MATCHING PROGRAMED INSTRUCTION PACKAGES AND AN INSTRUCTIONAL SETTING TO STUDENTS, IN TERMS OF COGNITIVE STYLE: AN EXPLORATORY STUDY

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ABSTRACT

MATCHING PROGRAMED INSTRUCTION PACKAGES AND AN INSTRUCTIONAL SETTING TO STUDENTS, IN TERMS OF COGNITIVE SUYLE: AN EXPLORATORY STUDY

By

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Education has reached a financial crisis. The funds which came so easily from the taxpayers has dwindled considerably. One reason for this is public dissatisfaction with the status quo in education. The public is demanding to know where its money is going and if the money spent is bringing a reasonable return in the form of better education for America's youth.

Instructional Development appears to be an area of education from which gains in efficiency and effectiveness of instruction may be expected. One method of making the instructional process more efficient and effective is to adapt instructional strategies to the individual characteristics of the student, hopefully ensuring the greatest amount of success with the least expenditure of time and materials.

The purpose of this study was to find a method of matching certain student characteristics (in terms of cognitive style) to an instructional strategy and setting suited to the

student's characteristics. More specifically, the purpose was to investigate the significance of the degree of match between student characteristics and instructional strategy and setting characteristics.

Educational researchers have suggested studies in which student, media and environmental characteristics are analyzed, with learning tasks specifically defined, and learning conditions identified for those tasks. All these suggestions were employed within this study.

The conceptual framework called the Educational Sciences, as used at Oakland Community College in Michigan, was employed in this study. This framework includes the Educational Science of Cognitive Style, used to diagnose student characteristics in the planning of educational experiences at that college. Cognitive style elements were used to define the characteristics of the programed instruction packages and the instructional setting, as well as the characteristics of the students.

It is generally agreed that all students do not learn in the same ways. The literature in this study indicates that little is known about the structure of learning as it applies to either programed instruction or aptitude-treatment interactions. This study employed a framework (the Educational Sciences) within which cognitive characteristics are measurable and, by so doing, attempted to shed more light on student achievement.

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This study was conducted in a community college serving nearly 19,000 students. The population consisted of students enrolled in a freshman science course designed for the educationally disadvantaged. Two samples were drawn from this population (N=36, N=20) on the bases of accessibility and purpose of the study. Each sample was then divided according to the degree of match between student cognitive style and the mode of understanding required by the programed instruction package and the setting in which it was used. Each student completed a pretest, the programed text, and a posttest for the unit assigned.

The data were analyzed by use of the Kolmogorov-Smirnov one-tailed "two sample" Statistical Test Model to indicate interactions between groups of students matched, by degree, to the program and setting. All hypotheses were tested using the .10 level of confidence.

The findings of the study failed to reject the null form of the operational hypotheses which indicated that there would be no difference between cumulative relative frequencies of gain scores across groups. There was no significant difference between relative frequencies of gain scores. The data were further analyzed, with the only significant finding ($\alpha \leq .10$) indicating that posttest success for one of the two samples could be predicted on the basis of cognitive style.

MATCHING PROGRAMED INSTRUCTION PACKAGES AND AN INSTRUCTIONAL SETTING TO STUDENTS, IN TERMS OF COGNITIVE STYLE: AN EXPLORATORY STUDY

By

James D. Hand

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This dissertation is dedicated to Lynn, Micheline and David. One didn't know if it were possible to get to there from here; the others didn't know where here, there and father were for two years.

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CHAPTER I

NEED FOR THE STUDY

The many pressures for improvement in higher education have led to systematic analysis of educational institutions and instruction of various types. Dwindling educational funds coupled with public dissatisfaction with the educational system as it now exists have forced educators to seek means and methods for making instruction both more efficient and more effective. Instructional Development (ID) has recently come to the forefront of education as one systematic method for decision-making in the process of improving instruction. Within the area of Instructional Development much has been done with educational objectives and strategies for overcoming the constraints of time and money. One of the areas about which less is generally known is the relationships between student characteristics and the methods and settings of instruction. The goal of the present study, conducted within the conceptual framework called the "Educational Sciences" as employed at Oakland Community College in Michigan, was to provide information concerning the interactions between student characteristics, programed instruction, and the setting in which the program was used by the student.

Current Problems in Higher Education

Over the past five years the American taxpayer has become increasingly resistant on the funding of educational programs. Wildavsky senses this aspect of a general taxpayer revolt in his comment that, "Consumers of governmental services are entitled to know what they are getting."[1] Lessinger relates this feeling, this demand for accountability by educators to the public, in this way:

> Seekers of educational funds have always talked in terms of books, staff, materials, equipment and space to be acquired or used, together with students to be served and programs to be offered. Questioners in the past were content to listen to accounts of resources allocated. This has changed. Today the questions focus on results obtained for resources used. The questions are pointed, insistent and abrasive.[2]

The question "What results for how much?" is directly related to the functions of Instructional Development.

Instructional Development, as a systematic method for the improvement of instruction, is a time- and fund-expending process. The process involves viewing any given educational system[3] within which a problem is discovered, viewing its

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[1]Aaron Wildavsky, "A Program of Accountability for Elementary Schools," Phi Delta Kappan, LII (December 1970), p. 212.

[2]Leon Lessinger, "Engineering Accountability for Results in Public Education," Phi Delta Kappan, LII (December 1970), p. 217.

[3]Charles F. Schuller, in "Systems Approaches in Media and Their Application to Individualized Instruction at the University Level," Michigan State University, 1967, presented in part at Bucknell University Symposium, February, 1968 (Mimeographed), defines a "system" as: "any group of dynamically related components which operates in concert or in related fashion for the purpose of achieving a specified goal or set of goals."

relationships with its suprasystem or suprasystems and subsystems in order to formulate a series of feasible resolutions. Tentative solutions are then tested, evaluated, and accepted or revised. The initial costs of such a process may be substantial and therein lies a dilemma. As Stowe expresses it,

> ID's dilemma [cost] is deepened by the increasing emphasis on accountability in all areas of instruction. This concept's growing popularity is not surprising in a time of shrinking resources, taxpayer restiveness, and public skepticism about the effectiveness of education. Undeniably a healthy movement for education in general, accountability may work a severe hardship on innovations, especially those which have not had time to shake down into efficient processes.[4]

There is apparent need within the field of instructional Development for research which provides data from which increasingly effective and efficient development of materials and strategies can emerge, and efficient development of materials and strategies can eminate, perhaps leading to savings in both time and money.

The time and money constraints involved in Instructional Development led Abedor and Gustafson to state in a recent article that,

> Those of us in the instructional development (ID) profession often justify our existence or that of our programs by claiming to help others make their instructional systems more efficient and/or effective ... as dollars become more scarce and as more institutions move to a program budgeting strategy, instructional development programs are likely to be justified on the basis of

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[4]Richard A. Stowe, "The Crucial Issue in Instructional Development," Audiovisual Instruction, 16 (December 1971), p. 8.

measurable effects rather than on the opinions of proponents.[5]

There seems common agreement on the need for measurable results as a product of the educational system. Instructional Development shows promise in providing data on these measurable results. Information derived from research and analysis of the education system, leading to a feasible solution to a given problem, is fundamentally important in Instructional Development.

Need Within the Field for This Investigation

Many educators feel that Instructional Development holds the promise of discovering means and methods for the improvement of instructional efficiency and effectiveness. The Commission on Instructional Technology stated in its final report to President Nixon that "The Commission is convinced that technology properly employed could make education more productive, individual, and powerful...."[6] Proper employment of technology includes identification and analysis of the data within the system for accurate decision-making.

There are several components in any given educational system which must be analyzed. One of these components is the

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[5]Allan J. Abedor and Kent L. Gustafson, "Evaluating Instructional Development Programs: Two Sets of Criteria," Audiovisual Instruction, 16 (December 1971), p. 21.

[6]Commission on Instructional Technology, To Improve Learning (Washington, D. C.: Government Printing Office, March, 1970), p. 34.

student and his individual characteristics as related to the educational experience. Another factor is the instruction which the student receives: what form it takes, what strategies are involved, what objectives are set, and what criterion levels are established. There is a need to specify systematically those instructional strategies which will lead to optimum student achievement of objectives, taking into account student characteristics. Many educators have expressed this need, among them Tyler, Hamreus, Gustad, and the Presidentially-appointed Commission on Instructional Technology. As Tyler wrote in 1933,

> No one series of learning experiences has proved equally effective with all students ... the expansion of learning activities should be supplemented by a means of discovering for the students where their difficulties are and of suggesting what kinds of activities will be most helpful to them in overcoming these difficulties in learning.[7]

Hamreus echoed this thought when he stated:

> ... no systematic method presently exists which permits instructional technologists to make decisions regarding what the nature of instructional events should be to most effectively achieve the desired outcomes, i.e., should they be verbal, non-verbal, visual, or auditory, various combinations of these....[8]

These views, in essence, call for personalizing education.

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[7]Ralph Tyler, "Prevailing Misconceptions," Journal of Higher Education, June 1933, p. 288.

[8]Dale G. Hamreus, "The Systems Approach to Instructional Development," in The Contribution of Behavioral Science to Instructional Technology: A Resource Book for Media Specialists, Teaching Research Division of the Oregon State System of Higher Education, pp. 1-50.

Gustad, in relating Instructional Development to educational problems, saw the necessity for a theoretical framework within which to formulate solutions:

> At one time or another, radio, motion pictures, filmstrips, TV, language labs, and teaching machines have been hailed as the saviors of education. So have large classes, small classes, seminars, tutorials, independent study, years abroad, work-study programs, mid-winter reading periods, and year-around operation. None of these is either as bad as detractors assert or as good as zealots claim. Lacking an adequate theoretical framework in which to place these innovations, the pendulum continues to swing wildly from euphoria to cynicism.[9]

The Commission on Instructional Technology stated:

> Instructional Technology could provide the framework necessary for designing conditions of learning that are more closely based on what is known about how human beings learn.[10]

The statements of Gustad and the Commission on Instructional Technology indicate not only the need for personalizing education but point out the necessity within the field of Instructional Development for establishing a conceptual framework for making decisions regarding strategies for that personalization.

Summarizing the statements of Tyler, Hamreus, Gustad, and the Commission on Instructional Technology, it may be stated that three of the factors which must be taken into account by Instructional Developers when seeking solutions to given instructional problems are the student's characteristics, the

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[9]John W. Gustad, "On Improving College Teaching," NEA Journal, V53(3):37-38 (1964), p. 38.

[10]Commission on Instructional Technology, op. cit., p. 32.

instructional strategy by which that particular student could be brought to a specified criterion level, and some unifying conceptual framework within which decisions can be made concerning both the student and the strategy. This investigation was designed to study the interrelationships between a student's characteristics, the instructional material and the setting in which the instruction took place, all within the conceptual framework called "The Educational Sciences."

Need as Expressed by Researchers

A need has been expressed by certain researchers for further investigations which involve specific educational tasks, conditions, and analysis of student-, media-, and environment-related characteristics. Campeau, in attempting to uncover methods by which research in educational media and Instructional Development could be improved, has suggested that:

> neither the learning psychologist nor the classroom teacher can justify such decisions [choosing and using media] entirely on the basis of present research evidence.... The view of the present writer is that even current findings will be of very limited usefulness until media research systematically provides for the (a) explicit definition of learning tasks used, (b) careful identification of learning conditions required by these tasks ... and (d) thorough analysis of media-, learner-, and environment-related characteristics to determine the nature and extent of their influence on experimental results.[11]

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[11]Peggie L. Campeau, "Selective Review of Literature on Audiovisual Media of Instruction," in Leslie J. Briggs, Peggie L. Campeau, Robert M. Gagné and Mark A. May, Instructional Media: A Procedure for the Design of Multi-Media Instruction, a Critical Review of Research, and Suggestions for Future Research (Pittsburg: American Institutes for Research, December, 1966), pp. 138-139.

Within this study the learning task was explicitly defined, the conditions required by the task identified, and media-, environment-, and student-related characteristics analyzed within the framework of "The Educational Sciences."

In the past many studies dealing with programed instruction have been carried out. Some have investigated the effects of program characteristics such as pacing, step size or timed trials. Others have concentrated on student characteristics such as I.Q., sex, age, or final grade reports.

A search of recent literature has brought to light only one study using programed instruction which related the effects of certain student characteristics with differing instructional methods. This study, by Haskell,[12] related the personality measures of "Friendliness" and "General Activity" to two instructional settings: programed instruction in a solitary environment, student paced; and traditional instruction permitting a considerable amount of pupil-teacher interaction, requiring explicit student responses in front of peers, and teacher-paced. Results indicated that these two learning environments differently affected student academic performance. Concerning these results, Haskell reports:

> This finding suggested that the characteristics of students could be specified in such a way that one could

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[12]Roger W. Haskell, "Effect of Certain Individual Learner Personality Differences on Instructional Methods," AV Communication Review, 19 (Fall, 1971), pp. 287-297.

> increase the effectiveness of learning by prescribing the instructional method to which the learner would be exposed.[13]

Expressing a need to continue this line of study, he states:

> ... researchers have only begun to identify the vast array of possible relationships between learner characteristics and the instructional environment. At present it seems ... important to examine further the complexity of interrelationships between individuals and the learning milieu.[14]

The relationships between certain students, instructional and setting characteristics of which Haskell speaks were investigated within the present study.

Learning tasks, conditions and analysis of media-, learner-, and environment-related characteristics were provided for in the present study, as suggested by Campeau. In similar fashion, individual student differences and strategies for meeting the needs of those students were investigated, as suggested by Tyler and Hamreus. In addition to these considerations, the study was conducted within a conceptual framework for identifying student characteristics and for designing conditions for learning, as suggested by Gustad and the Commission on Instructional Technology.

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[13]Roger W. Haskell, "Effect of Certain Individual Learner Personality Differences on Instructional Methods," AV Communication Review, 19 (Fall, 1971), p. 294.

[14]Ibid., p. 295.

The Educational Sciences

The Oakland Community College Program: An Overview

There is a testing program at Oakland Community College which provides a computerized "cognitive style" map printout for all students who are enrolled in at least two courses during their first session at the college. The data included on the printouts are used in matching students and teachers and also matching students with certain instructional procedures. The resulting product is called the Personalized Education Program (PEP) for that student. PEP has the desirable components of flexibility and personal feedback for individualization of instruction. Using the cognitive style printout (map) and subjective information gathered in private conversation with the student, a team of teachers and the student jointly develop a PEP for that student which is geared to his strengths and weaknesses--a program intended to give every possibility for his success.

Within the courses currently running under the PEP concept (approximately 35% of the college's offerings) the student is presented with course objectives and proceeds to follow these instructional procedures jointly arrived at in the counseling session:

1. Lecture discussion where a more traditional approach to instruction predominates, i.e., material is presented and students are allowed to ask questions.

2. Seminar where the student meets with a small group of students, led by the instructor or a student leader, to clarify course concepts or principles.

3. Individualized Programmed Learning Lab (IPLL) where students can work on programed materials, models, and portable tachistiscopes on an individual basis or receive tutorial aid from faculty members.

4. Carrel Arcades where students can utilize audio tapes, slide-tape materials, movies, filmstrips and videotapes.

5. Youth-tutor-youth where students work with more advanced students towards the instructional objectives.

The validation sample for the battery of diagnostic tests and the program itself included one thousand student maps. Since no instruments exist to determine the concurrent validity of this program, it was validated empirically through observation, learning successes and interviews with the students and their associates. To date over 20,000 students have been mapped for cognitive style, with less than 2% of them needing retesting by the Oakland testing staff in order to satisfy indications of their styles being decidedly different from those shown in their original mappings. This statistic was determined, in part, by the need for retesting students for whom the prescribed instructional strategies were not successful.

Cognitive Style in Psychology

The formulation of the concept of cognitive style in psychology began in the late 1920's, and continued with studies of

predictability and consistency of personality carried out by such noted psychologists as Allport, Havighurst, Hartshorne, May, Lewin and Pressey.

In the latter half of the 1930's, Allport[15] referred to "style of life" and to "modes of adaptation" as a means of identifying distinctive personality types. In 1940 Allport referred to the concept of "style" and defined it as the consistency and pattern of expressive behaviors that one displays in performing various tasks.[16] Allport's use of the term "style" is similar to its common use in such phrases as: style of living, writing style, style of dress, a basketball player's style of play, or a comedian's style of delivery. This orientation permits the use of the term "style" to denote an entire pattern of responses, either general (as in "life style") or relatively specific behavior (as in "skiing style").

In the late 1940's researchers became concerned with concept formation as a cognitive behavior. This group became known as one that studied "cognitive processing," and as Gardner notes, they considered a response to a stimulus as "... coerced not by stimulus alone, but also by the organizational dispositions of the responding system...."[17]

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[15]Gordon W. Allport, Personality, A Psychological Interpretation (New York: Henry Holt and Company, 1937), p. 47.

[16]Gordon W. Allport, "Motivation in Personality: Reply to Mr. Bertocci," Psychological Review, 47 (November 1940), pp. 549-553.

[17]R. W. Gardner, et al., "Cognitive Control: A Study of Individual Consistencies in Cognitive Behavior," Psychological Issues, Vol. 1, No. 4, p. 3.

Klein[18] identified the organizational processes referred to by Gardner as "cognitive control principles." While Gardner[19] suggested that the term "cognitive style" should only be applied to those control principles within an individual, more recent investigators have considered cognitive style as an individual's response to specific stimuli.

Broverman suggested that certain types of cognitive style as defined by Gardner and Klein appear to correspond to particular broad classes of behavior, and that "... cognitive styles seem promising parameters on which to order a perplexing array of individual differences in human behavior."[20]

In the early and mid-1950's the concept of cognitive style was investigated in the context of cognition as a component of personality. Witkin[21] proposed, for example, that the phenomenon termed "cognitive style" is a type of personality construct shown in the interaction between the events in a person's life history and that person's perceptual (cognitive) response systems. This type of investigator was interested in

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[18]G. S. Klein, "The Personal World Through Perception," in Perception: An Approach to Personality, ed. by R. R. Blake and G. V. Ramsey (New York: Ronald Press, 1951), pp. 328-353.

[19]R. W. Gardner, "Cognitive Styles in Categorizing Behavior," Journal of Personality, Vol. 22 (1935), pp. 214-233.

[20]D. M. Broverman, "Dimensions of Cognitive Styles," Journal of Personality, Vol. 38 (1960), p. 183.

[21]H. A. Witkin et al., Personality Through Perception (New York: Harper and Brothers Publishers, 1954), pp. 495-500.

such phenomena as the quality of sibling relationships as antecedents to particular types of cognitive styles.

Some contemporary investigators who have considered cognitive style as a consistent form or pattern of behavior have examined categories of cognitive style in relation to particular personality variables such as passivity, anxiety and dependency.

Witkin[22] defined the concepts of field-dependence field-independence. Witkin's investigations revealed that field-dependence was associated with such personality traits as high anxiety, low self-esteem, lack of self-awareness and general passivity. Field-independence was found in subjects exhibiting high self-awareness, low anxiety, high self-esteem and high activity.

In other studies Barron[23] found that persons exhibiting independence of judgment in an experimental social situation tended to prefer complexity in drawings, place a greater value on creativity, on the individual rather than the group, and on close interpersonal relations. Individuals termed "yielders" in the same experimental situation tended to be group oriented, pragmatic and somewhat "physicalistic" in their thinking.

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[22]H. A. Witkin, "Individual Differences in Cases of Embedded Figures," Journal of Personality, Vol. 19 (1952), pp. 1-15.

