFORE I GO SHOPPING.
3. I PREFER TO READ DIRECTIONS TO MYSELF RATHER THAN HAVE SOMEONE READ THEM TO ME.
4. WHEN I GO SHOPPING, I READ THE PRICES OF EACH ITEM AND KEEP A TOTAL IN MY HEAD SO I DON'T SPEND TOO MUCH.
5. NOISES BOTHER ME WHEN I AM TRYING TO READ OR TALK TO SOMEONE.
6. ANY BAD SMELL IN A ROOM BOTHERS ME MORE THAN IT DOES OTHER PEOPLE.
7. I ENJOY TRYING NEW FOODS TO FIND OUT WHAT THEY TASTE LIKE.
8. I CAN TELL A NICKEL FROM A DIME WITH MY FINGERS WHEN I REACH INSIDE MY POCKET.
9. WHEN I TUNE A RADIO, I LOOK AT THE DIAL.
10. I CAN PLAY MANY GAMES WELL ENOUGH TO ENJOY THEM.
11. I CAN BE PATIENT WITH PEOPLE WHO HAVE SOMETHING ELSE ON THEIR MIND.
12. POETRY IS BEAUTIFUL BECAUSE OF ITS IDEAS AS WELL AS ITS WORDS AND RHYTHM.
13. I WORK JUST AS HARD WHETHER OR NOT MY TEACHER OR PARENTS ARE THERE.
14. I SHOUT AND ACT TOUGH IN ORDER TO FRIGHTEN OTHERS WHEN I AM FRIGHTENED MYSELF.
15. I CAN TELL HOW A PERSON FEELS BY THE WAY HE SITS OR STANDS.
16. I ENJOY PRACTICING GOOD PHYSICAL SKILLS SO THAT I CAN COMPETE SUCCESSFULLY IN SPORTS.
17. IF I BUMP AGAINST ANOTHER PERSON IN A STORE, I KNOW WHETHER TO APOLOGIZE A LOT OR WITH A SINGLE WORD.
18. I CAN CONVINCE MYSELF THAT BORING TASKS MUST BE FACED OR COMPLETED.
19. AT PARTIES, I CAN GET EVERYBODY TO HAVE FUN.
20. I ARRIVE AT CLASS ON TIME.
21. I AM INFLUENCED BY MY FRIENDS' POLITICAL OPINIONS.
22. I CONSULT WITH MY FAMILY BEFORE MAKING DECISIONS.
23. AFTER GATHERING INFORMATION FROM MANY SOURCES, I MAKE DECISIONS ALONE.
24. ONCE I MAKE UP MY MIND, I DON'T CHANGE IT.
25. WHEN I AM SAD, HAPPY MUSIC CHEERS ME UP.
26. THERE IS ALWAYS A REASON FOR A PERSON'S BEHAVIOR.
27. THE MORE I KNOW ABOUT A PROBLEM, THE MORE I WANT TO KNOW ABOUT IT.
28. I UNDERSTAND THE WAY TO FIND ANSWERS IN MATH.

RETURN TO THE TOP OF THE NEXT PAGE AND THE TALLY SHEET AND FOLLOW THE SAME PROCEDURE AS BEFORE!