[23]Frank Barron, "Some Personality Correlates of Independence of Judgment," Journal of Personality, Vol. 21 (March, 1953), pp. 287-297.

The studies cited above investigate cognitive processes within the context of defined social and personality variables. Certain psychologists (e.g., Broverman, Gardner, Klein, Witkin) have used the term "cognitive style" in their studies to identify consistent qualities of behavior exhibited by individuals.

The Educational Science of Cognitive Style

A method of exploring cognitive style, the "educational science of cognitive style," as used by Hill[24] and others, is somewhat different from that which has been investigated, described and defined by psychologists. The approach within the educational sciences is an attempt to describe a "style" or broad pattern of behavior using symbolic language.

Hill defines cognitive style in the Educational Sciences as:

> a Cartesian product, G, composed of three sets, S, E and H, where S denotes the set of elements defining symbolic orientation, E indicates the set of cultural determinants of the meaning of symbols and H designates the set of modalities of inference.[25]

An individual's cognitive style is defined as "a set g, a Cartesian product of sub-sets (s, e and h) of appropriate elements drawn from (all of the possible elements in) sets S,

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[24]Dr. Joseph E. Hill is currently president of Oakland Community College. During the past thirteen years, Hill and others (e.g., Nunney, Cotter, Dehnke, DeLoach, Fragale, Ort, Rankin, Robinson, Shuert, Wasser, Wyett and Zussman) have developed the educational sciences as employed at Oakland Community College.

[25]Joseph E. Hill, "Cognitive Style as an Educational Science" (Unpublished paper, Oakland Community College, 1968), p. 2.

E and H."[26] A Cartesian product is a non-arithmetic display of elements contained in two or more sets, used for showing possible combinations of these elements without actually breaking down each of those possible combinations in graphic form. Thus the Cartesian product for cognitive style in the educational sciences is represented as

$$G = \left\{ S \right\} \times \left\{ E \right\} \times \left\{ H \right\},$$

in which "G" is defined as the combination of all possible elements found in S, E and H.

Cognitive style in the educational sciences is a concept for describing an individual's mode of behavior in searching for meaning. Cognitive style is identified by an individual's disposition or propensity: 1) to use certain types of symbolic forms versus others, 2) to derive meanings of symbols from the cultural role the individual finds most satisfying, and 3) to use one reasoning pattern in preference to others in reaching conclusions from data inputs. A graphic representation of the elements included within the three sets (Symbols, Cultural Determinants and Modalities of Inference) is called a "map." This map provides a picture of the way in which the individual derives meaning from his environment based upon his symbolic orientations, personal experiences, and methods of reasoning.

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[26] Ibid., p. 4.

An individual's academic performances, such as test scores and grades coupled with a wide variety of demonstrable performances and his responses to questions regarding various matters involved in his life experience, can be translated into elements comprising his cognitive style.

Components of Cognitive Style in the Educational Sciences

Three subsets of information are combined to describe the set "cognitive style." These three subsets are: (1) Symbols and their Meanings, (2) Cultural Determinants of the Meaning of Symbols, and (3) Modalities of Inference. A fourth subset, Biochemical and Electrophysiological Aspects of Memory, is in the early stages of development and cannot be included at this time.

Hill has defined "symbols and their meanings" as "that component of cognitive style which defines an individual's ability to derive meaning from theoretical and qualitative representations of his environment and personal experiences."[27] Information from the environment is processed by the human neural system in the form of coded messages, as shown through the works of Broadbent,[28] Katzman,[29] Miller,[30] and Shannon

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[27]Joseph E. Hill, "Symbols and Their Meanings" (Unpublished paper, Oakland Community College, 1972), p. 1.

[28]D. E. Broadbent, Perception and Communication (London: Pergamon Press, 1958).

[29]Nathan I. Katzman, "Uncertainty, Choice Points, and Information Packing" (East Lansing, Michigan: Michigan State

and Weaver.[31] The two types of symbols, theoretical (words and numbers) and qualitative (sensory and code data), which man encodes for information processing have been defined by Hill as follows:

> a) The theoretical symbol is that symbol which presents to the awareness of the individual something different from that which the symbol itself is.
>
> b) 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.[32]

For example, the spoken word "cup" is an auditory sensation which represents to the individual's nervous system some type of representation associated with the physical object of a cup. Since this auditory sensation presents to the individual's neural system something other than that which the symbol itself is, it is a theoretical symbol. In contrast, the visual image resulting from the individual's observation of an actual cup would be a qualitative symbol because it presents to the senses that which the symbol itself is to the individual. Both types of symbols are used by man in encoding information from the environment and are, therefore, essential to the educative process, i.e., the process of searching for meaning.

University, Department of Communication, 1971). (Mimeographed.)

[30]G. A. Miller, "The Magical Number Seven, Plus or Minus Two: Some Limits on Our Capacity for Processing Information," The Psychological Review, LXIII, 2 (1956), pp. 81-97.

[31]C. E. Shannon and W. Weaver, The Mathematical Theory of Communication (Urbana, Illinois: University of Illinois Press, 1949).

[32]Joseph E. Hill, "Part One: Symbols and Their Meanings" (Bloomfield Hills, Michigan: Oakland Community College Press), p. 26.

There are two main types of theoretical symbols: auditory and visual. Each of these is divided into linguistic and quantitative elements in the Educational Sciences. The four theoretical symbols used in cognitive style mapping are:

1. T(AL)[33]--Theoretical Auditory Linguistic--the sound of a word.
2. T(AQ)--Theoretical Auditory Quantitative--the sound of a number.
3. T(VL)--Theoretical Visual Linguistic--the written word.
4. T(VQ)--Theoretical Visual Quantitative--the written number.

The above four types of theoretical symbols are used in ordinary languages to communicate ideas in a connected, consecutive manner, according to the principles of common logic. In most languages theoretical symbols are words or numbers, in written or oral form. The ability of an individual to use these theoretical forms to derive meaning from the environment is tested for and then represented on the individual's cognitive style map.

Qualitative symbols are used to convey "feelings," commitments, values, and to provide particular types of insights into the domain of "self." In this context qualitative symbols influence, and are influenced by, sub-cultural individualism. "The main function of the qualitative symbol is figurative

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[33]The symbolic notations used have been developed in the educational sciences for more concise communication between those individuals who employ this framework, and for simplicity in computer printouts of cognitive style maps used in the Personalized Education Program at Oakland Community College.

expression, not literal statement. Theoretical symbolic languages are oriented toward generalization, qualitative symbolic codes toward sub-cultural individualism."[34]

The meaning of qualitative symbols is derived from three sources: 1) sensory stimuli, 2) cultural codes ("games" according to social psychologists), and 3) programmatic effects of objects which present an impression of a definite series of operations, scenes, events or images.[35] There are eighteen qualitative symbols. Five are associated with sensory stimuli:

1) auditory--perception through hearing--Q(a)

2) olfactory--perception through sense of smell--Q(o)

3) savory--perception through taste--Q(s)

4) tactile--perception through sense of touch--Q(t)

5) visual--perception through sight--Q(v)

Three are programmatic in nature, dealing with neurological conditioning which allows an individual to do two or more things at once. These are: 1) proprioceptiveness-Q(p), 2) proprioceptive kinematics-Q(pk), and 3) proprioceptive temporal-Q(pt). Proprioceptiveness is defined as "the ability to synthesize stimuli produced within the body to produce a manifest behavior such as typewriting, playing a musical instrument while reading music, or any other seemingly automatic activity."[36]

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[34]Joseph E. Hill, "Qualitative Symbols" (Bloomfield Hills, Michigan: Oakland Community College Press), p. 1.

[35]Joseph E. Hill and Betty D. Setz, Educational Sciences at Oakland Community College (Bloomfield Hills, Michigan: Oakland Community College Press, 1970), p. 4.

[36]Joseph E. Hill, "Qualitative Symbols," p. 4.

The latter two forms of proprioceptiveness are subsets of the first and deal with motor skill ability and timing, respectively.

The remaining ten qualitative symbols are associated with cultural codes.

1) empathetic--the ability to identify with another's feelings, volitions or ideas--Q(cem)
2) esthetic--the ability to enjoy the beauty or pureness of an idea or object--Q(ces)
3) ethic--dedication to a set of values, principles or duties--Q(cet)
4) histrionic--staged behavior to produce a particular effect on others--Q(ch)
5) kinesics--the ability to communicate by "body language"--Q(ck)
6) kinesthetics--ability to employ motor skills in the performance of certain activities according to normative performance expectations imposed by one's culture--Q(ckh)
7) proxemics--the ability to judge "critical" physical and social distance in the act of communication relative to normative behavior patterns and the interpretations of the role as perceived by the other person--Q(cp)
8) synnoetics--knowledge of oneself in relation to one's environment--Q(cs)

9) temporal--social timing in communication with others, relative to normative behavioral patterns and the interpretation of the role as perceived by the other person--Q(ctm)

10) transactional--ability to maintain a positive communication interaction which significantly influences the goal of the persons involved in that interaction--Q(ct)

Qualitative symbols, whether they be sensory, programmatic or cultural codes, are used by humans in the process of mediating meaning from one's environment or personal experiences (e.g., pain).

The second subset of the educational science of cognitive style is the cultural determinants of the meaning of symbols. Man's mediation of theoretical and qualitative symbols is influenced by such sociological aspects as norms and role expectations. Psychologists such as Thorndike[37] and Hull[38] recognized the influence of man's environment on man's thoughts and actions. Within the framework of the Educational Sciences, cognitive style considers the following three determining factors in the mediation of symbols: 1) family - F, 2) associates - A, and 3) individuality of a person - I. "These

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[37]E. L. Thorndike, The Fundamentals of Learning (New York: Teachers College, Columbia University, 1932), pp. 53, 194.

[38]C. L. Hull, Principles of Behavior (New York: Appleton-Century-Crofts, Inc., 1943), pp. 41, 67, 168.

determinants, i.e., family, associates and individuality, are significant enforcing agents of societal norms and determiners of role definitions and expectations."[39] Whether a student is influenced most by his family, associates or self becomes important information to any educator. From this datum can come a variety of instructional strategies aimed at the role the student perceives for himself in his environment.

The third subset of cognitive style is modalities of inference. The process of deriving meaning employs two basic types of reasoning, induction and deduction. Inductive processes yield probability conclusions. Deductive processes produce conclusions which are necessary consequences of the premises and the chain of reasoning used.

Within the Educational Sciences there are four inductive inferential models and one deductive model. The inductive models are: 1) magnitude (M), 2) difference (D), 3) relationship (R), and 4) appraisal (L). Magnitude inference is a form of "categorical thinking," and utilizes norms categorically classified, and attitudes accepted as true by the individual as the basis for acceptance or rejection of advanced hypotheses. Difference deals with hypotheses of difference such as one-to-one contrasts or comparisons of selected characteristics or measurements. The relationship process involves the

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[39]Laurence Wasser, "The Educational Science of Cognitive Style: An Introduction" (Bloomfield Hills, Michigan: Oakland Community College Press, 1971), p. 10.

synthesizing of two or more characteristics or measurements in deriving a conclusion. Appraisal type of inference employs, with equal weight, hypotheses of all the previous three (M, D, R), depending upon the situation with which the individual is confronted in coming to a conclusion. Deductive inferential -□K - (see above) exists frequently in the study of mathematics and the natural sciences.

In summary, cognitive style within the Educational Sciences is a concept for describing an individual's mode of behavior in searching for meaning. It is identified by an individual's disposition to use certain types of symbolic forms versus others; the derivation of meaning of symbols from roles the individual has found most satisfying; and the manner in which he reasons. A map of an individual's cognitive style provides a picture of the way in which he derives meaning from his environment based upon his symbolic orientations, personal experiences, and ways of reasoning.

Cognitive Style Mapping

A cognitive style map is a pictorial representation of elements diagnosed through testing. The elements were discussed in the previous section. The Oakland Community College battery of tests from which the maps are drawn by computer is described fully in Chapter III and in Appendix A. Mapping is a convenient method of presenting a vast amount of data in a concise form. An example of a cognitive style map of an individual is shown in Figure 1.1. At the 12th grade level of

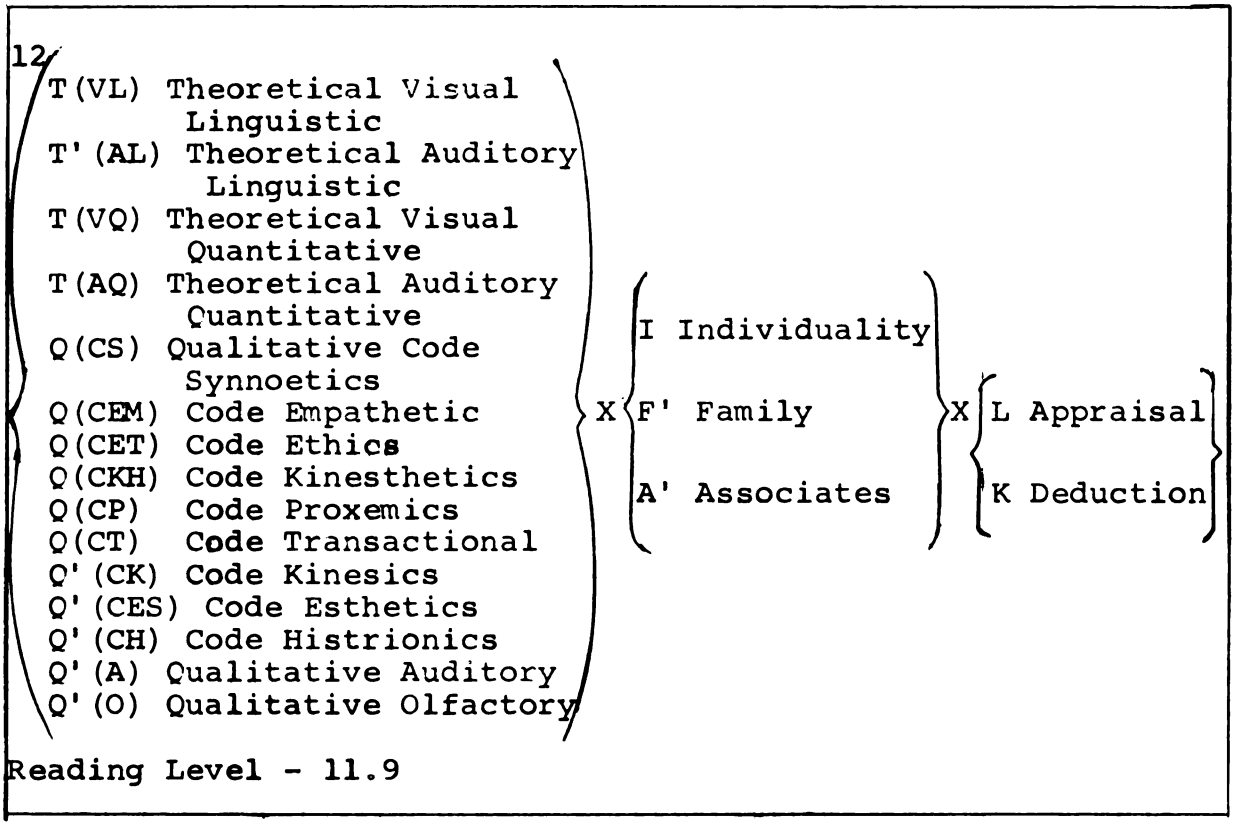

Figure 1.1 - Sample Cognitive Style Map

educational development this person shows that he prefers to read, T(VL), to derive meaning, with far less preference for listening, T'(AL). In working with numbers this person does equally well when reading, T(VQ), or listening, T(AQ), to them. His knowledge of his own abilities, Q(CS), is tempered by his being able to identify with the roles of others, Q(CEM), and his dedication and adherence to a set of rules and principles, Q(CET). His ability to use motor skills according to normative performance expectations serves him well - Q(CKH). He is able to judge critical social distance, so as not to offend others - Q(CP). He is able to influence others toward his point of view - Q(CT).

Other abilities he shows, although in lesser strength, are the ability to communicate through "body language" - Q'(CK)-, the ability to enjoy and learn from beauty and pureness of thought - Q'(CES), the ability to play a socially acceptable role when the situation warrants it - Q'(CH), and to learn from his senses of hearing and smell - Q'(A) and Q'(O).

In perception and decision-making regarding his life, this person is primarily self-oriented. He accepts some of the influencing stimuli from both family and associates - F and A.

The reasoning pattern of this person incorporates all three of the inferential modes described previously as magnitude, difference and relationship. He is an "L." He also has sound mathematical and scientific reasoning powers - □K.

It should be noted that there were three forms of symbols used on the sample cognitive style map: 1) "major" orientation, 2) "minor" orientation, and 3) negligible elements. The major orientations were listed in this manner: T(VL). The minor orientations had an added "prime": T ⓘ (AL). The negligible elements did not appear on the map. Based on the work of Flanagan,[40] Hill has developed the following

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[40]John C. Flanagan, "General Considerations in the Selection of Test Items and a Short Method of Estimating the Product-Moment from the Data at the Tails of the Distribution," Journal of Educational Psychology, XXXII (December 1939), pp. 674-680.

principles for use in cognitive style mapping:

> Principle I. If the percentile rank of an individual's score in a given ... [cognitive style element] occurs in an array of values ranging from the fiftieth through the ninety-ninth percentile (inclusively) of a population of these scores, then the individual is accorded a major orientation ... in that domain.
>
> Principle II. If the percentile rank of an individual's score ... occurs in the array of values ranging from the twenty-fifth through the forty-ninth percentile (inclusively) of a population of these scores, then the individual is accorded a minor orientation ... in that domain.
>
> Principle III. If the percentile rank of an individual's score ... occurs in the array of values ranging from the zero percentile through the twenty-fourth percentile of a population of these scores, then the individual is accorded neither a major nor a minor orientation in that domain.[41]

The major and minor orientations are designated for specific levels of educational development, according to grade level. On the sample cognitive style map a "12" is coded in the upper left corner. This indicates that all major and minor orientations listed are for the 12th grade level of educational development.

Cognitive style mapping allows a great deal of information concerning an individual's traits to be condensed into a small, inexpensive computer printout. The cost of this computer work has never risen above 18 cents per map at the college.

Use of Cognitive Style and Mapping in This Study

Statements concerning the need for more data on individual characteristics were previously cited, along with other

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[41]Joseph E. Hill, "Symbols and Their Meanings," pp. 18-19.

concerns regarding the expense of educational innovations (Tyler, Hamreus, Gustad, Campeau, Haskell, Stowe). The Oakland Community College program for improving education provides a framework within which to study the effects of some individual differences on the instructional process. The Educational Sciences are still under development. Although much research has been done within the conceptual framework of the Educational Sciences as indicated in Chapter II, much more remains to be done. One of the areas needing research is in the selection of appropriate mediated instructional materials and techniques in terms of the cognitive styles of individual students, which is the subject of the present study.

The Educational Sciences provide data on student characteristics and media characteristics used in this study. One useful approach to selecting media for certain kinds of learning tasks has been to classify media characteristics in terms of specific types of behavioral objectives.[42] Within the Educational Sciences media selection can be made in terms of student characteristics as well as in terms of the proposed outcomes. In the present study the investigator chose to use programed instruction materials with a variety of student cognitive styles in order to determine if style differences

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[42]M. David Merrill and R. Irwin Goodman, Selecting Instructional Strategies and Media: A Place to Begin (Provo, Utah: Brigham Young University, Department of Instructional Research and Development, 1971). Prepared for the Instructional Development Institutes, project of the National Special Media Institutes Consortium.

produced differing student achievement. The student characteristics investigated were determined through a battery of diagnostic tests (described in Chapter III and Appendix A), which provided the basis for individual cognitive style maps. The programed materials and tests associated with those materials were viewed by a panel of experts in the Educational Sciences to determine the mode of understanding required by the instructional package in the Individualized Programmed Learning Laboratory (IPLL). "Mode of understanding" may be defined as that combination of cognitive style elements needed by an individual to ensure success when given a specific action to carry out. A description of the determination of the mode of understanding for the two programed instruction packages is found in Chapter III.

Determining Degree of Match

The process of determining a student's degree of match between his cognitive style and the mode of understanding required by the instructional package and the setting in which it is used is shown in the example provided below.

The mode of understanding required by a particular educational task involves the following hypothetical elements:

$$\left\{\begin{matrix} T(AL) \\ Q(CET) \\ Q(CEM) \\ Q(CS) \end{matrix}\right\} \quad X \quad \left\{\begin{matrix} I \\ A' \end{matrix}\right\} \quad X \quad \left\{\begin{matrix} M \\ R' \end{matrix}\right\}$$

The scoring of computer addresses then becomes

all T(AL)s = 2	all I = 2	all Ms = 2
Q(CET)s= 2	A'= 2	R' = 2
Q(CEM)s= 2		
Q(CS)s = 2	all I'= 1	all M' = 1
	A = 1	R = 1
all T'(AL)s = 1		
Q'(CET)s= 1		
Q'(CEM)s= 1		
Q'(CS)s = 1		

When taken in binomial combinations within each set of elements, the scoring becomes

T(AL) + Q(CET) = 4	I = 2	M = 2
T(AL) + Q(CEM) = 4	I + A' = 4	M + R' = 4
T(AL) + Q(CS) = 4	6	6
12		

and a perfect "score" would be $\frac{\frac{12}{12} + \frac{6}{6} + \frac{6}{6}}{3} = \frac{3}{3}$ or 1.00

A student whose cognitive map shows the following elements, which can be used in working with the package, would be "scored" as follows:

$$\left\{\begin{matrix} T'(AL) \\ Q(CET) \\ Q'(CEM) \end{matrix}\right\} \quad X \quad \left\{\begin{matrix} I \\ F' \end{matrix}\right\} \quad X \quad \left\{\begin{matrix} M \\ D' \end{matrix}\right\}$$

T'(AL)+ Q(CET) = 3	I = 2	M = 2
T'(AL) + Q'(CEM) = 2	I+F'= 2	M+D'= 2
5	4	4

Match is $\frac{\frac{5}{12} + \frac{4}{6} + \frac{4}{6}}{3} = \frac{.417+.66+.67}{3} = \frac{1.747}{3} = .582$ or 58th percentile

Purpose

Within the Educational Sciences as employed at Oakland Community College the modes of understanding required by particular instructional settings, especially prescriptions

centers (see definition of terms), have been determined. Figure 1.2 represents the centers, activities conducted by the students in those centers, and the probable modes of understanding required by the centers. These modes are then compared to the cognitive style of a student when prescribing educational experiences for that individual. Prior to this study prescription matching had not included the mode of understanding required by both the setting and the instructional package with which the student (and his cognitive style) interacts in the prescription centers.

The purpose of this investigation was to determine the significance of the degree of match between the cognitive style of a student and the mode of understanding required by a programed instruction package and the setting in which the package was used. The significance was measured in terms of gain scores of groups of students divided according to degrees of match.

The matching process was conducted by means of a scoring technique described earlier in this chapter. The data derived from this analysis determined the degree of match expressed in percentiles. It was expected that the group of students showing the highest match with the package and setting would have a greater gain score on the test battery associated with the package than the group exhibiting the middle-range degree of match or the group showing the lowest degree of match. In turn, the group exhibiting the middle-range degree of match

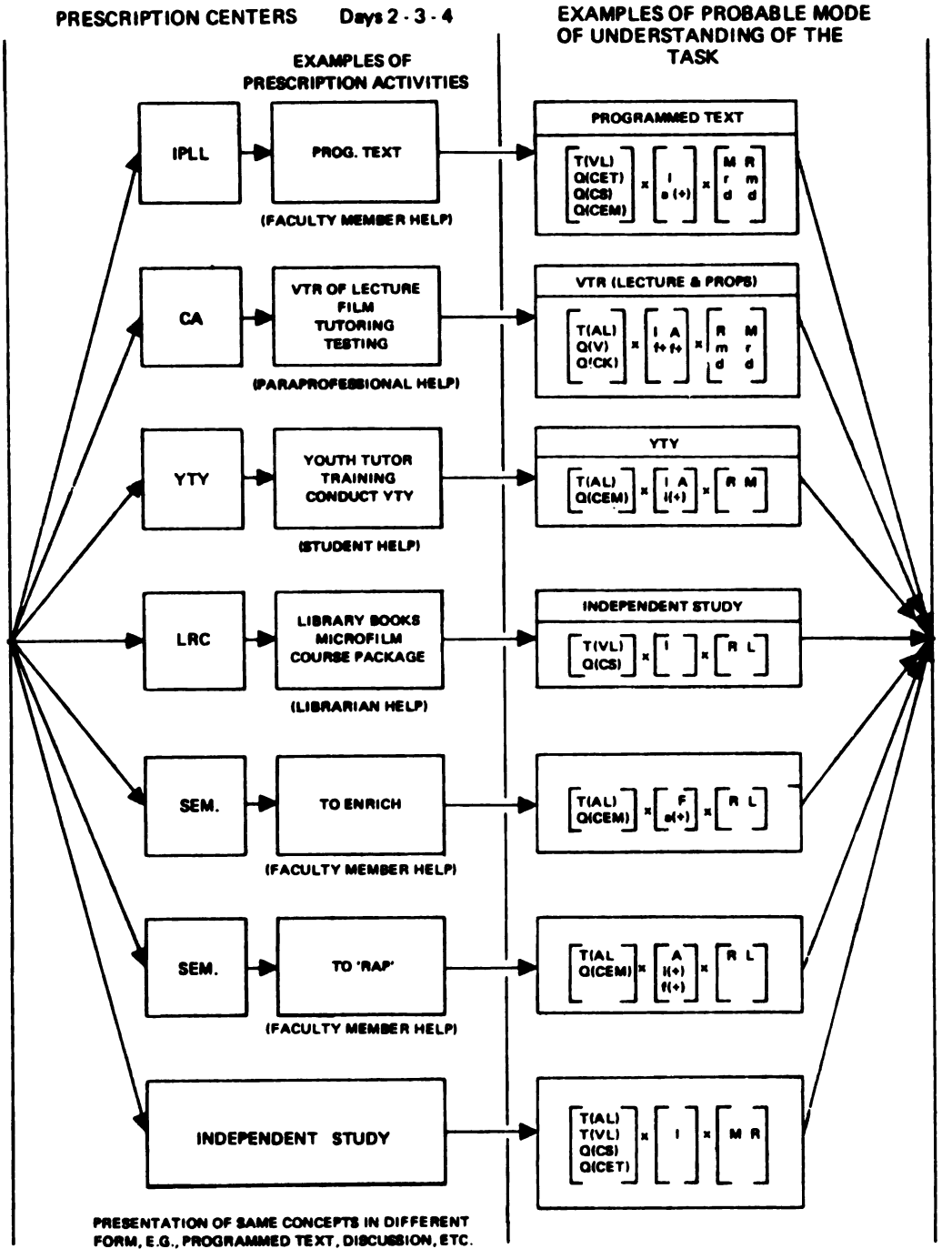

Figure 1.2 - Prescription Centers and Associated Modes of Understanding[43]

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[43]Joseph E. Hill and Derek N. Nunney, "Personalizing Educational Programs Utilizing Cognitive Style Mapping at Oakland Community College" (Bloomfield Hills, Michigan: Oakland Community College Press, 1971), pp. 2-3.

was expected to show a greater gain score on the tests of the package than the group exhibiting the lowest degree of match.

It was anticipated that if positive results were obtained in this investigation, they would add a significant element in the prescription of educational experiences for individual students and thus contribute to greater precision in the process of personalizing education.

Questions for Study

The investigation was designed to answer the following questions:

Is the gain score (on tests included in an instructional package) for the group of students whose cognitive styles most match the mode of understanding required by a particular instructional package and a specified instructional setting greater than the gain scores of the other groups, as predicted by the assessment of their cognitive styles?

Within the framework of this general question it was possible to measure differences in cognitive gain by answering the following subquestions:

1. Does the group of students exhibiting the highest degree of match between cognitive style and the package and the setting show a greater gain score that is significantly greater, statistically, than that of the group showing a middle-range match?

2. Does the group of students exhibiting the highest degree of match between cognitive style and the package and the setting show a gain score that is significantly greater, statistically, than that of the group displaying the lowest match?

3. Does the group of students exhibiting the middle-range match between cognitive style and the package and setting show a gain score that is significantly greater, statistically, than that of the group exhibiting the lowest degree of match?

Definition of Key Terms

The following basic terms and definitions are used in this and subsequent chapters of this study:

Individualized Programmed Learning Laboratory: an area designed for individual or small group work with programed texts and other highly organized materials under supervision of faculty members trained in individualized instruction techniques. The IPLL at Oakland Community College, Orchard Ridge Campus, was the site of this investigation. It is one of several prescription centers on campus.

Instructional Prescription: an educational program consisting of courses and the prescription centers to which the student will be assigned. The prescription at Oakland Community College is developed by the student, his guidance counselor, and instructors from information gathered through cognitive

style testing and conversation with the student. The prescription is developed for adapting educational experiences to the strengths of the student.

Prescription Centers: areas designed for specific types of non-classroom instruction, such as independent study, work with programed texts, slide-tape demonstrations, movies, videotapes, or individual tutoring sessions. The specific prescription center in which this study was conducted was the Individualized Programmed Learning Laboratory (IPLL).

Instructional Package: a unit developed for teaching one or more concepts, facts or principles, which may contain both print and non-print components, pretest, instructional materials, and posttest.

Instructional Setting: the physical environment in which the teaching process takes place, with or without a person called a "teacher" or "instructor" present. For example, a programed text used in the IPLL can be studied in an individual carrel or at a group table, thereby providing the student with discussion privilege, or work with a tutor.

Instructional Development

In this study the term "instructional development" is considered synonymous with the terms "educational technology" and "instructional technology." The definition of the term "instructional development," as used in this investigation, is

the same as the second definition offered for the term "instructional technology" by the Commission on Instructional Technology:

> The second ... definition goes beyond any particular medium or device. In this sense, instructional technology is more than the sum of its parts. It is a systematic way of designing, carrying out, and evaluating the total process of learning and teaching in terms of specific objectives, based on research in human learning and communication, and employing a combination of human and nonhuman resources to bring about more effective instruction.[44]

Programed Instruction

> Programed instruction is a process for the specification, design, perfection, and validation of instruction, a process which is applicable to all media.[45]

Programed Instruction Text: one of the many forms in which programed instruction may appear. In text book form, the format may be linear extrinsic, linear skipping, sublinear, parallel linear, conversational chaining, intrinsic branching, RULEG, EGRULE or other formats.

Symbolic Mediation: the process by which theoretical or qualitative representations are converted into meaning by one's nervous system.

System

System, as used in this investigation, has been defined by Schuller as follows:

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[44]Commission on Instructional Technology, op. cit., p. 19.

[45]Ibid., pp. 72-73.

> A 'system' may be defined as any group of dynamically related components which operates in concert or in related fashion for the purpose of achieving a specified goal or set of goals.[46]

Assumptions of the Study

1. The FNS 150 classes during winter session, 1972, represent normative classes of FNS 150 students.
2. It is assumed that student responses to unit tests and the cognitive style battery were normal, and are therefore valid responses for the purposes of this study.
3. The experiences of students enrolled in FNS 150 during winter session, 1972, were the normative experience of previous sessions using the programed texts.

Limitations of the Study

The following limitations are acknowledged as inherent in this study and the scope of its findings is restricted accordingly:

1. FNS 150 reflects a specific content orientation for an audience whose characteristics are not the norm for

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[46]Charles F. Schuller, "Systems Approaches in Media and Their Application to Individualized Instruction at the University Level," Michigan State University, 1967, presented in part at Bucknell University Symposium, February, 1968. (Mimeographed.)

entering college freshmen. These characteristics are detailed in Chapter III of this study. The findings of the study may or may not be generalizable to other audiences.

2. The programed texts used in this study[47,48] are linear extrinsic in nature. Findings based upon these texts may or may not be generalizable to experiences based upon other programing paradigms.
3. This study is limited by the number of sample population. Inferences to broader generalizations to other groups not included in this study are beyond the scope of this exploratory study.
4. This investigation is limited to measuring cognitive gain scores. Measurement of gains in the affective domain are not included in this study.

Summary

Higher education is facing many problems, among them public dissatisfaction with the status quo and a lack of funds. Instructional Development is considered by many to hold the promise of improving both the efficiency and effectiveness of

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[47]James E. Bradner and Tamar Y. Susskind, Newton's Laws of Motion (Anaheim, California: Litton Instructional Materials, Inc., 1966).

[48]James E. Banks, Naming Organic Compounds: A Programed Introduction to Organic Chemistry (Philadelphia, W. B. Saunders Co., 1967), pp. 1-80.

instruction. While much work has been done within Instructional Development, there is need for research relating student characteristics to instructional methods and settings.

The purpose of the present study was to investigate interrelationships between certain student, instructional, and setting characteristics. A conceptual framework called the "Educational Sciences" was employed to facilitate specification of these characteristics. The Educational Sciences are presently used to personalize education at Oakland Community College in Michigan. The present investigation was conducted at that institution.

CHAPTER II

REVIEW OF RELATED RESEARCH

Introduction

Research studies concerning the effects of individual differences on student use of programed texts are scarce. The most recent psychological literature reflects a trend towards research on individual differences based upon aptitude-by-treatment interactions (ATI). The ATI research is new, but the direction in which it points could lead to many more studies relating student characteristics to the use of programed instruction texts. The general goal of ATI research is:

> ... to match specific instructional methods or materials to selected learner characteristics so that alternative instructional methods are designed to capitalize on different patterns of learner characteristics. Differential assignment is based upon an analysis of task characteristics and of learner style and abilities, personality characteristics, and others.[1]

The present investigation, however appears to be the first attempt to study individual differences in relation to characteristics of both a programed text and the setting in which it is used. This study attempts to discover the significance of

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[1]Mary Lou Koran, "Varying Instructional Methods to Fit Trainee Characteristics," AV Communication Review, Vol. 20, No. 2 (Summer 1972), p. 136.

a person's cognitive style (as defined in the Educational Sciences) in relation to some of the characteristics of two programed texts in addition to the instructional setting in which they are used. The literature most pertinent to these elements appears under the following classifications:

1) programed instruction and individual differences among students;
2) aptitude-by-treatment interactions;
3) the effects of cognitive style on student achievement, teacher-student interaction, and administrator-teacher interaction.

Programed Instruction and Individual Differences

In an extensive review of the literature concerning individual differences and programed instruction, Fry stated that "programed instruction has shown little improvement over other methods of adapting training to other interests, aptitudes, motivations and background characteristics of the learners."[2] One reason for this may be the lack of research relating the use of programed instruction to student characteristics. Many of the studies which do touch upon individual differences indicate significant differences only between high ability and low ability students.

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[2]John P. Fry, "The Effect of Student-Controlled Instruction on Learning" (Unpublished Doctoral dissertation, Michigan State University, 1970), p. 26.

Several of the "ability type" studies appear in the literature. Campbell et al.,[3] conducted a study in which it was found that there is a high correlation between ability and performance. Beane[4] compared linear and branching techniques in programed instruction, with the results indicating that in each treatment the high ability students exceeded the low ability students in achievement, retention and efficiency. A similar study, conducted by Hampton,[5] yielded results which also indicated that there is a direct relationship between learning and ability level.

There are a few investigations the results of which do indicate positive correlational effects between individual differences and the use of programed instruction. Flynn,[6] in a study of freshmen in a college educational psychology course, found that programed instruction yielded greater gains in learning for high achievers, but did not result in greater retention than the lecture-discussion method. Underachievers

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[3]V. N. Campbell; L. W. Bivens; and D. F. Terry, Effects of Mathematical Ability, Pretraining, and Interest on Self-Direction in Programed Instruction (American Institutes for Research Technical Report: AIR-DIO-10/63-TR, October 1963).

[4]Donald G. Beane, "A Comparison of Linear and Branching Techniques of Programmed Instruction in Plane Geometry," Journal of Educational Research, Vol. 58, no. 7, pp. 319-326.

[5]John D. Hampton, "Evaluating Programmed Instruction Techniques," California Journal of Education, Vol. 18 (1967), pp. 49-60.

[6]J. T. Flynn, "The Influence of Programmed Instruction Upon Learning in Educational Psychology," The Journal of Educational Research, Vol. 59 (1966), pp. 387-391.

performed and retained equally well regardless of teaching method. In another study of college freshmen psychology students, Lubin[7] found that high autonomy need students scored significantly lower than the low autonomy need students on performance tests associated with a programed instruction sequence. Lubin also found that subjects exhibiting high scholastic aptitude showed greater achievement than subjects exhibiting low scholastic aptitude.

Investigations have been conducted which combined the programed instructional format with individual differences such as anxiety, test anxiety, creativity, achievement need, and other personality variables. Doty and Doty[8] viewed five such variables in a study of college undergraduates. The variables were: 1) cumulative grade point average, 2) creativity, 3) achievement need, 4) social need, and 5) attitude toward programed instruction. The results indicated a low but significant positive correlation between achievement and GPA, achievement need and GPA, and GPA and attitude toward programed instruction. A low but significant negative correlation was obtained between both achievement on programed instruction and social need and achievement on programed instruction and creativity. No correlation was found between

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[7]Shirley C. Lubin, "Reinforcement Schedules, Scholastic Aptitude, Autonomy Need, and Achievement in a Programmed Course," Journal of Educational Psychology, Vol. 56, no. 6, pp. 295-302.

[8]Barbara A. Doty and Larry A. Doty, "Programed Instruction Effectiveness in Relation to Certain Student Characteristics," Journal of Educational Psychology, Vol. 55, no. 6, pp. 334-338.

achievement on programed instruction and attitude toward programed instruction.

A study of five variables in relation to programed instruction was carried out by Traweek.[9] Test anxiety, general anxiety, withdrawal tendencies, nervous symptoms and self-reliance were tested. Results indicated that test anxiety was significantly higher for successful students. Successful students were also those who had shown more withdrawal tendencies than other subjects. Successful students exhibited less self-reliance. There was no difference between successful and unsuccessful students with respect to general anxiety, nervous symptoms or intelligence quotient.

Two other studies which take into account personality variables in relation to programed instruction are those by Ripple et al.,[10] and Sutter and Reid.[11] In the Ripple study the variables were anxiety, compulsivity and exhibitionism. The modes of instruction were text book and programed text. No significant interactions were found; however, anxiety was associated with lower performance scores. Sutter and Reid

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[9]Melvin W. Traweek, "The Relationship Between Certain Personality Variables and Achievement Through Programed Instruction," California Journal of Educational Research, Vol. 15 (1964), pp. 215-220.

[10]R. E. Ripple; J. Millman; and M. D. Glock, "Learner Characteristics and Instructional Mode: A Search for Disordinal Interactions," Journal of Educational Psychology, Vol. 60, no. 2, pp. 113-120.