1. I PREFER CLASSES WHERE THE TEACHER LETS STUDENTS TELL WHAT THEY THINK AND ASK QUESTIONS.
2. IF I WERE BUYING A BICYCLE, I WOULD DISCUSS COST, SERVICE, AND WHAT COMES WITH IT WITH THE SALESMAN OR WITH A FRIEND.
3. I UNDERSTAND INFORMATION BETTER WHEN I READ IT RATHER THAN WHEN I HEAR IT.
4. IF I WERE BUYING A BICYCLE, I WOULD ASK THE SALESMAN TO WRITE OUT THE COST, SERVICE, AND WHAT COMES WITH IT.
5. I TUNE THE RADIO BY SOUND NOT BY THE NUMBERS ON THE DIAL.
6. WHEN THERE ARE FUMES IN THE CAR OR IN THE HOUSE I NOTICE THEM SOONER THAN OTHERS DO.
7. MY "SUFFERING" IN THE DENTIST'S CHAIR IS LESS IF HE USES GOOD TASTING MATERIALS IN MY MOUTH.
8. I PREFER TO WRITE WITH A PEN THAT FEELS COMFORTABLE.
9. I KNOW A PERSON BETTER IF I SEE A PICTURE OF HIM THAN IF I READ ABOUT HIM.
10. I AM CONSIDERED TO BE A "GOOD" ATHLETE.
11. I ONLY LAUGH AT PEOPLE WHEN THEY LAUGH AT THEMSELVES.
12. USEFULNESS IS IMPORTANT, BUT BEAUTY IS IMPORTANT TOO.
13. I WOULD STOP FOR A "STOP" SIGN ANY TIME IF THERE WERE NO OTHER CAR OR PERSON IN SIGHT.
14. I CAN ACT INTERESTED EVEN THOUGH BORED WHEN LISTENING TO A TEACHER.
15. WHEN I AM TALKING, I USE MY EYES TO EXPRESS MY FEELINGS.
16. I HAVE PRACTICED SUCH THINGS AS BASKETBALL, RUNNING RACES, HANDWRITING, SO THAT I CAN DO THEM WELL.
17. I KNOW WHICH PEOPLE ENJOY A PAT ON THE BACK WHEN THEY DESERVE IT.
18. I CAN TELL WHEN I AM JUST ABOUT TO LOSE MY PATIENCE.
19. SALES PEOPLE FIND EASILY WHATEVER I AM ASKING FOR.
20. I KEEP MY APPOINTMENTS ON TIME.
21. I WOULD JOIN A RELIGIOUS GROUP IF MY FRIENDS BELONGED TO IT.
22. I MAKE IT A POINT NOT TO LET MY SCHOOL WORK INTERFERE WITH FAMILY PLANS.
23. WHEN GIVEN A JOB TO DO, I'D RATHER DO IT MYSELF.
24. IN JUDGING OTHERS, I FIND IT IMPORTANT TO KNOW THE RULES THAT WERE SET FOR THEM.
25. PEOPLE WHO BECOME A SUCCESS ARE DIFFERENT FROM PEOPLE WHO FAIL.
26. I PREFER TO BE OFFERED MORE THAN ONE CHOICE.
27. THE MORE INFORMATION YOU COLLECT ABOUT A PROBLEM THE BETTER YOUR ANSWER WILL BE.
28. I LIKE THE KINDS OF PROBLEMS THAT HAVE DEFINITE ANSWERS.

THE END

APPENDIX B



OAKLAND
COMMUNITY
COLLEGE

GEORGE A. BEE
ADMINISTRATIVE
CENTER

2460 OPOYKE ROAD
BLOOMFIELD HILLS, MICHIGAN 48013

PHONE 647-6200

To Whom it May Concern:

In view of the many inquiries regarding matters of validity and reliability in connection with cognitive style mapping, Dr. Hill has asked that I quote from his recent response to such inquiry:

"Educational cognitive style is highly dependent upon what James Jenkins of the University of Minnesota, a theorist on the topic of memory, calls "contextualism." The basic notion underlying the use of a cognitive style test and inventory battery is to produce mathematical mappings which can be used by a trained mapper as aids to his empirical mappings of cognitive style elements. An analogy which might serve to clarify the issue would be that of how the medical doctor takes into account such mathematical mappings as: body temperature, blood pressure, blood counts, counts of biochemical elements found in specimens of body fluids, and intensity counts associated with X-ray interpretations in the process of questioning the patient to gain "empirical data" to diagnose the condition of the patient. Essentially, the medical doctor holds his empirical mapping processes in a higher order or priority, or, if you will, "weight," than the mathematical mappings, in the process of diagnosing an individual's condition of health. Contextualism enters into the doctor's diagnosis in the form of a series of norms and situations with which the physician is trained to become familiar. For example, a physician may diagnose a 55-year-old man to be in "good health" in comparison with norms for 55-year-old persons in the context of pursuits usually included in the life space of a 55-year-old individual. If the person being examined were to indicate to the physician that he was planning to engage in physical activities (e.g., skiing, swimming) at a level of competition usually found associated with 19 - 22-year-old varsity performers, the medical doctor might well revise his diagnosis of "good health" in consideration of that context.