[11]E. G. Sutter and J. B. Reid, "Learner Variables and Interpersonal Conditions in Computer-Assisted Instruction," Journal of Educational Psychology, Vol. 60, no. 3, pp. 153-157.

investigated the relationships between individual performance and attitudes compared to test anxiety, dominance and sociability. Students were divided into two groups: those who would work alone, and those who would work in groups. There was no significant difference between these two groups in achievement. A significant difference did appear among student attitudes with respect to performance and to preference for working with certain personality types.

Although The research relating individual differences and programed instruction is not voluminous, there have been some studies which indicate certain personality variables and other individual differences which may affect learning through programed instruction texts. The study by Ripple et al., is also a step toward discovering aptitude-by-treatment interactions which affect the use of programed instruction.

Aptitude-By-Treatment Interaction

One of the first to express the need for aptitude-by-treatment interaction research was Cronbach.[12] It was Cronbach's contention that:

> The organism which adapts well under one condition would not survive under another. If for each environment there is a best organism, for every organism there is a best environment. The job of applied psychology is to improve

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[12]Lee J. Cronbach, "The Two Disciplines of Scientific Psychology," an Address of the President at the Sixty-Fifth Annual Convention of the American Psychological Association, New York, September 2, 1957.

> decisions about people. The greatest social benefit will come from applied psychology if we can find for each individual the treatment to which he can most easily adapt.[13]

Recognition of this need caused increased interest and experimentation among educational psychologists in the area of aptitude-by-treatment interaction (ATI). As Bracht states, "the goal of research on ATI is to find significant disordinal interactions between alternate treatments and personological variables...."[14] It is this disordinal interaction which can provide information from which an educator can derive a better judgment as to what type of instruction a student should be provided to ensure success. On graphs of experimental cell mean scores, a significant interaction is ordinal when the treatment lines do not cross, and disordinal when treatment lines do cross (Figure 2.1).

Although educational psychologists have shown increasing interest in ATI, very little empirical evidence has been provided to date in support of this concept. For example, in 85 studies cited by Bracht[15] only five showed disordinal interactions. It is for this reason that Koran et al., states that

> It appears that additional analysis of the ways in which internal response processes work in relation to various stimulus and overt response variables will be required

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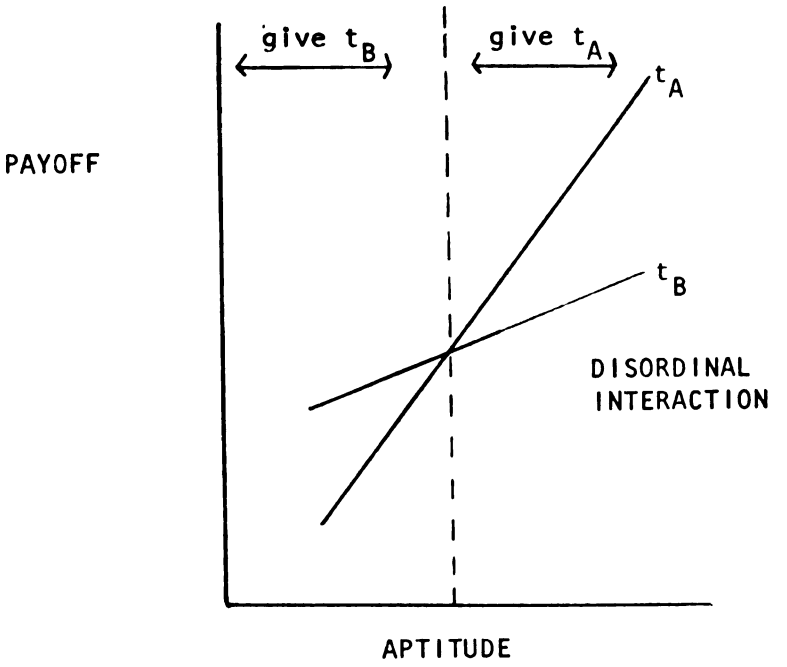
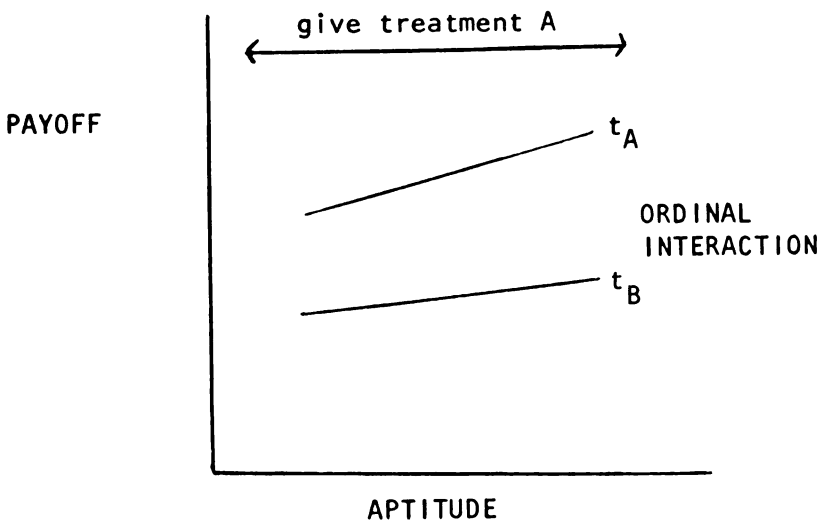
[13] Ibid., p. 9.

[14] G. H. Bracht, "Experimental Factors Related to Aptitude-Treatment Interactions," Review of Educational Research, Vol. 40, no. 5, p. 627.

[15] Ibid., pp. 637-641.



Payoff functions for two treatments



Payoff functions for two treatments

Figure 2.1 - Disordinal and Ordinal Interactions

> in guiding both the selection of aptitude measures and ways in which treatment could be contrasted to capitalize on learner characteristics.[16]

Despite the large amount of studies which have shown only ordinal interactions, there are a few which have shown the desired disordinal interactions.

One of the earliest studies which produced disordinal interaction was reported by Hovland et al.[17] The investigators found that presenting one side of an issue was more effective for changing the opinion of the men who initially favored the opinion of the program, and that presenting both sides of an issue was more effective for changing the opinion of the men who initially opposed the opinion of the program.

Atkinson and Reitman[18] found that subjects low on affiliation motive performed better with an achievement-oriented treatment, and subjects high on affiliation motive performed better with a multi-incentive treatment.

In another study, Van De Riet[19] discovered that underachievers performed better when they received reproof during

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[16]M. L. Koran; R. E. Snow; and F. J. McDonald, "Teacher Aptitude and Observational Learning of a Teaching Skill," Journal of Educational Psychology, Vol. 62, no. 3, p. 227.

[17]C. I. Hovland; A. A. Lumsdaine; and F. D. Sheffield, Experiments on Mass Communication, Vol. 3 (Princeton, New Jersey: Princeton University Press, 1949).

[18]J. W. Atkinson and W. R. Reitman, "Performance as a Function of Motive Strength and Expectancy of Goal-Attainment," Journal of Abnormal and Social Psychology, Vol. 53 (1956), pp. 361-366.

[19]H. Van De Riet, "Effects of Praise and Reproof on Paired Associate Learning in Educationally Retarded Children," Journal of Educational Psychology, Vol. 55 (1964), pp. 139-143.

instruction, and normal achievers performed better when they received praise or were asked unrelated questions.

More recently, Marshall[20] reported that subjects from poor educational environments performed better on high-interest tasks and students from good educational environments performed better on low-interest tasks.

The most recent studies reported on ATI are those of Koran et al.,[21] and Koran.[22] In the former investigation the purpose was to study individual differences in the acquisition of a teaching skill from videotape and from a verbatim written text from the videotape sound track. The written treatment yielded significantly greater posttest scores for those subjects who scored high on the Hidden Figure test, while the videotape treatment proved best for those subjects scoring low on the same Hidden Figures measure. In the latter study, Koran investigated the aptitudes of teacher trainees in relation to inductive and deductive programed instruction sequences. Two inductive and two deductive sequences were used. The frames used in each booklet were identical, but the order of presentation differed. Inductive sequences provided example frames

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[20]H. H. Marshall, "Learning as a Function of Task Interest, Reinforcement, and Social Class Variables," Journal of Educational Psychology, Vol. 60 (1969), pp. 133-137.

[21]M. L. Koran; R. E. Snow; and F. J. McDonald, op. cit., pp. 219-228.

[22]M. L. Koran, "Differential Response to Inductive and Deductive Sequences of Programed Instruction," Journal of Educational Psychology, Vol. 62, no. 4, pp. 300-307.

prior to rule frames (EGRULE) while deductive sequences presented rule frames before example frames (RULEG). A delayed performance test was administered two weeks after the students had completed the programs. In reporting the results, Koran states:

> ... while the aptitude measures failed to interact with inductive and deductive programed sequences for the criterion test scores, they did produce significant interactions for the time variables.[23]

The deduction (RULEG) sequences proved less time consuming for the low ability students, while students of high ability took significantly less time in completing the inductive sequences (EGRULE).

While most ATI research has not produced findings which indicate disordinal interactions, a few interactions have been found which are significant and disordinal. As ATI research becomes more widespread this investigator feels that interaction studies dealing with programed instruction will become more numerous.

Studies in the Educational Science of Cognitive Style

Over 40 doctoral dissertations have been completed within the framework of the Educational Sciences. Nine of these deal specifically with the Educational Science of cognitive style.

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[23]M. L. Koran, "Varying Instructional Methods to Fit Trainee Characteristics," p. 141.

Some have treated subject areas; others, teachers' ratings of students. Two have studied cognitive style during enrollment in a course; another, the effects of cognitive style on student choice of curricula.

Shuert,[24] in an investigation of the cognitive styles of successful mathematics students, found that the following elements of cognitive style were unique to the successful group.

1. Major theoretical visual quantitative - T(VQ)
2. Major theoretical auditory quantitative - T(AQ)
3. Minor theoretical auditory linguistic - T'(AL)
4. Minor associates determinant - A'
5. Appraisal inference - L
6. Deductive inference - □K

A cognitive style map of these elements appears in Figure 2.2.

^{12}T(VQ)	T(AQ)	T'(AL)	A'	L	K

Figure 2.2 - Cognitive Style Map of Shuert's Findings

The study of Dehnke[25] indicated that there seemed to be a

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[24]Keith L. Shuert, "A Study to Determine Whether a Selected Type of Cognitive Style Predisposes One to do Well in Mathematics" (Unpublished Ph.D. dissertation, Wayne State University, 1970).

[25]Ronald E. Dehnke, "An Exploration of the Possible Isomorphism of Cognitive Style and Successful Teaching of Secondary School English" (Unpublished Ph.D. dissertation, Wayne State University, 1966).

common cognitive style pattern among successful English teachers.

In a comparison study, Ort[26] related the cognitive styles of successful foreign language students to those of the instructors in two foreign language courses. The findings of the study reflected no significance between the degree to which successful and unsuccessful students shared "like" cognitive style elements with the instructor. The Ort study was designed to view each segment of cognitive style separately, rather than as a grouped phenomenon. Cognitive style is defined as a "Cartesian product,... composed of three sets...."[27] as described in Chapter I. In a Cartesian product all elements act in concert, as a system. A study by Wasser[28] employed total cognitive style interrelationships in the investigation of student-rating by teachers. Wasser discovered that 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. These teachers also tended to give higher grades to those students who made use of the theoretical auditory and visual symbols.

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[26]Barbara Ort, "An Examination of Relationships Between The Measurable Cognitive Characteristics of a French I Teacher and the Student's Success in That Course" (Unpublished Ph.D. dissertation, Michigan State University, 1971).

[27]Joseph E. Hill, "Cognitive Style as an Educational Science," p. 2.

[28]Laurence Wasser, "An Investigation into Cognitive Style as a Facet of Teachers' Systems of Appraisal" (Unpublished Ph.D. dissertation, University of Michigan, 1969).

Changes that occurred in the cognitive style of participants in a "Higher Opportunities Program in Education" were investigated by Robinson.[29] He found increases in theoretical visual linguistic - T(VL) - and quantitative - T(VQ) - orientations. The findings also indicated that certain qualitative codes can be related to the increase or lack of increase in T(VL) and T(VQ).

Zussman[30] identified group cognitive styles for public school administrators and community college administrators. Both groups displayed theoretical and auditory orientations - T(VL), T(VQ), T(AL), T(AQ) - as well as qualitative codes "empathetic" and "kinesthetic" - Q(cem), Q(ckh). The two groups shared the same cultural determinants: a "major" individuality (I) and a "minor" associates (A'). Modalities of inference were markedly different between groups. The community college administrators exhibited the modalities of appraisal and difference (L and D) to a major degree and relationship (R') to a minor degree. There were no modalities of inference in common among public school administrators.

In a study of administrators' cognitive styles relating to instructor evaluations at the university level,

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[29]Richard L. Robinson, "A Descriptive Study of Specific Achievements and Aptitudes of the High Risk Students in Oakland University's Higher Opportunities Program in Education" (Unpublished Ph.D. dissertation, Wayne State University, 1969).

[30]Steven P. Zussman, "A Pilot Study Exploration of Cognitive Style and Administrative Style as Defined in the Education Sciences" (Unpublished Ph.D. dissertation, Wayne State University, 1968).

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DeLoach[31] found that similarity in styles between administrator and instructor led to a higher rating of the instructor than those other teachers with styles dissimilar to that of the administrator. Similarities of teaching style between administrators and instructors were also significant to the evaluation process.

An investigation by Cotter[32] related student cognitive style with student curricula choice. It was found that students who exhibit a "major individuality" - I - selected curricula which stress fundamental disciplines (i.e., liberal arts and science curricula) as opposed to applied arts and sciences. This trend, however, could not be supported statistically.

Summary

Research studies involving individual differences in relation to programed instruction are relatively few in number and these tend to focus on ability relationships. In these studies the findings support the principle that high ability students outscore low ability students on nearly every measure.

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[31]Joseph F. DeLoach, "An Analysis of Cognitive Style Disparity as an Antecedent of Cognitive Dissonance in Instructional Evaluation: An Exploratory Study in the 'Educational Sciences'" (Unpublished Ph.D. dissertation, Wayne State University, 1969).

[32]Jude T. Cotter, "The Effects of the Educational Science of Cultural Determinants of the Meanings of Symbols on Curricular Choice" (Unpublished Ph.D. dissertation, Wayne State University, 1970).

Investigations relating personality variables to the use of programed instruction show that some characteristics of students have an effect on the students' interaction with a programed text. Some of the personality variables studied include: 1) achievement motivation, 2) general anxiety, 3) test anxiety, 4) creativity, 5) dominance, 6) exhibitionism, 7) self-reliance and 8) social need.

The relatively new area of aptitude-by-treatment interaction (ATI) has shown a few significant findings. Presentation method has an effect on opinion-change (Hovland). Affiliation motive interacts negatively with achievement-oriented treatments, while interacting positively with a multi-incentive treatment (Atkinson and Reitman). Underachievers interact positively with reproof in instruction while normal achievers interact positively with praise (Van De Riet). Achievement on the Hidden Figures test is indicative of success in written instruction, while videotape treatment worked best for subjects scoring low on the Hidden Figures test (Koran, et al.). ATI research related to programed instruction has revealed a positive interaction between low ability and deductive reasoning, and between high ability and inductive reasoning in the presentation of material.

Studies conducted within the framework of the Educational Science of cognitive style are more numerous than either ATI research or those studies relating personality variables to programed instruction. Cognitive style patterns of successful

mathematics students and successful English teachers have been determined. Teachers tend to rate students more highly when the student's cognitive style matches the instructor's. A study by Robinson showed that cognitive styles of individuals change as they receive instruction. Another study indicated that college administrators differ from public school administrators in cognitive style. DeLoach found that administrators tend to rate instructors higher when the instructor's teaching and cognitive styles matched those of the administrator than when the styles were dissimilar. Cotter discovered that cognitive style affects student choice of curricula.

Of interest to this study are the dimensions of cognitive style which lead to success in completing a programed text. The studies of the first section of this chapter indicated some of the personality variables which interact with the programed text. The ATI research cited indicates that variables working upon a situation should be viewed in pairs, with paired treatment, so that aptitude-by-treatment interactions can be derived from the study, if they exist within the data. However, nowhere could this investigator find a study which sought the relationship, as this investigation does, between 1) individual differences, 2) characteristics of the instructional materials used by the student, and 3) characteristics of the setting in which the student uses the materials.

CHAPTER III

DESIGN OF THE STUDY

The conceptual framework called the "Educational Sciences," as employed at Oakland Community College, was developed over the past thirteen years under Dr. Joseph E. Hill, first at Wayne State University in Detroit and later at Oakland Community College. The framework is based upon investigations carried out under Hill and others (e.g., Alam and Blackman of Michigan State University; Byrne and Pinix of the University of Michigan; Clute, Rislov and Smith of Wayne State University), and observations and studies carried out by the Oakland Community College staff.

Oakland Community College is a public two-year institution of higher learning serving Oakland County in Michigan. The institution has four campuses (Auburn Hills, Highland Lakes, Orchard Ridge, and Southwest) serving approximately 15,000 students, and twenty-five extension centers serving another 3,700 students. The area served includes nearly 900 square miles and has an assessed valuation of $4.7 billion.

The college has a total student population of nearly 19,000 which is served by a staff of approximately 350, including 25 administrators and 66 support personnel. The staff

includes 31 doctorates, 267 master's degrees and 43 bachelor's degrees.

Approximately one-third of the graduates of the college go on to four-year institutions.

The present investigation was conducted within the Foundational Studies program because of the investigator's interest in educationally disadvantaged students, and the open enrollment problems pressing community colleges and four-year institutions. Foundational Studies is an experimental program initiated by the College Academic Senate for the 1969-1970 academic year, and continued to the present. The program consists of twelve courses: three in Communications, three in Humanities, three in Behavioral and Social Sciences, and three in Natural and Life Sciences. This study was conducted within the introductory course in Natural and Life Sciences (FNS 150 - Foundations of Natural and Life Sciences).

The students enrolled in Foundations of Natural and Life Sciences fluctuates from 250 to 400 per session during the academic year, with an average enrollment of approximately 300 per session.

The students enrolled in FNS 150 have the following characteristics:

a. They are first year college students;

b. They have lower than twelfth grade reading levels, as diagnosed by the reading tests incorporated within the Oakland Community College test battery;

c. they did not like science in public school;

d. one-half had not had science since junior high school;

e. only 10% had successfully completed general biology in high school.

Of the nearly 300 students enrolled each session, approximately 90% earn a grade of C or better on a traditional scale of A, B, C, D, or F, with grading procedures consistent within the science departments. This compares to 71% of the enrolled students who earned a grade of D or better in the science courses outside the Foundational Studies, but employing the same criteria for success. The science courses outside the Foundational Studies do not presently use cognitive style mapping as a tool for prescribing educational experiences for students. In addition, the Foundational Studies Natural and Life Science courses enroll nearly twice the number of students, per instructor, as the rest of the science departments' courses.

The course within which this study was carried out (FNS 150) is taught by two classroom instructors and one instructor specially trained for individualized tutorial instruction within the Individualized Programmed Learning Laboratory, or IPLL (see Chapter I for a description). One classroom instructor is a Ph.D. The other instructors hold Master's degrees. Both classroom instructors hold tenure at the college, one having served seven years and the other three years in the school. Both classroom instructors are authors of Science textbooks.

See Appendix B for a complete description of the course employed within this study.