Regardless of the matters noted above, I can provide you with validity and reliability indices that have been found, not only in some of our work here at the College, but in those doctoral dissertations (of the 84 that have been completed in this arena) dealing with community college samples. Under these circumstances, validity coefficients associated with the elements of T(VL), T(VQ), T(AL), and T(AQ) are as shown below:

T(VL)	Females = .80	T(AL)	Females = .75
	Males = .72		Males = .70
T(VQ)	Females = .72	T(AQ)	Females = .66
	Males = .73		Males = .61

Reliability coefficients are derived by means of the Kuder Richardson formula, based upon the

-2-

concept of domain sampling. The coefficients for T(VL), T(VQ), T(AL), and T(AQ) are as shown below:

T(VL)	Females = .93	T(AL)	Females = .89
	Males = .92		Males = .87
T(VQ)	Females = .92	T(AQ)	Females = .85
	Males = .93		Males = .82

The validity and reliability coefficients associated with these elements of cognitive style mapping have been derived from sub-tests of the Differential Aptitude Tests (4th Ed. - Forms L and M - The Psychological Corp. - 1966), the Nelson-Denny Reading Test, the Carlsen-Brown Listening Test, and the quantitative section of the "Wechsler." Point bi-serial correlation coefficients for the qualitative symbolic elements, the cultural determinant elements of individuality, associates, and family; the modalities of inference elements of magnitude, difference, relationship, and appraisal show the range of values in bi-serial correlation coefficients indicated below:

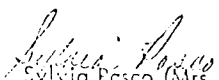
$$\text{low } r_{bis} = .54, \text{ to } r_{bis} = .93$$

The average bi-serial coefficient value for all these elements is:

$$r_{bis} = .783$$

The reliability for the inventories that provide results for the mapping of these elements of style is a Kuder Richardson: $r = .81$. In regard to the topic of predictability, this matter depends greatly upon the ability of the diagnostician to empirically map the style of the individual under consideration in the context, or intended context, of the instructional setting."

Sincerely,


Sylvia Pasco (Mrs.)
Administrative Asst.
6/2/78

APPENDIX C

NAME _____

MATHEMATICS ATTITUDE SCALE

Directions: Please write your name in the upper right-hand corner. Then for each of the following statements draw a circle around the letter(s) that show(s) how closely you agree or disagree with the statement: SD (Strongly Disagree), D (Disagree), U (Undecided), A (Agree), SA (Strongly Agree).

- | | |
|--|-------------|
| 1. I am always under a terrible strain in a mathematics class. | SD D U A SA |
| 2. I do not like mathematics, and it scares me to have to take it. | SD D U A SA |
| 3. Mathematics is very interesting to me, and I enjoy arithmetic and mathematics courses. | SD D U A SA |
| 4. Mathematics is fascinating and fun. | SD D U A SA |
| 5. Mathematics makes me feel secure, and at the same time it is stimulating. | SD D U A SA |
| 6. My mind goes blank and I am unable to think clearly when working mathematics. | SD D U A SA |
| 7. I feel a sense of insecurity when attempting mathematics. | SD D U A SA |
| 8. Mathematics makes me feel uncomfortable, restless, irritable, and impatient. | SD D U A SA |
| 9. The feeling that I have toward mathematics is a good feeling. | SD D U A SA |
| 10. Mathematics makes me feel as though I'm lost in a jungle of numbers and can't find my way out. | SD D U A SA |
| 11. Mathematics is something that I enjoy a great deal. | SD D U A SA |

- | | |
|---|-------------|
| 12. When I hear the word mathematics,
I have a feeling of dislike. | SD D U A SA |
| 13. I approach mathematics with a feeling
of hesitation, resulting from a fear
of not being able to do mathematics. | SD D U A SA |
| 14. I really like mathematics. | SD D U A SA |
| 15. Mathematics is a course in school
that I have always enjoyed studying. | SD D U A SA |
| 16. It makes me nervous to even think
about having to do a mathematics
problem. | SD D U A SA |
| 17. I have never like mathematics, and
it is my most dreaded subject. | SD D U A SA |
| 18. I am happier in a mathematics class
than in any other class. | SD D U A SA |
| 19. I feel at ease in mathematics,
and I like it very much. | SD D U A SA |
| 20. I have a definite positive reaction
toward mathematics; it's enjoyable. | SD D U A SA |

APPENDIX D

MATHEMATICS TEST

ROANE STATE COMMUNITY COLLEGE

Placement Test

Each question is followed by five suggested answers, labeled (a) through (e). Select the best answer to each problem and mark your answer on the 3M scan sheet with a #2 pencil. If you need to change an answer, please erase your previous response completely. DO not spend too much time on any one question.

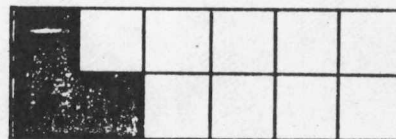
Suggested time: 45 minutes

11. $(7000 - 568) \div 4 =$

- (a) 168 (b) 1182 (c) 1608 (d) 1633 (e) 6858
-

12. The shaded region represents what fraction of the whole rectangle?

- (a) $\frac{1}{12}$ (b) $\frac{1}{4}$ (c) $\frac{1}{2}$ (d) $\frac{3}{9}$ (e) $\frac{3}{4}$



13. $\frac{1}{8} + \frac{7}{12} + \frac{2}{3} =$

- (a) $\frac{8}{19}$ (b) $\frac{10}{23}$ (c) $\frac{11}{8}$ (d) $\frac{3}{2}$ (e) $\frac{15}{4}$
-

14. The decimal representation of $\frac{3}{40}$ is

- (a) 0.00075 (b) 0.0075 (c) 0.075 (d) 0.75 (e) 7.5
-

15. $0.2 \times 0.104 =$

- (a) 0.0208 (b) 0.028 (c) 0.208 (d) 0.28 (e) 2.08
-

16. $9\frac{1}{8} - 4\frac{3}{4} =$

- (a) $4\frac{3}{8}$ (b) $4\frac{5}{8}$ (c) $5\frac{3}{8}$ (d) $5\frac{5}{8}$ (e) $5\frac{7}{8}$
-

17. Which of the following is the largest?

- (a) $\frac{1}{2}$ (b) 0.7 (c) $\frac{3}{5}$ (d) 0.2356 (e) 0.68
-

18. $\left(\frac{2}{3} + 1\right)^2 =$

- (a) $\frac{5}{9}$ (b) 1 (c) $\frac{13}{9}$ (d) $\frac{25}{9}$ (e) $\frac{25}{3}$
-

19. The sale price of a television set was \$500. After the sale, the price increased to \$625. What is the percent increase over the sale price?

- (a) 0.2% (b) 0.25% (c) 2% (d) 20% (e) 25%
-

20. The ages of the students in a certain school are given by the following table.

<u>Age</u>	<u>Number of Students</u>
17	600
18	1500
19	1650
20	<u>450</u>

Total 4200

What percent of the students are 19 or over?

- (a) 20% (b) 30% (c) 40% (d) 50% (e) 60%
-

21. $\sqrt{108}$ is between

- (a) 7 and 8 (b) 8 and 9 (c) 9 and 10 (d) 10 and 11 (e) 11 and 12
-

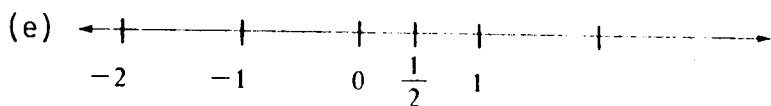
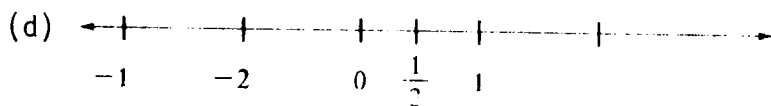
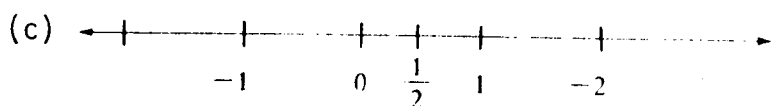
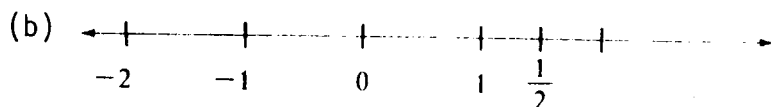
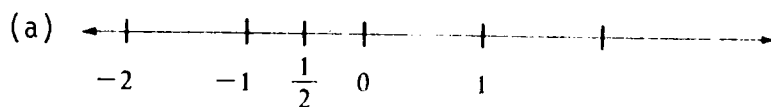
22. $(-5)(-2) + (-14) =$