Samples Employed by the Study

The investigation was conducted during the winter session, 1972, using two groups of students who met the following criteria:

a. the student had taken the Oakland Community College test battery for determining cognitive style;
b. a cognitive style map had been prepared from the results of the Oakland Community College battery;
c. the student's cognitive style map indicated to him and the instructors that the IPLL experience would be well suited to the student's cognitive style.

The sample was further limited to: d) those students who completed the programed text materials associated with the unit under consideration, e) to those who also completed a pretest and posttest associated with the unit's programed materials, and, f) to those who received no aid from the tutorial instructor.

Thirty-six (36) students met the above criteria for the unit on the naming of organic compounds.[1] Twenty (20) students

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[1]The programed text used for this unit was: James E. Banks, Naming Organic Compounds: A Programed Introduction to Organic Chemistry (Philadelphia: W. B. Saunders Co., 1967), pp. 1-80.

met those six criteria for the unit on Newton's laws of motion.[2] Thirteen of the students met the criteria for both units. All 43 students were included in the sample for this investigation. Hill and Kerber refer to this type of sampling procedure as "judgment" or "purposive." "Purposive" sample selection is described as follows:

> When the selection of a sample is based upon human judgment, it is called "purposive" or "judgment" selection. Such selection is determined on the basis of what the research worker might consider from his past experience to be a typical or representative sampling unit. It may also be based upon the findings of an analysis of the statistical population relative to physical, psychological, sociological, or economic characteristics. Sometimes it is a haphazard selection of accessible population elements--persons who pass a particular corner in a certain city, for example. Frequently, "purposive" selection is considered "segmental" selection, to the extent that the selection is restricted to certain segments of the total statistical population.[3]

The purpose of this study was to determine the significance of the degree of match between a student's cognitive style and the mode of understanding required by an instructional package plus the setting in which that package was used. Accordingly, only those students whose cognitive styles were known and who completed the instructional package (pretest, programed text and posttest) in the IPLL setting could be used.

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[2]The programed text used for this unit was: James E. Bradner and Tamar Y. Susskind, Newton's Laws of Motion (Anaheim, California: Litton Instructional Materials, Inc., 1966), 80 pp.

[3]Joseph E. Hill and August Kerber, Models, Methods, and Analytical Procedures in Educational Research (Detroit: Wayne State University Press, 1967), pp. 43-44.

Representativeness of Population

The population of interest in this study consisted of all Oakland Community College students enrolled in Foundational Studies Natural and Life Science courses, and who had cognitive style elements which indicated to the students and instructors that IPLL experience would be valuable for those students. The process involved in development of personalized prescriptions is discussed in Chapter I. Of all winter session (1972) students whose maps indicated IPLL assignment (N = 61), 11 elected other assignment study areas for the two units under consideration and seven sought tutorial aid from the IPLL instructor. The remaining 43 students formed the defined population.[4] Since there is no reason to believe that winter session students differ from those who enroll in fall or spring sessions, and all students who met the criteria were included in the sample, the defined population was considered representative of the population from which it was drawn.

Adequacy of the Sample Size

Since this investigation was designed as an exploratory study, small sample theory was employed. Since the parameter

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[4]While the breakdown of the population by sex is not important to this study, it can be noted that the school's fall, 1971 enrollment included 58% males and 42% females. Within Foundational Studies Natural and Life Sciences the breakdown during winter session, 1972 was 68% male and 32% female. The defined population was 57% male and 43% female. The sample for the instructional unit concerning the naming of organic

to be estimated was that of the mean score of a group on a performance test, the following formula to determine the adequacy of the size of sample was employed: $n = \left[\frac{Z\,\sigma}{d}\right]^2$.[5] Here "Z" denotes the value of the "normal deviate," "σ" denotes an estimated value of the standard deviation of the population scores, and "d" indicates the "size" of the acceptable sampling error. A "Z" of 1.96 was chosen to give a confidence interval of 95%. A "σ" of 1.67 was chosen since the criterion level for "success" was established for the pre- and posttests as a score of 95% or better, and thereby limited scores to the range 95-100, inclusive. A "d" of 1 was chosen because of the limited range of scores (95-100).

In this study the formula was employed as follows:

$$n = \left[\frac{(1.96)\ (1.67)}{(1)}\right]^2 \approx 11$$

Under the conditions acceptable to the study effort, a sample size of 11 or more was considered adequate.

Data Collection

The data collection aspect of this investigation is described in two parts: (A) the instruments and techniques, and (B) the procedures which were followed during data collection.

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compounds was 53% male and 47% female. The sample for the unit on Newton's laws of motion was 65% male and 35% female.

[5]W. Dixon and F. Massey, Introduction to Statistical Analysis (New York: McGraw-Hill Book Company, Inc., 1957), pp. 84-85.

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Instruments--The Cognitive Style Test Battery

The first of the instruments used was the test battery designed at Oakland Community College to determine the cognitive style of individuals. The battery is divided into two parts. The first part includes nine individually timed tests, and requires nearly two and one-half hours to complete. The student characteristics which the testing staff attempts to determine through each of these timed tests are:

Theoretical Tests--

#1: Verbal Reasoning--T(vl)

#2: Listening--T(al)--an audio tape

#3: Numerical Reasoning--T(vq)

#4: Reading--T(vl)--Gates Reading Test

#5: Numerical Listening--T(aq)--an audio tape

#6: Grammar--T(vl)--developed by the English departments at Oakland Community College

Qualitative Tests--

A: Visual Patterns--Q(v)

B: Auditory Patterns--Q(a)

C: Olfactory Discrimination--Q(o)

The second section of the Oakland test battery consists of five untimed tests. The measures test for the following cognitive style elements:

Test #7: Qualitative Codes--Q(cem), Q(ces), Q(cet), Q(ch), Q(ck)

Test #8: Qualitative Codes--Q(ckh), Q(cp), Q(cs), Q(ct)

Test #9: Cultural Determinants--I, A, F

Test #10: Modalities of Inference and Deductive Reasoning } M, D, R, L, K

Test D: Qualitative Test for Tactile Discrimination and Proprioceptiveness } Q(t), Q(p)

The test battery is both diagnostic and descriptive in nature. From test results the Testing Center personnel are able to determine certain strengths and weaknesses of the student in areas of language and mathematics usage, auditory language and mathematics propensities, and the qualitative symbolic areas of auditory, olfactory, tactile, visual and proprioceptiveness. The tests also call upon the student to provide descriptive information concerning his qualitative codes, cultural determinants of the meanings of symbols, and modalities of inference. Items included in all these tests have either been developed at the college or taken from a variety of instruments, including the Iowa tests of Educational Development, the Gates Reading Tests, and Vineland Social Maturity Scale, the Differential Aptitude Test, the Raven Matrices Survey, the Mueller Auditory Test, Nottus Pattern test, and the Science Research Associates batteries.

All of the Oakland Community College tests have item validity. Since no instruments exist to determine the concurrent validity of this battery of tests, it was validated empirically through observation, learning successes and interviews with the students and their associates. The validation sample included one thousand student maps. To date over twenty

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thousand students have been mapped for cognitive style, with less than 2% needing retesting in order to satisfy indications that their styles were decidedly different from those shown in their original mappings.

Appendix A contains a copy of the manual of directions for the Oakland Community College test battery. The tests in their entirity may be found in the library of the Testing Center at Orchard Ridge Campus, Farmington, Michigan.

Instruments--The Foundational Studies 150 Unit Tests

The Foundational Studies in Natural and Life Sciences is an unique series of three courses developed by the instructors. The characteristics of the students enrolled in these courses was reviewed earlier. Foundations of Natural and Life Sciences (FNS 150) is an overview course covering biology, chemistry, geology and physics. Over three-quarters of the instructional materials used in the course (audio tapes, video tapes, models, slides, filmstrips, programed texts and tests) were developed by the classroom instructors. These materials were designed for use within the Educational Sciences framework employed at the college. The content tests for the two units used within this study were developed by the classroom instructors, and the content validated by them. The content tests have a reliability rating of .84. Copies of the several forms of these tests appear in Appendix C.

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Conditions Under Which the Study was Conducted

During the fall session of 1971 contact was made with the classroom instructors for Foundations of Natural and Life Sciences (FNS 150). The idea was presented that perhaps gain scores on tests could be predicted on the basis of student cognitive styles. Pre- and posttest scores for selected units would be compared to the degree of match between student styles and the instructional package plus the setting in which it was used. The proposed study interested the instructors, who had completed several studies involving instruction and cognitive style mapping. They saw the proposed study as both a complement and supplement to their efforts.

The investigator had originally hoped to carry out the study with several types of mediated instruction (e.g., audio tapes, video tapes, movies, slides, filmstrips, programed instruction). However, pretests and posttests for each of these forms of instruction had not been developed by the instructors at that time. It was decided that the instructional units in the Individualized Programmed Learning Laboratory (IPLL) would be used because both pre- and posttests were available and had been validated. It was further decided that the two units which had been most difficult for students to complete successfully (to a 95 or 100% criterion level on posttests) would be employed in the study.

Certain conditions were required of the investigator, namely: 1) conditions consistent with standard Oakland

Community College procedures were to be retained, including normal procedures followed in FNS 150; 2) students assigned to the IPLL for the sixth and seventh weeks' units would constitute the population from which the sample would be selected; 3) students could work with the materials at any time during the week assigned and seek tutorial aid as they felt need; 4) materials could be reworked until any form of the posttest was passed at or above the 95% criterion level; 5) only those students who completed the unit within the IPLL setting, without tutorial aid would be included in the sample for this study.

It was agreed that the students would not be informed that their test performance was monitored by a person other than Oakland Community College staff members. Feedback of results was guaranteed to the classroom instructors.

Data Collection Procedures

The following procedures were followed in gathering data for the study:

1. Class lists were obtained for FNS 150. The Data Processing Center ran copies of the cognitive style maps of all class members previously tested for cognitive style.
2. During the fifth week of the winter session (February 7-11, 1972) IPLL assignments were prescribed for sixty-one (61) students. Of these, eleven (11) chose to enter other assignment areas and seven sought

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tutorial aid in the IPLL. Of the forty-three (43) remaining, twenty (20) met the criteria for inclusion in the sample for the unit on "Newton's laws of motion" during the week of February 14-18, 1972. Thirty-six (36) of the forty-three (43) met the criteria for inclusion in the sample dealing with "naming organic compounds" during the week of February 21-25, 1972. The criteria for inclusion were previously cited under Samples Employed by the Study in this chapter. Pre- and posttest results were gathered during the weeks indicated for the units.

The modes of understanding required by the two tasks in the IPLL setting were determined by a panel of experts at a meeting held on March 22, 1972, in the IPLL offices on the Orchard Ridge Campus. The panel consisted of Dr. Joseph E. Hill, Dr, Virginia Svagr (Director of the Diagnostic Center and Learning Systems), Dr. Calvin Moore and Mr. James E. Bradner (instructors of Foundational Studies courses in Natural and Life Sciences), Mr. Albert Grasser (instructor in mathematics), Mr. Robert Leszczynski (IPLL instructor), and this investigator. All had been designated by Hill as experts in the required evaluation techniques within the Educational Sciences. The panel viewed the package (text and tests) for each unit, keeping in mind the IPLL setting in which the materials were used, and noted in writing the mode of understanding required by each package. These notes were then

tallied, and the mode of understanding traits listed. The following table indicates the cognitive style traits included in the mode of understanding required by the package and setting for "Newton's laws of motion" (Figure 3.1). The mode of understanding required by the package entitled "naming organic compounds" is found in Figure 3.2.

The Data Processing Center of the college then ran a computer check of each student completing the unit on Newton's laws of motion to determine the degree of match between the student's cognitive style and the mode of understanding required by the unit as presented in the IPLL. (See Chapter I for a description of the process for determining the "degree of match.") The same computer procedure was carried out for the students completing the programed unit on the naming of organic compounds.

The data gathered on the degrees of match for each student were then divided into nearly equally populated groups according to the degree of match, for statistical analysis.

Analytical Technique

The data gathered from cognitive style maps of students included in the sample, the mode of understanding required by the two instructional units as used in the IPLL, and the students' pre- and posttest scores were analyzed using the "two sample" Kolmogorov-Smirnov statistical test model, a

MODE OF UNDERSTANDING	NUMBER OF PANEL MEMBERS LISTING THE TRAIT
T(vl)	7 of 7
T(vq)	7 of 7
Q(v)	5 of 7
Q'(p)	5 of 7
Q(cem)	6 of 7
Q(cet)	7 of 7
Q(cs)	6 of 7
Q'(ces)	5 of 7
I	7 of 7
M R' D'	7 of 7
R M' D'	7 of 7
K	7 of 7

Figure 3.1 - Mode of Understanding Required by "Newton's Laws of Motion" Unit

MODE OF UNDERSTANDING —	NUMBER OF PANEL MEMBERS LISTING THE TRAIT
T(vl)	7 of 7
T(vq)	7 of 7
Q(v)	7 of 7
Q(cem)	7 of 7
Q(cet)	7 of 7
Q(cs)	6 of 7
I	7 of 7
M R' D'	7 of 7
R M' D'	7 of 7
D M' R'	7 of 7

Figure 3.2 - Mode of Understanding Required by the "Naming Organic Compounds" Unit

non-parametric procedure. The Kolmogorov-Smirnov model is described by Hill and Kerber as follows:

> The two-sample test is concerned with the degree of agreement between the two cumulative distributions of the relative frequencies observed in the respective samples. If the two samples have actually been drawn from the same population, or populations having the same distribution, the cumulative distributions of both samples should be reasonably close to each other over the range of values involved. If the two-sample cumulative distributions evidence too much divergence at any point, there is a given probability that the samples might come from different populations. If the deviation between the two cumulative distributions at any point is so great that it would occur, according to the appropriate Kolmogorov-Smirnov probability distribution, less than 5 per cent, or 1 per cent of the time, due to chance factors alone, the null hypothesis (no difference between the respective cumulative distributions) is rejected in favor of the statistical alternative hypothesis (H_1).[6]

The one-tailed two-sample test was used to indicate direction of any statistically significant differences between groups. A two-tailed test indicates difference but not the direction of the difference. An example of the application of this technique as applied to this study is described below.

MATCH GROUP BY DEGREE OF MATCH	DISTRIBUTION OF GAIN SCORES (CUMULATIVE)				TOTAL
	- to 0 to 25	26-50	51-75	76-100	
100-81%	1 $\frac{1}{8} = \frac{7}{56}$	0 $\frac{1}{8}=\frac{7}{56}$	1 $\frac{2}{8}=\frac{14}{56}$	6 $\frac{8}{8}=\frac{56}{56}$	8
80-61%	2 $\frac{2}{7} = \frac{16}{56}$	0 $\frac{2}{7}=\frac{16}{56}$	1 $\frac{3}{7}=\frac{24}{56}$	4 $\frac{7}{7}=\frac{56}{56}$	7
ABSOLUTE DIFFERENCE BETWEEN GROUPS	$\frac{9}{56}$	$\frac{9}{56}$	$\frac{10}{56}$ D=.178	0	

Figure 3.3 - Hypothetical Distribution of Student Scores

[6]Joseph E. Hill and August Kerber, op. cit., p. 311.

In the hypothetical distribution shown above, $\frac{10}{56}$, or .178, is the maximum difference between groups and, as such, is the difference to be tested using the Kolmogorov-Smirnov model. The testing consists of comparing this test difference to "a chi-square distribution with two degrees of freedom, where X^2 is computed by the formula:

$$X^2 = 4D^2\left[\frac{n_1 n_2}{n_1+n_2}\right]."[7]$$

"D" denotes the maximum difference between groups and "n_1" and "n_2" indicate the number of subjects in each group. The chi-square value at the .10 alpha level, with two degrees of freedom, is 4.60.[8] The test is computed as follows:

$$X^2 = 4D^2\left[\frac{n_1 n_2}{n_1+n_2}\right]$$

$$X^2 = (4)\ (.178)^2\left[\frac{(8)\ (7)}{8+7}\right]$$

$$X^2 = (4)\ (.178)^2\left(\frac{56}{15}\right)$$

$$X^2 = 4(.03168)\left(\frac{56}{15}\right)$$

$$X^2 = 4(.3168)\,(3.733)$$

$$X^2 = (.12672)\,(3.733)$$

$$X^2 = .473$$

This tested value (.473) is compared to the chi-square value at the .10 alpha level, with two degrees of freedom. Since

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[7]Hill and Kerber, p. 319.

[8]Ibid., p. 303.

the chi-square value (4.60) is greater than the tested value (.473), the tested value is not significant at the .10 alpha level.

Statistical Hypotheses

This study was designed to determine the significance of the degree of match between the cognitive style of an individual and the mode of understanding required by the task the individual had to perform, in terms of gain scores between pre- and posttests. There were three general questions to be answered by the investigator, as presented in Chapter I. The general questions to be answered are stated here in hypothesis-testing form for convenience in applying the Kolmogorov-Smirnov nonparametric measure to the data gathered.

Operational Hypothesis 1: The group of students exhibiting the greatest degree of match between cognitive style and mode of understanding required by the task will show a gain score (on tests associated with a unit-long instructional package) that is significantly greater, statistically, than the group of students in the sample exhibiting a middle-range degree of match.

Operational Hypothesis 2: The group of students exhibiting the greatest degree of match between cognitive style and the mode of understanding required by the task will show a greater gain score (on tests associated with a unit-long instructional

package) that is significantly greater, statistically, than the group of students exhibiting the lowest degree of match.

Operational Hypothesis 3: The group of students exhibiting the middle-range degree of match between cognitive style and mode of understanding required by the task will show a greater gain score (on tests associated with a unit-long instructional package) than the group of students exhibiting the lowest degree of match.

Summary

The purpose of this investigation was to determine the significance of the degree of match between the cognitive style of the student and the mode of understanding required by a particular instructional package and the setting in which the package is used. Two groups of students and two programed instruction packages were used in the study.

Twenty (20) students at the Orchard Ridge campus of Oakland Community College in Farmington, Michigan were selected from students assigned to the Individualized Programmed Learning Laboratory (IPLL) for a unit on Newton's laws of motion. These students were enrolled in Foundations of Natural and Life Sciences (FNS 150) during winter session, 1972. The unit was part of their normal course of study. In addition, thirty-six (36) students enrolled in FNS 150 at Orchard Ridge Campus were selected from students assigned to the IPLL for a unit on the naming of organic compounds.

Each sample group followed the same procedures within the IPLL setting. Each student was pretested, each completed the programed instruction materials, and each was posttested. Pretest and posttest scores were recorded to obtain gain scores of individuals.

A panel of experts determined the mode of understanding for each unit package (pretests, programed instruction and posttests) as used within the IPLL setting.

The Oakland Community College computer was utilized to compare individual student cognitive style maps with the mode of understanding required by each unit instructional package, yielding individual degrees of match.

Students were grouped by degrees of match. Gain scores on the units completed by the students were then analyzed in terms of the degrees of match using the Kolmogorov-Smirnov two sample statistical test model.

Three operational hypotheses were listed for statistical analysis, using the data gathered in the study.

CHAPTER IV

ANALYSIS OF THE DATA AND FINDINGS

The operational hypotheses tested in this study were the following:

Operational Hypothesis 1: The group of students exhibiting the greatest degree of match between cognitive style and mode of understanding required by the task will show a gain score (on tests associated with a unit-long instructional package) that is significantly greater, statistically, than the group of students in the sample exhibiting a middle-range degree of match.

Operational Hypothesis 2: The group of students exhibiting the greatest degree of match between cognitive style and the mode of understanding required by the task will show a greater gain score (on tests associated with a unit-long instructional package) that is significantly greater, statistically, than the group of students exhibiting the lowest degree of match.