- (a) -24 (b) -7 (c) -4 (d) 4 (e) 24
-

23. $-2[3 - (5 - 1)] =$

- (a) -14 (b) -10 (c) -2 (d) 2 (e) 4
-

-
24. On which of these number lines are $\frac{1}{2}$, -1, and -2 all located correctly?



25. $\sqrt{16} - (2)^3 =$

- (a) -4 (b) -2 (c) 0 (d) 2 (e) 4

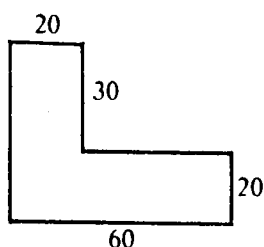
-
26. The ratio of copper to zinc in a certain alloy is 3 to 2. If 30 pounds of copper are used, how many pounds of zinc are needed to make this alloy?

- (a) 5 (b) 20 (c) 40 (d) 45 (e) 50

-
27. In a diving contest five judges score each dive. The high and low numbers are discarded and then the arithmetic average of the remaining numbers is taken. If the five judges score a dive as 6.3, 7.0, 6.0, 6.2 and 7.5, then the diver's score is:

- (a) 6.2 (b) 6.3 (c) 6.4 (d) 6.5 (e) 6.6
-

-
28. What is the perimeter in centimeters of this right-angled plane figure? All measurements are in centimeters.



- (a) 130
(b) 180
(c) 190
(d) 200
(e) 220

-
29. The base of a rectangular box measures 2 feet by 3 feet. How many feet deep should the box be so that the volume will be 24 cubic feet?

- (a) 4 (b) 6 (c) 12 (d) 24 (e) 144

-
30. If $C = \frac{5}{9}(F - 32)$ and F is 50, what is C ?

- (a) 10 (b) 20 (c) 27.7 (d) 30 (e) 40

-
31. If $2x - 5 = 9$, then $x =$

- (a) -7 (b) -2 (c) 2 (d) 7 (e) 12

-
32. If $\frac{x}{6} = \frac{3}{4}$, then $x =$

- (a) $\frac{1}{8}$ (b) $\frac{2}{9}$ (c) $\frac{1}{2}$ (d) $\frac{9}{2}$ (e) 8

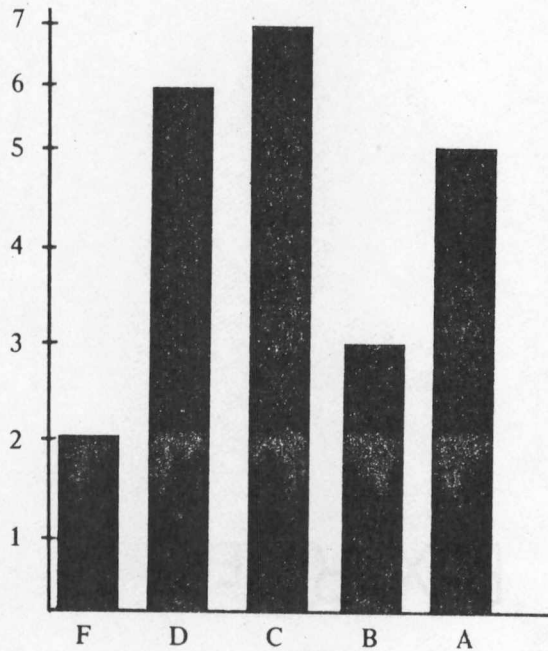
-
33. Which size box of detergent is least expensive per ounce?

Size	Price
16 ounces	\$.80
30 ounces	\$1.20
50 ounces	\$2.00

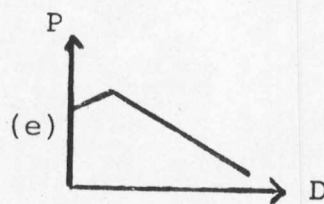
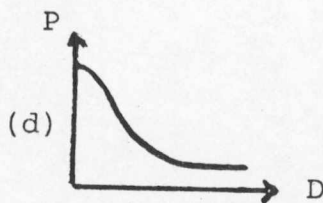
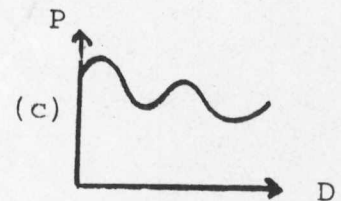
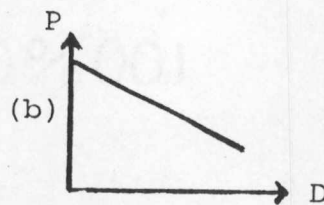
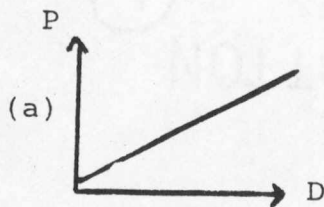
- (a) 16 ounce box only
(b) 30 ounce box only
(c) 50 ounce box only
(d) 16 ounce box and 30 ounce box
(e) 30 ounce box and 50 ounce box
-

34. The following graph shows the grades students earned in an English course. The number with grades higher than C is

(a) 3 (b) 4 (c) 7 (d) 8 (e) 15



35. Which graph shows that the price (P) for a product increases as the demand (d) of the product increases?



36. $8 - [-2(3 - 5) + 2] =$

- (a) -10 (b) -2 (c) 2 (d) 8 (e) 14
-

37. If $2x + 4 = 14$, then $x =$

- (a) 4 (b) 5 (c) 8 (d) 9 (e) 16
-

38. Which of the following is a factor of $rx - rsy$?

- (a) r (b) s (c) x (d) y (e) rx
-

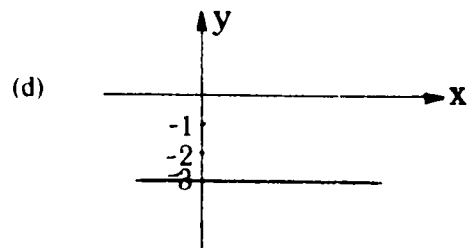
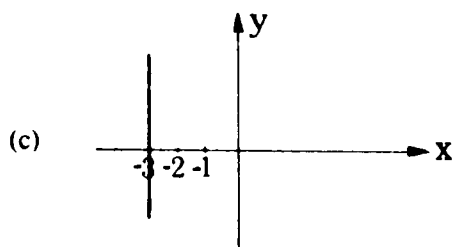
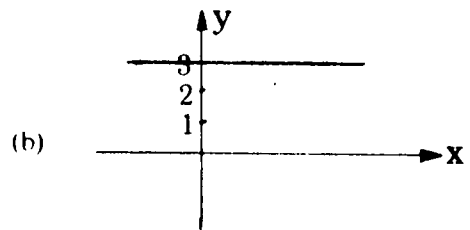
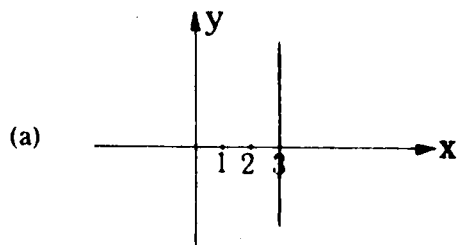
39. If $x = 2$ and $y = -3$, then $x - y =$

- (a) -6 (b) -5 (c) -1 (d) 1 (e) 5
-

40. When simplified, $\frac{3a + 6a^2}{3a} =$

- (a) $2a$ (b) $6a^2$ (c) $1 + 2a$ (d) $1 + 2a^2$ (e) $1 + 6a^2$
-

41. Which of the following represents the graph of $y = -3$?



- (e) None of these
-

42. $2^0 \cdot 2^3 =$

- (a) 0 (b) 1 (c) 6 (d) 8 (e) 16
-

43. $(3x^5y^3)(-5x^2y) =$

- (a) $-15x^{10}y^3$ (b) $-15x^7y^4$ (c) $-2x^7y^4$ (d) $15x^7y^4$ (e) $15x^{10}y^3$
-