Operational Hypothesis 3: The group of students exhibiting the middle-range degree of match between cognitive style and the mode of understanding required by the task will show a greater gain score (on tests associated with a unit-long instructional

package) than the group of students exhibiting the lowest degree of match.

The hypotheses were tested using the Kolmogorov-Smirnov two sample statistical test model. Siegel describes the Kolmogorov-Smirnov test as "... sensitive to any kind of difference in the distribution...."[1] and "... when compared with the t-test, the Kolmogorov-Smirnov test has high power-efficiency (about 96%) for small samples ... [and] seems to be more powerful in all cases than either the chi-square test or the median test ... for very small samples ... [and] is slightly more efficient than the Mann-Whitney test...."[2]

Since this study was exploratory in nature, all hypotheses were tested at the .10 alpha level.

Charts representing the Kolmogorov-Smirnov analysis will be included following the section in which each hypothesis is discussed.

Findings of the Study

The purpose of the study was to determine the significance of the degree of match between a student's cognitive style and the mode of understanding required by an instructional package and the setting in which it is used. Students were grouped

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[1]Sidney Siegel, Nonparametric Statistics for the Behavioral Sciences (New York: McGraw-Hill Book Company, Inc., 1956), p. 127.

[2]Ibid., p. 136.

into one of three groups, depending upon the degree of match their cognitive style map exhibited when compared to the mode of understanding for the instructional unit. Table 4.1 displays the students' degree of match, the number of trials (pre- and posttests taken), and the gain scores and posttest scores for the sample dealing with the unit on Newton's laws of motion. Table 4.2 displays the same data for those students working with the materials for the unit on the naming of organic compounds.

Operational Hypothesis 1: The group of students exhibiting the greatest degree of match between cognitive style and mode of understanding required by the task will show a gain score (on tests associated with a unit-long instructional package) that is significantly greater, statistically, than the group of students in the sample exhibiting a middle-range degree of match.

Statistical Alternative Hypothesis

H_1: $CRF_1 > CRF_2$, where CRF_1 denotes "Cumulative Relative Frequency" of the first group, and CRF_2 denotes "Cumulative Relative Frequency" of the second group.

Null Hypothesis

H_0: $CRF_1 \leq CRF_2$

Table 4.1 - Degree of Match Groupings for Newton's Laws Unit

STUDENTS	DEGREE OF MATCH	TRIALS	GAIN SCORE	POSTTEST SCORE	
1.	97	2	100	100	HIGHEST MATCH GROUP
2.	96	2	85	95	
3.	95	2	70	95	
4.	87	2	95	100	
5.	86	2	90	95	
6.	83	3	95	100	
7.	82	2	10	100	
8.	82	3	80	100	
9.	77	2	100	100	MIDDLE MATCH GROUP
10.	77	2	60	95	
11.	72	3	90	100	
12.	70	2	90	100	
13.	67	2	25	25	
14.	64	2	20	20	
15.	62	2	95	95	
16.	58	2	10	100	LOWEST MATCH GROUP
17.	58	2	15	100	
18.	54	2	5	95	
19.	52	2	80	100	
20.	41	2	100	100	

Table 4.2 - Degree of Match Groupings for "Naming Organic Compounds" Unit

STUDENTS	DEGREE OF MATCH	TRIALS	GAIN SCORE	POSTTEST SCORE	
1.	100	3	40	95	HIGHEST MATCH GROUP
2.	97	2	25	100	
3.	92	3	95	100	
4.	88	2	80	95	
5.	84	2	35	45	
6.	84	2	15	100	
7.	84	2	60	95	
8.	81	2	35	95	
9.	81	3	70	100	
10.	79	3	60	95	MIDDLE MATCH GROUP
11.	78	2	65	95	
12.	77	2	30	100	
13.	74	2	70	95	
14.	73	2	35	45	
15.	73	3	45	100	
16.	72	3	75	100	
17.	72	2	15	100	
18.	69	3	20	60	
19.	65	2	70	95	
20.	63	2	30	100	
21.	63	3	35	100	
22.	62	3	100	100	
23.	62	2	80	100	
24.	59	3	90	95	LOWEST MATCH GROUP
25.	59	3	50	55	
26.	58	2	45	95	
27.	55	5	60	95	
28.	55	2	15	20	
29.	52	2	0	60	
30.	51	2	40	85	
31.	51	3	45	70	
32.	47	2	20	40	
33.	42	3	45	95	
34.	38	3	20	80	
35.	37	3	60	95	
36.	33	2	40	75	

Tables 4.3 and 4.4 indicate the pretest-posttest gain scores on the programed instruction units covering Newton's laws of motion and the naming of organic compounds, respectively.

Table 4.3 - Kolmogorov-Smirnov Test Between Highest and Middle-range Match Groups for the Unit on Newton's Laws of Motion

MATCH GROUP, BY DEGREE OF MATCH	PRETEST-POSTTEST GAIN SCORES				n
	- to 0 to 25	26-50	51-75	76-100	
100-81%	1 $\frac{1}{8} = \frac{7}{56}$	0 $\frac{7}{56}$	1 $\frac{14}{56}$	6 $\frac{56}{56}$	8
80-61%	2 $\frac{2}{7} = \frac{16}{56}$	0 $\frac{16}{56}$	1 $\frac{24}{56}$	4 $\frac{56}{56}$	7
ABSOLUTE DIFFERENCE BETWEEN GROUPS	$\frac{9}{56}$	$\frac{9}{56}$	$\frac{10}{56}$ D=.178	0	

Table 4.4 - Kolmogorov-Smirnov Test Between Highest and Middle-range Match Groups for the Unit on the Naming of Organic Compounds

MATCH GROUP, BY DEGREE OF MATCH	PRETEST-POSTTEST GAIN SCORES				n
	- to 0 to 25	26-59	51-75	76-100	
100-81%	2 $\frac{2}{9} = \frac{28}{126}$	3 $\frac{70}{126}$	2 $\frac{98}{126}$	2 $\frac{126}{126}$	9
80-61%	2 $\frac{2}{14} = \frac{18}{126}$	5 $\frac{63}{126}$	6 $\frac{108}{126}$	1 $\frac{126}{126}$	14
ABSOLUTE DIFFERENCE BETWEEN GROUPS	$\frac{10}{126}$ .079	$\frac{7}{126}$	$\frac{10}{126}$ D=.079	0	

Since the largest absolute difference in Table 4.3 is .178, this is the value which was tested by the Kolmogorov-Smirnov one-tailed two-sample model. The formula for testing this value is:

$$X^2 = 4D^2 \left[\frac{n_1 n_2}{n_1+n_2}\right] .$$

This computed value was .473. The computed value was compared to the chi-square value with two degrees of freedom, at the .10 alpha level. The chi-square value, 4.60, was greater than the computed test value (.473). The computed test value was found not to be significant at the .10 alpha level. The method for determining the test value is found in Chapter III. Computational work tables are found in Appendix D.

The largest absolute difference in Table 4.4 is .079. The computed value is .13147. When compared to the chi-square value (4.60) this computed value was also not found to be significant at the .10 alpha level.

In neither sample was the difference in gain scores found to be significant (α = .10) between the highest match group and the middle-range match group. Therefore the null hypothesis cannot be rejected and the operational hypothesis cannot be accepted.

Operational Hypothesis 2: The group of students exhibiting the greatest degree of match between cognitive style and the mode of understanding required by the task will show a greater gain score (on tests associated with a unit-long instructional

package) that is significantly greater, statistically, than the group of students exhibiting the lowest degree of match.

Statistical Alternative Hypothesis

H_1: $CRF_1 > CRF_2$

Null Hypothesis

H_0: $CRF_1 \leq CRF_2$

Table 4.5 - Kolmogorov-Smirnov Test Between Highest and Lowest Match Groups for the Unit on Newton's Laws

MATCH GROUP, BY DEGREE OF MATCH	PRETEST-POSTTEST GAIN SCORES				n
	- to 0 to 25	26-50	51-75	76-100	
100-81%	1 $\frac{1}{8} = \frac{5}{40}$	0 $\frac{5}{40}$	1 $\frac{10}{40}$	6 $\frac{40}{40}$	8
60-0%	3 $\frac{3}{5} = \frac{24}{40}$	0 $\frac{24}{40}$	0 $\frac{24}{40}$	2 $\frac{40}{40}$	5
ABSOLUTE DIFFERENCE BETWEEN GROUPS	$\frac{19}{40}$ .475	$\frac{19}{40}$ D=.475	$\frac{10}{40}$	0	

Since the largest absolute value in Table 4.5 is .475, this test value was used to determine the computed value (2.7766). The computed value was found not to be significant when compared to the chi-square value of 4.60 at the .10 alpha level.

Table 4.6 - Kolmogorov-Smirnov Test Between Highest and Lowest Match Groups for "Naming Organic Compounds"

MATCH GROUP, BY DEGREE OF MATCH	PRETEST-POSTTEST GAIN SCORES				n
	- to 0 to 25	26-50	51-75	76-100	
100-81%	2 $\frac{2}{9} = \frac{26}{117}$	3 $\frac{65}{117}$	2 $\frac{91}{117}$	2 $\frac{117}{117}$	9
60-0%	4 $\frac{4}{13} = \frac{36}{117}$	6 $\frac{90}{117}$	2 $\frac{108}{117}$	1 $\frac{117}{117}$	13
ABSOLUTE DIFFERENCE BETWEEN GROUPS	$\frac{10}{117}$	$\frac{25}{117}$ D=.2137	$\frac{17}{117}$	0	

The largest absolute value in Table 4.6 is .2137. The computed value becomes .9700. This computed value is not significant at the .10 alpha level when compared to the chi-square value (4.60).

In neither sample, then, was the difference in gain scores between the highest match group and the lowest match group found to be significant ($\alpha = .10$). Therefore, the null hypothesis could not be rejected and Operational Hypothesis 2 cannot be accepted.

Operational Hypothesis 3: The group of students exhibiting the middle-range degree of match between cognitive style and the mode of understanding required by the task will show a gain score (on tests associated with a unit-long instructional

package) that is significantly greater, statistically, than the group of students exhibiting the lowest degree of match.

Statistical Alternative Hypothesis

H_1: $CRF_1 > CRF_2$

Null Hypothesis

H_0: $CRF_1 \leq CRF_2$

Table 4.7 - Kolmogorov-Smirnov Test Between Middle-range and Lowest Match Groups for Unit "Newton's Laws"

MATCH GROUP, BY DEGREE OF MATCH	PRETEST-POSTTEST GAIN SCORES				n
	- to 0 to 25	26-50	51-75	76-100	
80-61%	2 $\frac{2}{7} = \frac{10}{35}$	0 $\frac{10}{35}$	1 $\frac{15}{35}$	4 $\frac{35}{35}$	7
60-0%	3 $\frac{3}{5} = \frac{21}{35}$	0 $\frac{21}{35}$	0 $\frac{21}{35}$	2 $\frac{35}{35}$	5
ABSOLUTE DIFFERENCE BETWEEN GROUPS	$\frac{11}{35}$ D=.314	$\frac{11}{35}$ .314	$\frac{6}{35}$	0	

The largest absolute value in Table 4.7 is .314, yielding a computed value of 1.1430. When compared to the chi-square value (4.60) the computed value was found not to be significant at the .10 alpha level.

Table 4.8 - Kolmogorov-Smirnov Test Between Middle-range and Lowest Match Groups on "Naming Organic Compounds"

MATCH GROUP, BY DEGREE OF MATCH	PRETEST-POSTTEST GAIN SCORES				n
	- to 0 to 25	26-50	51-75	76-100	
80-61%	2 $\frac{2}{14} = \frac{26}{182}$	5 $\frac{91}{182}$	5 $\frac{156}{182}$	2 $\frac{182}{182}$	14
60-0%	4 $\frac{4}{13} = \frac{56}{182}$	6 $\frac{140}{182}$	2 $\frac{168}{182}$	1 $\frac{182}{182}$	13
ABSOLUTE DIFFERENCE BETWEEN GROUPS	$\frac{30}{182}$	$\frac{49}{182}$ D=.269	$\frac{12}{182}$	0	

The largest absolute difference in Table 4.8 is .269. The computed value becomes 1.949. This computed value is also less than the chi-square value, 4.60, and therefore not significant at the .10 alpha level.

In neither sample was the difference in gain scores between the middle-range match group and the lowest match group found to be significant (α = .10). Therefore, the null hypothesis could not be rejected and Operational Hypothesis 3 cannot be accepted.

Additional Findings

As stated previously, this study was exploratory in nature. For this reason the investigator analyzed data on other aspects of the problem under consideration. Other data

analyzed included the number of trials (pretests and posttests) the students needed to reach the criterion level on posttests. Students were divided into groups according to degree of match, as in the previous analyses.

Tables 4.9 and 4.10 are Kolmogorov-Smirnov tests between "degree of match" groups indicating the number of trials to criterion. In no case was the largest value significant at the .10 alpha level. Therefore it could not be stated that the number of trials needed by a student to reach the criterion level is predictable on the basis of his cognitive style.

Tables 4.11 and 4.12 represent Kolmogorov-Smirnov tests between a combination of high and middle-range match groups and the lowest match group, indicating posttest scores on the two instructional units. The break point of a 60% degree of match for "Newton's laws" was chosen because of sample size. If a break point of 55% had been chosen, one portion of the sample would have included only three members, and if 50% had been chosen (as the Educational Sciences have, for selecting between "major" and "minor" elements of cognitive style) there would have been but one member. The break point of a 55% degree of match was used for "naming organic compounds" for the same reason.

The largest absolute difference appearing in Table 4.11 is .1333. This computes to a Kolmogorov-Smirnov one-tailed test value of .2655, which is not significant at the .10 alpha level when compared to the chi-square value (4.60).

Table 4.9 - Kolmogorov-Smirnov Test Between Match Groups for Number of Trials, "Newton's Laws"

DEGREE OF MATCH	NUMBER OF TRIALS TO CRITERION			n
	2	3	4 or more	
100-81%	6 $\frac{6}{8} = \frac{30}{40}$	2 $\frac{40}{40}$	0 $\frac{40}{40}$	8
80-61%	4 $\frac{4}{5} = \frac{32}{40}$	1 $\frac{40}{40}$	0 $\frac{40}{40}$	5
ABSOLUTE DIFFERENCE	D=.050	0	0	
100-81%	6 $\frac{6}{8} = \frac{30}{40}$	2 $\frac{40}{40}$	0 $\frac{40}{40}$	8
60-0%	5 $\frac{5}{5} = \frac{40}{40}$	0 $\frac{40}{40}$	0 $\frac{40}{40}$	5
ABSOLUTE DIFFERENCE	D=.250	0	0	
80-61%	4 $\frac{4}{5}$	1 $\frac{5}{5}$	0 $\frac{5}{5}$	5
60-0%	5 $\frac{5}{5}$	0 $\frac{5}{5}$	0 $\frac{5}{5}$	5
ABSOLUTE DIFFERENCE	D=.200	0	0	

Table 4.10 - Kolmogorov-Smirnov Test Between Match Groups for Number of Trials, "Naming Organic Compounds"

DEGREE OF MATCH	NUMBER OF TRIALS TO CRITERION			n
	2	3	4 or more	
100-81%	$\frac{5}{8} = \frac{30}{48}$	$\frac{8}{8}$	$\frac{8}{8}$	8
80-61%	$\frac{7}{12} = \frac{28}{48}$	$\frac{12}{12}$	$\frac{12}{12}$	12
ABSOLUTE DIFFERENCE	D=.0415	0	0	
100-81%	$\frac{5}{8} = \frac{25}{40}$	$\frac{8}{8}$	$\frac{8}{8}$	8
60-0%	$\frac{1}{5} = \frac{8}{40}$	$\frac{32}{40}$	$\frac{5}{5}$	5
ABSOLUTE DIFFERENCE	D=.3245	$\frac{8}{40}$	0	
80-61%	$\frac{7}{12} = \frac{35}{60}$	$\frac{12}{12}$	$\frac{12}{12}$	12
60-0%	$\frac{1}{5} = \frac{12}{60}$	$\frac{48}{60}$	$\frac{5}{5}$	5
ABSOLUTE DIFFERENCE	23/60 D=.383	$\frac{12}{60}$	0	

Table 4.11 - Posttest Scores by Degree of Match, "Newton's Laws of Motion"

DEGREE OF MATCH	POSTTEST SCORES				n
	0-25	26-50	51-75	76-100	
100-61%	2 $\frac{2}{15}$	$\frac{2}{15}$	$\frac{2}{15}$	13 $\frac{15}{15}$	15
60-0%	0	0	0	5 $\frac{5}{5}$	5
ABSOLUTE DIFFERENCE	D=.1333	.1333	.1333	0	X

Table 4.12 - Posttest Scores by Degree of Match, "Naming Organic Compounds"

DEGREE OF MATCH	POSTTEST SCORES				n
	0-25	26-50	51-75	76-100	
100-56%	0	2 $\frac{10}{130}$	2 $\frac{20}{130}$	22 $\frac{26}{26}$	26
55-0%	1 $\frac{13}{130}$	1 $\frac{26}{130}$	4 $\frac{78}{130}$	4 $\frac{10}{10}$	10
ABSOLUTE DIFFERENCE	$\frac{13}{130}$	$\frac{16}{130}$	D=.446	0	X

The largest absolute difference in Table 4.12 is .446. This computes to a value of 5.748, which is significant at the .10 alpha level when compared to the chi-square value of 4.60. The computed value is nearly significant when compared to the chi-square value at the .05 alpha level (5.99).

Summary

The findings resulting from analysis of the data indicate that none of the null hypotheses stated for the study could be rejected in favor of the statistical alternative. Further analysis of the data did not indicate a significance in the relationship between the number of trials needed by a student and his degree of match between cognitive style and mode of understanding. Analysis of the data supports a significance above the .10 alpha level in the relationship between degree of match and posttest performance for the sample completing the unit on the naming of organic compounds. The data does not support significance in match-posttest for the sample completing the unit on Newton's laws of motion. Discussion and implications of these findings are considered in the following chapter.

CHAPTER V

SUMMARY AND CONCLUSIONS

Instructional Development appears to be an area of education from which gains in efficiency and effectiveness of instruction may be expected. One method of making the instructional process more efficient and effective is to adapt instructional strategies to the individual characteristics of the student, hopefully ensuring the greatest amount of success with the least expenditure of time and materials.

The purpose of this study was to find a method of matching certain student characteristics (in terms of cognitive style) to an instructional strategy and setting suited to the students' characteristics. More specifically, the purpose was to investigate the significance of the degree of match between student characteristics and instructional strategy and setting characteristics.

Educational researchers have suggested studies in which student, media and environmental characteristics are analyzed, with learning tasks specifically defined, and learning conditions identified for those tasks. All these suggestions were employed within this study.

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The conceptual framework called the Educational Sciences, as used at Oakland Community College in Michigan, was employed in this study. This framework includes the Educational Science of Cognitive Style, used to diagnose student characteristics in the planning of educational experiences at that college. Cognitive style elements were used to define the characteristics of the programed instruction package and the instructional setting, as well as the characteristics of the student.

It is generally agreed that all students do not learn in the same ways. The literature reviewed in this study indicates that little is known about the structure of learning as it applies to either programed instruction or aptitude-treatment interactions. This study employed a framework (the Educational Sciences) within which cognitive characteristics are measurable and, by so doing, attempted to shed more light on student achievement.