44. If $a = 5$ and $b = -7$, then $|a + b|$

- (a) -12 (b) -2 (c) 2 (d) 12 (e) 35
-

45. If $\frac{4}{x} = \frac{5}{3}$, then $x =$

- (a) $\frac{12}{5}$ (b) $\frac{5}{12}$ (c) $\frac{20}{3}$ (d) $\frac{3}{20}$ (e) 7
-

46. $\sqrt{8x^6y^4} =$

- (a) $4x^6y^4$ (b) $4x^4y^2$ (c) $4x^3y^2$ (d) $2x^3y^2(\sqrt{2})$ (e) $2x^4y^2(\sqrt{2})$
-

47. $4x - 15 < x + 15$ is equivalent to

- (a) $x < 0$ (b) $x < 3$ (c) $x < 6$ (d) $x < 10$ (e) $x < 30$
-

48. $\frac{2}{x} - \frac{1}{y} =$

- (a) $\frac{1}{xy}$ (b) $\frac{1}{x - y}$ (c) $\frac{1}{x + y}$ (d) $\frac{2x - y}{xy}$ (e) $\frac{2y - x}{xy}$
-

49. The graph of $3x - y + 6 = 0$ crosses the x -axis at $x =$

- (a) -6 (b) -2 (c) 0 (d) 2 (e) 6
-

50. The x-coordinate of the solution of the system of equations

$$\begin{cases} 2x + y = 3 \\ x - 2y = 4 \end{cases} \quad \text{is}$$

- (a) 0 (b) 1 (c) 2 (d) 3 (e) 4
-

APPENDIX E

PARTICIPATION AGREEMENT

AND

INFORMATION ABOUT THE PROJECT ENTITLED

An Investigation of Applications of Cognitive Mapping to Instructional Strategies for Basic Mathematics

During Fall Quarter, 1979, a study is to be conducted to investigate the effectiveness of utilizing certain types of instruction with certain learning patterns to seek information regarding whether this approach improves the achievement and attitudes of students. As a participant in this program, the following things will be asked of you:

1. To take a basic skills test and respond to an attitude survey and a learning pattern inventory at the beginning of the course.
2. To follow the prescribed course of study to the best of your ability.
3. To take a basic skills test and respond to the attitude survey at the conclusion of the quarter.
4. To consent to the use of test scores and other data collected in the course of the quarter with the assurances of absolute confidentiality and a guarantee that your name will not be used in any publication about the project.

There is NO penalty for not participating in this study. If you are not willing to participate, please check with your instructor, who will set up a program of study for you that does not call for your involvement in this project. If you have any questions, please ask your instructor now, or if any questions arise during the course of the project, do not hesitate to ask them then. If for any reason you later desire to withdraw from this study, you may do so with no penalty.

I have read the above explanation and hereby give my consent for my inclusion and participation in this project.

I am over [] under [] eighteen years of age.

NAME: _____

DATE: _____

APPENDIX F

TABLE F.1
SCORES USED TO DETERMINE VISUAL OR AUDITORY COGNITIVE
STYLE OF SUBJECTS IN THE STUDY

Group A/A		Group V/V		Group V/A		Group A/V	
Subject	Score	Subject	Score	Subject	Score	Subject	Score
1	28	24	27	45	30	67	31
2	30	25	32	46	36	68	29
3	31	26	30	47	28	69	28
4	27	27	30	48	27	70	30
5	26	28	36	49	29	71	27
6	30	29	38	50	30	72	34
7	32	30	38	51	38	73	28
8	31	31	28	52	27	74	32
9	29	32	31	53	31		
10	27	33	27	54	28		
11	30	34	29	55	28		
12	27	35	28	56	27		
13	36	36	34	57	34		
14	31	37	28	58	36		
15	38	38	31	59	30		
16	28	39	30	60	27		
17	34	40	32	61	28		
18	31	41	26	62	29		
19	29	42	32	63	32		
20	28	43	30	64	30		
21	30	44	30	65	28		
22	26			66	27		
23	30						

APPENDIX G

____ Quarter, 19____

SYLLABUS

DVS 0710, 0720, and 0730 BASIC MATHEMATICS I, II, AND III

Instructor:

Office:

Office Hours Available:

TEXTS:

You will be required to buy one or more of the following books:

1. Basic Applied Mathematics, Modules 1-7. Santa Monica, California, Educulture, Inc., 1974.
2. Drooyan, Irving and Wooton, William, Elementary Algebra for College Students. Canada, John Wiley & Sons, Inc., 1976.
3. Curtis, Alan R., Practical Math for Business. Boston, Massachusetts, Houghton Mifflin Company, 1973.