This study was conducted in a community college serving nearly 19,000 students. The population consisted of students enrolled in a freshman science course designed for the educationally disadvantaged. Two samples were drawn from this population (N=36, N=20) on the bases of accessibility and purpose of the study. Each sample was then divided according to the degree of match between student cognitive style and the mode of understanding required by the programed instruction package and the setting in which it was used. Each student completed a pretest, the programed text, and a posttest for the unit assigned.

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The data were analyzed by use of the Kolmogorov-Smirnov "two sample" Statistical Test Model to indicate interactions between groups of students matched, by degree, to the program and setting. All hypotheses were tested using the .10 level of confidence with appropriate degrees of freedom.

The findings of the study failed to reject the null form of the operational hypotheses which indicated that there would be no difference between cumulative relative frequencies of gain scores across groups. There was no significant difference between relative frequencies of gain scores. The data were further analyzed, with the only significant finding (α = .10) indicating that posttest success for one of the two samples could be predicted on the basis of cognitive style.

Conclusions

Analysis of the data supports the following conclusions:

1. No significant difference was found between gain scores (on tests associated with either unit-long instructional package) of the group exhibiting the highest degree of match and the group showing the middle-range degree of match between student characteristics and characteristics of the package and setting.

2. No significant difference was found between gain scores (on the same tests) of the group displaying the highest match and the group exhibiting the lowest match between student characteristics and package and setting characteristics.

3. No significant difference was found between gain scores (on the same tests) of the group showing the middle-range match and the group displaying the lowest match between student characteristics and those of the package and setting.

4. In addition, analysis of the data did not indicate any significant difference between the number of trials needed to reach criterion between students with the lowest match and the rest of the subjects.

5. The data was then analyzed for possible correlations between degree of match and posttest scores. One sample showed no significant difference between the lower "degree of match" group and the higher group. The second sample showed a significant difference ($\alpha = .10$) in favor of the higher "degree of match" group.

Discussion

This exploratory study appears to have initiated more questions than it answered. Many of these questions need to be pursued. The specific direction of these questions is discussed in some detail in the section "Implications for Future Research."

Analysis of the data has indicated that no significance in gain score was found between any combination of the three groups in each sample. There was no significance in the number of trials needed to reach criterion. There was significance in the relationship between degree of match and posttest

scores, and with but one of the two sample groups.

There could be several reasons for these results. The first deals with the nature of the criterion tests. Most achievement tests have built into them an artificial ceiling. In this case, the ceiling was a 100% test score. No matter where the student placed on the pretest, the posttest ceiling was 100%. A student scoring 0% on the pretest could gain 100 points on the posttest. A student scoring 90% could gain only 10 points on the posttest. However, trends in the data did not indicate that this feature of the study favored one group over another.

A second possible reason for the results obtained deals with the composition of the samples. In neither sample were there included any students with negligible (0-24%) degrees of match between student characteristics and those of the package and setting. Each student has at least a "minor" (25-49%) degree of match. In one sample, 19 of 20 subjects had a "major" (50-99%) match. In the other, 31 of 36 had a major match. The finding of no significant difference in the data analysis tends to support Hill's principle that anyone in the 50th to 99th percentiles, at a given educational level, for a given characteristic or set of characteristics is a "major," regardless of the degree of that match (50-99%). Clearly, the degree of match hypotheses of this study did not counter that principle. In other words, the data support the conclusion that there is no significant difference between degrees of a major orientation.

A third possible reason for the lack of statistical significance may lie in the number of "minor" degrees of match included in the samples. Perhaps if more students with degrees of match ranging from 25 to 49% had been included in the study the findings would have been different. If an equal number of "minor match" students had been included and results had indicated a significant difference between major and minor matches, this portion of the Educational Sciences (cognitive style) would have been strengthened. If no significant difference could be found it would point up a possible weakness in the framework.

A fourth possible reason for finding no significant difference in the data is related to sample size. To find statistical significance with small samples the data must reflect a great absolute difference in the Kolmogorov-Smirnov tables. For a sample of ten, the critical value is four, at the .10 alpha level. The absolute difference must meet or exceed 4 to indicate significance. In samples of forty, however, the critical value is only 9 for the .10 alpha level. Sample sizes in this study were determined by situations within the Foundational Sciences Natural and Life Sciences course and the normal procedures attendant to those situations. A study incorporating larger samples may show significant differences in those areas where this exploratory study could show none.

It appears, from the analysis of the data, that the time and effort devoted to determining the mode of understanding

required by the instructional package and the setting in which it was used provided no better data from which to prescribe educational experiences than the original method used at the college. The original method was to match students with settings which matched their cognitive styles. The most efficient and effective method of selecting experiences for students was that which already existed at the college.

The effects of programed instruction cannot be overlooked in this discussion. Within the sample completing the unit on Newton's laws of motion, 18 of 20 students reached the 95% criterion level on the posttests. In the other sample 25 of 36 met the criterion. Seven of the eleven who failed to reach the criterion were in the lowest 9 subjects in degree of match. Only 4 of the first 27 (in terms of degree of match) failed to reach criterion. By viewing the unit tests in Appendix C one can see that the reason for this high rate of success is not due to the simplicity of the tests. The results should be credited to the effectiveness of the programed texts. However, it is still the considered opinion of this investigator that these programs would not bring as great a percentage of those students to criterion level whose cognitive styles were negligibly matched (0-24%) to the package and setting.

Implications and Recommendations for Future Research

The following suggestions for future research are based on the findings of this study and the experiences and insights

gained during the investigation.

1. It is suggested that this study be replicated using a larger set of sample groups. This investigation was exploratory, and data pointed up trends which might be significant, statistically, with larger samples. The increased sample size would yield greater statistical precision of group measurements.

2. This study was conducted within a science course designed for specific student characteristics. For the results discovered in the study to become generalizable to the field of education, other studies should be conducted within additional subject areas, at additional grade levels.

3. Replication should also include those students who are negligibly matched (0-24%) to the package and setting.

4. Further, replication should include other forms of mediated instruction (audio tapes, video tapes, filmstrips, movies, slide-tape demonstrations, transparencies and other forms of media) in addition to programed texts.

5. This study used first year college students with a particular set of characteristics. Future studies should include students at the other levels of educational development and students with other demographic characteristics.

6. Cognitive style diagnosis is very new. Past studies have shown the effectiveness of this diagnostic tool, but care must be used in utilizing the data represented in this and other such studies. Educators have found implementation

of innovations relatively easy, but maintenance of those innovations more difficult. Often this implementation-maintenance predicament stems from inadequate knowledge relating to the innovative phenomenon. The possibilities and limitations of use of the cognitive style concept must be determined by professional educators in light of their particular institutional situations.

To blindly accept the framework called the Educational Sciences and cognitive style mapping as another educational panacea would be dangerous. Knowledge of the framework is the key to success. Researchers should examine findings carefully before either implementing or dismissing programs based upon such findings.

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APPENDICES

APPENDIX A

OAKLAND COMMUNITY COLLEGE COGNITIVE STYLE TEST BATTERY, MANUAL OF INSTRUCTIONS

COGNITIVE STYLE

DIAGNOSTIC TEST BATTERY

MANUAL OF DIRECTIONS

OAKLAND COMMUNITY COLLEGE

TEST ADMINISTRATION

T(VL) ALGORITHM

1. Score tests 1, 4, and 6. Go to Step 2.

2. Establish majors and minors for test 1 and 6 at the same grade level. Go to Step 3.

3. Is test 1 or test 6 negligible?

   NO: Go to Step 4
   YES: Go to Step 8

4. Establish entry level equal to grade level of test 1 and 6. Go to Step 5.

5. Are there two majors?

   NO: Go to Step 7
   YES: Go to Step 6

6. Record T(VL) as major. Go to Step 11.

7. Record T(VL) as minor. Go to Step 11.

8. Set entry level equal to reading level + .5. Go to Step 9.

9. Substitute test 4 for the negligible test. Go to Step 10.

10. If test 4 is negligible, lower entry level by 1 and set test 4 equal to major. Go to Step 11.

11. End of procedure.

TEST I

TEST I

ANSWER KEY

1.	B
2.	D
3.	B
4.	C
5.	C
6.	A
7.	E
8.	B
9.	B
10.	A
11.	A
12.	C
13.	A
14.	A
15.	E
16.	E
17.	D
18.	D
19.	A
20.	D
21.	A
22.	D
23.	E
24.	A
25.	B

Double Raw Score

12th Grade Level
30 - 50 Major
20 - 29 Minor
0 - 19 N/S

11th Grade Level
29 - 50 Major
19 - 28 Minor
0 - 18 N/S

I0th Grade Level
25 - 50 Major
16 - 24 Minor
0 - 15 N/S

9th Grade Level
20 - 50 Major
13 - 19 Minor
0 - 12 N/S

8th Grade Level
16 - 50 Major
11 - 15 Minor
0 - 10 N/S

TEST II TEST II

MAY I HAVE YOUR ATTENTION. LISTEN CAREFULLY. I'M GOING TO READ YOU A BRIEF SHORT STORY. IMMEDIATELY AFTER I AM FINISHED, YOU WILL BE GIVEN TEST SHEETS ON WHICH YOU ARE TO WRITE YOUR ANSWERS TO A FEW QUESTIONS ABOUT THE STORY. YOU ARE NOT TO WRITE OR PICK UP YOUR PENCILS WHILE THE STORY IS BEING READ. PAY CLOSE ATTENTION.

"COKE AND CHIPS IN THE CARIBBEAN"

ON A WARM DAY WHEN THEY'RE THIRSTY, CARIBBEAN KIDS SHINNY UP TO THE COCONUTS AT THE TOP CF A COCONUT PAIM TREE. THEY FIND THE RIPEST OF THE BUNCH, CUT IT LOOSE, AND LET IT FALL TO THE GROUND.

THEN THEY FIND AN OPENER (MOST OFTEN JUST A BIG ROCK) AND SMASH, SMASH, SMASH AT THE CUTER SKIN UNTIL THEY GET TO THE INNER SKIN. (THE ONE WITH THE MONKEY FACE.)

THEN THEY SMASH, SMASH, SMASH SOME MORE. UNTIL THEY REACH THE FRUITS OF THEIR LABOR. DELICIOUS COCONUT MILK, CRISP COCONUT MEAT.

IT'S "COKE AND CHIPS" IN THE CARIBBEAN.

ANSWER KEY TEST II

1. Warm
2. Caribbean
3. Coconut
4. Shinny up the tree, climb the tree
5. Drop it, let it fall to the ground
6. Monkey
7. Smash with a rock
8. Coke and chips

Boys and girls	7 - 8 Major 2 - 6 Minor 0 - 1 N/S

11/4/71

TEST III

TEST III

ANSWER KEY

1. B
2. A
3. E
4. C
5. B
6. D
7. D
8. D
9. A
10. B
11. C
12. E
13. C
14. D
15. D
16. D
17. E
18. A
19. E
20. B

Double Raw Score	24 - 40 Major
	18 - 23 Minor
	0 - 17 N/S

11/4/71

TEST IV

TEST IV

ANSWER KEY

1.	C	13.	B	25.	B
2.	B	14.	C	26.	C
3.	A	15.	D	27.	D
4.	C	16.	D	28.	A
5.	B	17.	A	29.	B
6.	C	18.	D	30.	C
7.	A	19.	B	31.	B
8.	D	20.	D	32.	C
9.	A	21.	A	33.	D
10.	B	22.	C	34.	A
11.	A	23.	D	35.	A
12.	D	24.	B	36.	C

GRADE NORMS

Raw Score	Reading Grade	Raw Score	Reading Grade	Raw Score	Reading Grade
0	2.0	13	6.1	25	11.0
1	2.2	14	6.3	26	11.3
2	2.4	15	6.5	27	11.4
3	2.5	16	6.8	28	11.5
4	2.7	17	7.1	29	11.6
5	3.0	18	7.4	30	11.7
6	3.4	19	7.8	31	11.8
7	3.9	20	8.2	32	11.9
8	4.2	21	8.6	33	12.0
9	4.5	22	9.1	34	12.1
10	4.8	23	9.9	35	12.2
11	5.3	24	10.6	36	12.3
12	5.8				

TEST V TEST V

MAY I HAVE YOUR ATTENTION. LISTEN CAREFULLY. I'M GOING TO READ YOU SOME BRIEF ARITHMETIC PROBLEMS. YOU ARE TO WRITE YOUR ANSWER TO THE PROBLEM IMMEDIATELY AFTER IT IS READ. THERE WILL BE A PAUSE OF 15 TO 20 SECONDS FOR YOU TO DO YOUR CALCULATIONS, THEN THE NEXT PROBLEM WILL BE READ. PAY CLOSE ATTENTION FOR THE PROBLEMS WILL BE READ ONLY ONCE. LISTEN CAREFULLY.

1. A newsboy collected 90¢ from each of 3 customers. The total amount he collected was...
2. How many inches are in 3 1/2 feet?
3. How many "cokes" can you buy for 88¢ if cokes cost 11¢ each?
4. How many hours will it take to drive 300 miles at 60 miles per hour?
5. How much change will the clerk give you from $1.00 if you purchase 15 cards at 5¢ each?
6. A chick with $8.00 spends $3.50. How much does she have left?
7. Ball point pens are two for 49¢. How much will one dozen cost?
8. A cat bought a second-hand motor bike for $400.00 which was 2/3 of what it cost new. How much did it cost new?
9. A teacher's salary is $200.00 per week. 5% of it is withheld for retirement. How much does he have left?
10. Four women can knit a blanket in two days. How many will be needed to finish it in 1/2 day?

TEST V

TEST V

ANSWER KEY

1. $2.70
2. 42"
3. 8
4. 5
5. 25¢
6. $4.50
7. $2.94
8. $600
9. $190
10. 16

Boys and Girls 8 - 10 Major
7 - 5 Minor
4 - 0 N/S

11/4/71

TEST VI

TEST VI

ANSWER KEY

1.	D	21.	D	41.	A
2.	C	22.	E	42.	C
3.	B	23.	D	43.	A
4.	D	24.	C	44.	D
5.	A	25.	C	45.	B
6.	B	26.	C	46.	E
7.	C	27.	D	47.	A
8.	D	28.	C	48.	D
9.	E	29.	B	49.	D
10.	C	30.	D	50.	C
11.	B	31.	A		
12.	C	32.	A		
13.	C	33.	B		
14.	D	34.	B		
15.	E	35.	C		
16.	B	36.	C		
17.	E	37.	B		
18.	E	38.	C		
19.	C	39.	C		
20.	B	40.	B		

Boys & Girls 35 - 50 Major
23 - 34 Minor
0 - 22 N/S

SCORE	PERCENT	COURSE
0-22	0-44	ENG 052
23-34	46-68	ENG 131
35-43	70-86	ENG 151
44-50	88-100	ENG 152

NORMS FOR GRADES 8 - 12 FOR TEST VI

GRADE	M	M'	N/S
12	35-50	23-34	0-22
11	30-34	18-29	0-17
10	25-29	13-24	0-12
9	20-25	8-19	0-7
8	15-19	3-14	0-2

11/4/71

TEST VII

TEST VII

A = 3
B = 2
C = 1
D = Ø

24 - 15 Major
14 - 8 Minor
7 - 0 N/S

1.	Qcem	21.	Qch
2.	Qces	22.	Qces
3.	Qcet	23.	Qck
4.	Qch	24.	Qcem
5.	Qck	25.	Qch
6.	Qcem	26.	Qck
7.	Qces	27.	Qcet
8.	Qcet	28.	Qcet
9.	Qcem	29.	Qck
10.	Qck	30.	Qces
11.	Qch	31.	Qck
12.	Qcem	32.	Qcem
13.	Qcem	33.	Qch
14.	Qcet	34.	Qces
15.	Qces	35.	Qck
16.	Qch	36.	Qces
17.	Qcet	37.	Qch
18.	Qch	38.	Qces
19.	Qcet	39.	Qck
20.	Qcem	40.	Qcet

TEST VIII

TEST VIII

A = 3
B = 2
C = 1
D = Ø

24 - 15 Major
14 - 8 Minor
14 - 0 N/S

1.	Qckh	17.	Qct
2.	Qcp	18.	Qckh
3.	Qcs	19.	Qcs
4.	Qct	20.	Qckh
5.	Qcs	21.	Qcs
6.	Qckh	22.	Qcp
7.	Qcs	23.	Qct
8.	Qct	24.	Qcp
9.	Qckh	25.	Qcp
10.	Qckh	26.	Qcs
11.	Qcs	27.	Qct
12.	Qckh	28.	Qcs
13.	Qct	29.	Qcp
14.	Qckh	30.	Qct
15.	Qcp	31.	Qcp
16.	Qcp	32.	Qct

TEST IX

TEST IX

SCORING KEY

F = Family
A = Associates
I = Individual

A.

1. F
2. A
3. I

B.

4. A
5. I
6. F

C.

7. I
8. F
9. A

D.

10. F
11. I
12. A

E.

13. F
14. A
15. I

F.

16. I
17. F
18. A

G.

19. F
20. I
21. A

H.

22. A
23. F
24. I

I.

25. F
26. I
27. A

J.

28. I
29. A
30. F

WEIGHTED SCORING METHOD

1. Score Most as 3
2. Score Least as 1
3. Score Blank as 2

KEY

30 - 21 Major
20 - 14 Minor
13 - 0 N/S

TEST X TEST X

SCORING KEY

M = Magnitude
D = Difference
R = Relationship
L = Appraisal

KEY
70 - 37 Major
36 - 22 Minor
21 - 0 N/S

I.		IV.		VIII.	
1.	R	13.	L	29.	M
2.	M	14.	M	30.	L
3.	D	15.	D	31.	R
4.	L	16.	R	32.	D
II.		V.		IX.	
5.	M	17.	L	33.	M
6.	L	18.	R	34.	L
7.	R	19.	M	35.	R
8.	D	20.	D	36.	D
III.		VI.		X.	
9.	R	21.	M	37.	R
10.	M	22.	R	38.	D
11.	D	23.	D	39.	M
12.	L	24.	L	40.	L
		VII.			
		25.	R	41.	C
		26.	M	42.	C
		27.	D	43.	C
		28.	L	44.	C
				45.	C

WEIGHTED
SCORING METHOD

1. Score A as 7
2. Score B as 3
3. Score C as 2
4. Score D as 1

Questions 41 - 45

If the student has 3 out of 5 answers correct and at least a minor in T(VQ); print (K).

Instructions for Raven Matrices Survey

1. Turn on the tape recorder.
2. Wait for instructions to be completed:

   (On tape) PLEASE LOOK AT THE FIRST PICTURE IN FRONT OF YOU. YOU SEE IT AS A PATTERN WITH A PIECE CUT OUT OF IT. EACH OF THE PIECES AT THE BOTTOM OF THE PICTURE IS THE RIGHT SHAPE TO FIT THE SPACE, BUT ONLY ONE OF THEM IS THE RIGHT PATTERN. #1 IS THE RIGHT SHAPE BUT IT IS NOT THE RIGHT PATTERN. #2 IS NOT A PATTERN AT ALL. #3 IS QUITE WRONG. #6 IS REALLY RIGHT BUT IT IS WRONG WITH THE WHITE PIECE IN IT. ONLY #4 IS QUITE RIGHT.
3. Turn off the recorder.
4. The testor says: I WOULD LIKE YOU TO DETERMINE THE CORRECT ANSWER FOR EACH OF THE PUZZLES AND WRITE THE CORRECT ANSWER IN THE SPACE PROVIDED. YOU WILL HAVE FROM 15 TO 20 SECONDS FOR EACH PUZZLE. GO AHEAD.