DO NOT MAKE ANY PURCHASES WITHOUT AUTHORIZATION FROM YOUR INSTRUCTOR.

GENERAL OBJECTIVES:

1. DVS Basic Math is designed to improve your computational skills and to increase your understanding of mathematical theory.
2. The learning procedure is individualized with each person working at his/her own speed and according to his/her prescribed needs.
3. The class structure is audiotutorial involving lab work, individual instruction and out-of-class assignments.

SPECIFIC OBJECTIVES:

1. You will be given a pretest at the beginning of the quarter to determine your area of study. This test will not be used when averaging your final grade.
2. You will be required to take a posttest at the end of the quarter. Posttests are used for statistical purposes in evaluating student progress.
3. Curriculum Content will be determined according to your major and will be subdivided into units of study according to your needs.

SYLLABUS

DVS 0710, 0720, and 0730 BASIC MATHEMATICS I, II, and III

Page 2

4. Individual Conferences will be held during the quarter to discuss your progress and/or any problems you may have encountered.

GRADING:

- A - Master of 5 or more units
- B - Master of 4 units
- C - Master of 3 units
- D - Master of 2 units
- F - Completing less than 2 units

Mastery of a unit will be indicated by:

1. Completion of all assigned work
2. A minimum score of 80% on a unit test

ATTENDANCE REQUIREMENTS:

One (1) unexcused absence will be allowed. For each additional absence, the final grade will be cut by a half a letter grade. Perfect attendance will raise the final grade by one half a letter grade.

A student may "make-up" an absence by spending an extra session in the Learning Lab. Any absence must be made up within a week of its occurrence. Also, a report will be made to the admissions office when a student has missed 30% of his/her classes.

Attendance is recorded daily in a register. Each student is responsible for recording the amount of time he/she spends in the Learning Lab.

CLASS SCHEDULE:

_____	Pretests and Class Scheduling
_____	Individual Conferences
_____	Midterm Conferences
_____	Final Date to drop and receive a "W"
_____	Deadline for make-ups
_____	Deadline for Unit Completions
_____	Posttests; evaluations

APPENDIX H

TABLE H.1
MEAN SCORES AND STANDARD DEVIATIONS

	V/V	A/A	A/V	V/A
Pretreatment Skills				
Means	38.9	37.8	41.5	44.23
S.D.	15.74	13.44	18.15	15.81
Posttreatment Skills				
Means	49.12	49.79	47.25	51.25
S.D.	18.48	18.96	26.13	15.98
Pretreatment Attitudes				
Means	39.19	37.96	40.88	31.86
S.D.	13.66	13.88	21.60	13.00
Posttreatment Attitudes				
Means	41.04	42.48	48.24	35.64
S.D.	11.83	10.59	15.10	17.44
Achievement Gains				
Means	10.21	11.98	5.75	7.03
S.D.	16.57	22.26	30.15	21.69
Attitude Gains				
Means	1.86	4.52	7.38	3.77
S.D.	8.59	9.95	8.57	12.98
Number of subjects (Total = 74)	21	23	8	22

VITA

Born December 1, 1948, Charles Larry Bouldin attended elementary schools in Grundy County, Tennessee, and graduated from the high school in this county in 1965. He received the Bachelor of Arts degree in mathematics from David Lipscomb College in August of 1969 and the Master of Science degree in mathematics in January 1972 from Middle Tennessee State University. He received the Doctor of Education degree in Curriculum and Instruction with concentration in the area of mathematics education from The University of Tennessee, Knoxville, in June 1982.

The author is a member of Phi Delta Kappa, the Mathematics Association of America, and the Tennessee Mathematics Teachers' Association. He currently is an associate professor of mathematics at Roane State Community College, where he has taught since 1972. He resides in Rockwood, Tennessee, with his wife, Anne Powers, and son, Patrick.