Q(V) - Qualitative Visual

Recording of Results for Raven Matrices Survey

The students record their answers on the self-scoring checklist.

VISUAL

A.	_____	E.	_____
B.	_____	F.	_____
C.	_____	G.	_____
D.	_____	H.	_____

Scoring for Raven Matrices

Use the weights as indicated. Score WRONG answers only.

Answers				Weights			
A	4	E	4	A	5	E	3
B	5	F	3	B	7	F	1
C	5	G	4	C	2	G	4
D	2	H	5	D	6	H	8

Add the total score and compare to the following chart.

0 - 11 Major
12 - 18 Minor
19 - 36 N/S

Mueller Auditory Survey

THIS IS AN AUDITORY REASONING TEST. YOU ARE ABOUT TO HEAR A SERIES OF SOUNDS WITH A DEFINITE PATTERN. YOU ARE TO WRITE THE NEXT SOUND OF THE PATTERN WHEN REQUESTED. FOR EXAMPLE, IF YOU HEAR "BA BA BA, BE BE BE, BA BA BA" YOU NOTICE AN ALTERNATING PATTERN AND PREDICT THE NEXT SOUND AS "BE BE BE". SIMILARLY, IF YOU "BA BE, BA BE BE, BA BE BE BE", YOU SHOULD NOTICE THAT IN EACH GROUP THERE IS ONE MORE "BE" THAN IN THE PREVIOUS GROUP, AND YOU SHOULD PREDICT "BA BE BE BE BE" OR ONE "BA" AND FOUR "BE'S". (pause) NOW LISTEN TO THE SOUNDS, FIGURE OUT THE PATTERN, AND WRITE THE NEXT SOUND IN THE SERIES ON YOUR ANSWER SHEET.

1. BE BE BE BE, BE BE BE, BE BE
2. BA BE BE BA, BE BA BA BE, BA BE BE BA, BE BA BA BE
3. BE BE BA BE BE BE, BE BE BA BA BE BE, BE BE BA BA BA BE
4. BE BA BE BE, BE BE BA BE, BE BE BE BA, BA BE BE BE
5. BA BA BA, BA BE BA, BE BE BE, BE BA BE

Scoring for Mueller Auditory Survey

The following weights have been assigned to the answers in the Mueller Auditory Survey as follows:

1. 3
2. 4
3. 5
4. 6
5. 7

Answers to the Mueller Auditory

1. BE
2. BA BE BE BA
3. BE BE BA BA EA BA
4. BE BA BE BE
5. BA BA BA

Score the weighted right answers as follows:

IF SCORE IS:	CHECK
0 - 3	N/S
4 - 7	Minor
8 +	Major

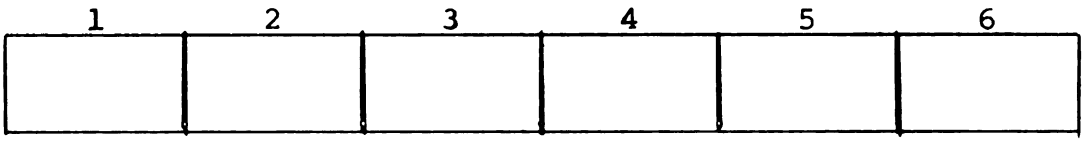
Q(O) - Qualitative Olfactory

Instructions for the Olfactory Cards

The testor shows the students a packet of six olfactory cards. THESE ARE OLFACTORY CARDS. YOU ARE TO SCRATCH THE TAPE LIKE THIS. (Here the testor demonstrates the proper way to scratch the cards.) THEN SNIFF THE TAPE. ON THE BACK OF THE CARD YOU WILL FIND FIVE CHOICES LABELED A THROUGH E. YOU WILL ALSO NOTICE THAT EACH CARD IS NUMBERED. THESE NUMBERS CORRESPOND TO THE NUMBERED BOXES ON YOUR SELF-SCORING CHECKLIST. PLEASE WRITE YOUR ANSWERS IN THESE BOXES. GO AHEAD.
The students do this test at their own pace.

Recording of Results for Olfactory Survey

OLFACTORY



Correct Answers

1. C
2. C
3. B
4. C
5. B
6. D

KEY

4 - 6 Major
2 - 3 Minor
0 - 1 N/S

KEY SHEET

(1) ONION	(2) CHOCOLATE	(3) COCONUT
Parsley Seed	Coke	Burnt Sugar
Pepper	Cinnamon	Coconut
Onion	Chocolate	Chocolate
Celery	Banana	Toasted Almond
Chocolate	Strawberry	Vanilla

(4) CHERRY	(5) SMOKE	(6) CINNAMON
Root Beer	Wood	Peppermint
Coke	Smoke	Nutmeg
Cherry	Bread	Cloves
Grape	Pizza	Cinnamon
Coffee	Charcoal	Coke

Q(T) - Qualitative Tactile
Q(P) - Qualitative Proprioceptive

Seat the student at the table in front of the curtain.

PLEASE PULL YOUR CHAIR UP AS CLOSE AS POSSIBLE. THANK YOU. BEHIND THIS CURTAIN YOU WILL FIND TWO PEG BOARDS; ONE FOR YOUR RIGHT HAND AND ONE FOR YOUR LEFT. IN THE CENTER OF EACH OF THESE BOARDS IS A MASTER PEG. PLEASE PUT YOUR HANDS THROUGH THE CURTAIN AND FIND THE TWO MASTER PEGS. (Pause while the student does this.) FEEL HOW THOSE PEGS ARE DIFFERENT FROM THESE PEGS (Testor is to show student regular pegs) IN THAT THEY HAVE RAISED RIDGES OR GROOVES IN THEM. I AM GOING TO MAKE A PATTERN ON THE LEFT BOARD USING THE MASTER PEGS AND ADDITIONAL PEGS LIKE THESE. THEN I WILL GIVE YOU SOME PEGS AND ASK YOU TO DUPLICATE THAT PATTERN ON THE RIGHT BOARD WITHOUT LOOKING. PLEASE REMOVE YOUR HANDS. THIS FIRST ONE IS A SAMPLE AND CONSISTS OF THE MASTER PEG AND ONE ADDITIONAL PEG AND YOU WILL HAVE THIRTY SECONDS TO DUPLICATE IT. GO AHEAD. THANK YOU. NOW, I AM GOING TO MAKE A PATTERN USING TWO PEGS AND THE MASTER PEG AND YOU WILL HAVE ONE MINUTE TO DUPLICATE THE PATTERN. GO AHEAD. THANK YOU. THIS LAST PATTERN WILL CONSIST OF THE MASTER PEG AND THREE ADDITIONAL PEGS AND YOU WILL HAVE TWO MINUTES TO DUPLICATE THE PATTERN. GO AHEAD. THANK YOU, THAT IS ALL.

The testor is to record the student answers on the guide checklist.

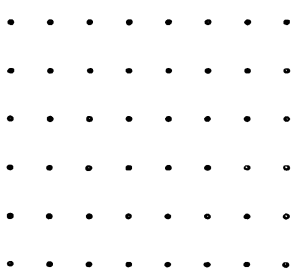
Recording of Results for the Nottus Pattern

The number of pegs placed correctly in each of the tests should be recorded. The sample is recorded only as a yes or no to indicate whether the students did the sample pattern correctly. The testor is to indicate, by circling the matrix on the score sheet, the dots that indicate the actual design of the test. The testor is to indicate the student's response by placing an "X" over the dot where the student actually placed each peg.

NOTTUS PATTERN

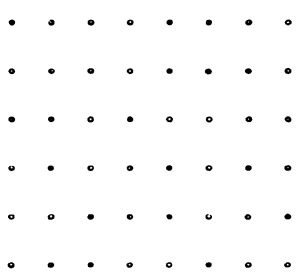
x = Subject Response

1. _____ Correct



0 = Example

2. _____ Correct



Scoring for the Nottus Pattern

Score the third pattern as follows (Number 2):

Correct Pegs

2 - 3 Major
1 Minor
0 N/S

TEST X DIRECTIONS TEST X

In this test there are ten (10) situations in which you are asked to imagine yourself. Each situation has four (4) alternative responses. You are to decide which response you would "most likely" make as the first or best solution, then the second best, the third best, and the fourth best.

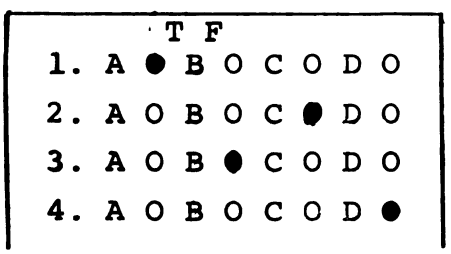
Remember YOU MUST RANK ALL FOUR RESPONSES for each situtation.

READ ALL FOUR(4) RESPONSES BEFORE YOU MAKE YOUR SELECTIONS.

EXAMPLE

If you had to organize a baseball team, you would:

1. Pick from previously established teams.
   A. first choice
   B. second choice
   C. third choice
   D. fourth choice
2. Get all new untried players.
   A. first choice
   B. second choice
   C. third choice
   D. fourth choice
3. Bring older experienced players from retirement.
   A. first choice
   B. second choice
   C. third choice
   D. fourth choice
4. Compare each choice to an established star.
   A. first choice
   B. second choice
   C. third choice
   D. fourth choice



SAMPLE ANSWER CARD

In this example #1 would be your first choice, #2 would be your third choice, #3 would be your second choice, and #4 would be your fourth choice.

I. If you were a member of the O.C.C. debate team and had to prepare a speech "in favor of public school education," which approach would you most likely take?

1. Compare American education with other American, European, and Far Eastern educational systems and point out the similarities among all of them.

   A. first choice
   B. second choice
   C. third choice
   D. fourth choice

2. Tell your audience that despite what appear to be "fads" and "frills" in the public school, it still contains the three R's and holds to standards to excellence and purpose.

   A. first choice
   B. second choice
   C. third choice
   D. fourth choice

3. Make a survey of all contemporary education pointing up differences between other educational systems and our own.

   A. first choice
   B. second choice
   C. third choice
   D. fourth choice

4. Compare the similarities and differences in the ideas of professional educators and show to what extent they meet the standards of the past.

   A. first choice
   B. second choice
   C. third choice
   D. fourth choice

II. If you were asked to recommend a "very good" restaurant to your best friend's family, what would you most likely do?

5. Determine if the restaurant has the high standards of very good restaurants you have visited in the past.

   A. first choice
   B. second choice
   C. third choice
   D. fourth choice

6. Find out if its standards are in keeping with older traditions as well as modern ones, and the extent to which it is like or different from other good restaurants and eating places.

   A. first choice
   B. second choice
   C. third choice
   D. fourth choice

7. Discover in what ways the restaurant resembles and duplicates other fine eating places.

   A. first choice
   B. second choice
   C. third choice
   D. fourth choice

8. Determine in what ways the restaurant's reputation is different from currently accepted standards of excellence.

   A. first choice
   B. second choice
   C. third choice
   D. fourth choice

III. In considering your <u>own</u> ideas about what helps to make a "good" education, how would you rate the following as methods of good classroom management?

9. Arrange a classroom that is as much as possible like the kind of situations the students will encounter in the "real" world (business, military, professional, etc.).

A. first choice
B. second choice
C. third choice
D. fourth choice

10. Place the teacher in position of authority. He should be one who leads, instructs, and controls the activities.

A. first choice
B. second choice
C. third choice
D. fourth choice

11. Use the latest theories of education to show how today's classroom differs from the past.

A. first choice
B. second choice
C. third choice
D. fourth choice

12. Recognize how our standards and values are changing and provide a classroom that will aid learning and, at the same time, help in the acceptance of society's standards.

A. first choice
B. second choice
C. third choice
D. fourth choice

IV. If you were asked to rate the performance of a group of workers or students, which method of rating would you most likely choose?

13. Check the past record of the student/worker, compare his performance to that of his fellow workers, and consider his performance in terms of the work of others in the past.

A. first choice
B. second choice
C. third choice
D. fourth choice

14. Rate the worker/student in terms of standards and requirements established for the whole group at the beginning of the year.

A. first choice
B. second choice
C. third choice
D. fourth choice

15. Rate this year's group in terms of its difference from the best group which performed in the past.

A. first choice
B. second choice
C. third choice
D. fourth choice

16. Grade the student in comparison with the performance of his present classmates.

A. first choice
B. second choice
C. third choice
D. fourth choice

V. If you believe that a good home is necessary and desirable for a child to make the greatest success in school, which of the following would you most likely choose as the best home environment?

17. One where the "old time" parent and child roles are somewhat followed. Difference and individuality is respected, but attempts are made by the family to fit into the neighborhood by being like other families on the block in most ways.

A. first choice
B. second choice
C. third choice
D. fourth choice

18. One where the child is sure that his home is pretty much like the home of his friends and classmates.

A. first choice
B. second choice
C. third choice
D. fourth choice

19. One where the members of the family follow the ideas put forward by social workers, family counsellors and family doctors.

A. first choice
B. second choice
C. third choice
D. fourth choice

20. One where the best home is considered independent of the rest of the society and is judged by its difference from other families.

A. first choice
B. second choice
C. third choice
D. fourth choice

 Turn to next page.

VI. If you feel that a course in psychology is helpful to a better understanding of normal behavior, which would you choose as the most effective way to teach such a course?

21. A method where the teacher lectures and uses a standard textbook which has been highly rated by psychology teachers.

A. first choice
B. second choice
C. third choice
D. fourth choice

22. Have students read various paperback novels and books which illustrate different psychological problems (such as, "I Never Promised You a Rose Garden") and compare the abnormal behavior brought out in the books with that discussed in class.

A. first choice
B. second choice
C. third choice
D. fourth choice

23. Have students engage in a discussion of which symptoms are typical of a particular illness and how it is different from another illness.

A. first choice
B. second choice
C. third choice
D. fourth choice

24. Use standard textbooks, tour a state mental hospital, read psychological research, and determine how accurate is the current method of classification of mental illness.

A. first choice
B. second choice
C. third choice
D. fourth choice

VII. If you wanted to find out more about O.C.C.'s basketball team, with hopes of making the varsity, which would you choose as most helpful?

25. Watch movies of games played in the past, note the strategy used by the O.C.C. winning team as compared with that used by the other team.

A. first choice
B. second choice
C. third choice
D. fourth choice

26. Attend a series of lectures by the coach in which he describes the usual kind of player who contributes to a successful team, and the traditional demands on the player.

A. first choice
B. second choice
C. third choice
D. fourth choice

27. Pay close attention to the players who are on the varsity team, and note the difference between their skills and those of players on the reserve team.

A. first choice
B. second choice
C. third choice
D. fourth choice

28. Listen to talks by coaches on the subject of what makes for success in basketball, compare your skills with those of other players but also realize your shortcomings.

A. first choice
B. second choice
C. third choice
D. fourth choice

VIII. In making plans for getting a job after high school graduation, which procedure would you follow?

29. Go to the state employment agency for an interview with the guidance counselor.

A. first choice
B. second choice
C. third choice
D. fourth choice

30. Ask your high school counselor about job possibilities, look at the want ads in the daily papers, and then make up your mind based on all of the information gathered.

A. first choice
B. second choice
C. third choice
D. fourth choice

31. Compare the advantages of the job listed in the want ads with those suggested by the state employment agency.

A. first choice
B. second choice
C. third choice
D. fourth choice

32. Check on the differences in pay, fringe benefits, and tasks required for the same kind of job at different places.

A. first choice
B. second choice
C. third choice
D. fourth choice

Turn to next page.

IX. If you were demonstrating to a group of youngsters a method for learning to draw pictures, which would be the most effective way?

33. To teach it as it is taught in school art classes where the methods are demonstrated by the instructor.

A. first choice
B. second choice
C. third choice
D. fourth choice

34. To show different approaches and methods in teaching art. Analyze the very early methods of African art, the later methods of European and modern artists.

A. first choice
B. second choice
C. third choice
D. fourth choice

35. To compare the methods of teaching some art skills to sketching, sculpture and the drawing of portraits.

A. first choice
B. second choice
C. third choice
D. fourth choice

36. To note the differences between new and past methods of teaching art.

A. first choice
B. second choice
C. third choice
D. fourth choice

X. The issues centering around student rights and censorship of school reading material is of concern to most students. Which of the following do you most agree with?

37. School systems should copy the censoring practices of other institutions of society (i.e., the courts, publishers, churches, and libraries).

A. first choice
B. second choice
C. third choice
D. fourth choice

38. School policy should recognize the policies of other arms of society, and show how the policies at O.C.C. differ from the usual ones.

A. first choice
B. second choice
C. third choice
D. fourth choice

39. The school system should honor its traditions and recognize the wisdom of the past controlling decisions of great leaders in education.

A. first choice
B. second choice
C. third choice
D. fourth choice

40. The school administration should secure recommended positions on this issue from as many official offices and unofficial organizations as possible, as well as student's opinions, and shape a policy from this research.

A. first choice
B. second choice
C. third choice
D. fourth choice

TEST X TEST X

The following statements are untimed.

Work quickly and give the first answer that comes to you.

Your first impression is important.

Fill in the space on the IBM card under the proper letter

A - Rarely
B - Sometimes
C - Usually

41. When I am in an argument I avoid probability statements.

42. I enjoy the type of reasoning used in solving arithmetic problems.

43. I enjoy puzzles in which the solution is deduced from the rules.

44. When I am defending a position, I attempt to develop a logical proof.

45. I resent being placed in situations in which I cannot predict what the outcome will be.

TEST IX

TEST IX

DIRECTIONS

Following are some stories or incidents that might happen to people. Three possible responses are given. You are required to choose which of these is "most like you" and which is "least like you". You will leave one choice blank. Read the example.

EXAMPLE

A. Sue Bryant is planning to buy a new set of clothes for a long vacation trip. She should:

1. Consult her parents and sisters on what to buy.
   A. MOST B. LEAST

2. Make her own decision.
   A. MOST B. LEAST

3. Ask the advice of her girlfriends.
   A. MOST B. LEAST

1. A O B O C O D O E O

2. A O B ● C O D O E O

3. A ● B O C O D O E O

In the above example it would be "most like you" to ask the advice of your friends and "least like you" to make a decision alone on what to buy, and you left one choice (1) blank.

TEST IX

TEST IX

A. Mrs. Jones, a widow with three children at home, is about to be evicted from the flat that she has rented for the past ten years. In order to help her solve her problem, she should:

1. Ask her married children (or sisters or brothers) for help.

A. MOST B. LEAST

2. Ask the ladies in her church group to give her some advice and help.

A. MOST B. LEAST

3. Realize that no one can really help her and decide to solve it on her own.

A. MOST B. LEAST

B. Bill Bowen, a 17 year old at Center High School, is having more and more frequent arguments and encounters with another fellow in school. It is beginning to seem as though a fight cannot be avoided. Bill should:

4. Talk to his best buddies about what he should do.

A. MOST B. LEAST

5. Decide for himself what to do and even fight if necessary.

A. MOST B. LEAST

6. Talk to folks at home and take their advice.

A. MOST B. LEAST

TEST IX

C. Mary is a sophomore student at Colorado University. A number of students are planning to go out on strike to protest "an inadequate educational system." Other students are not supporting the strike. Mary should:

7. Weigh the positive and negative arguments for the strike and make up her mind.

A. MOST B. LEAST

8. Call her parents (or brother or sister) and ask their advice.

A. MOST B. LEAST

9. Discuss the proposed strike with her friends and follow their suggestions.

A. MOST B. LEAST

D. Don Roberts needs a car to get to his new job. He goes to the used car agency with some of his buddies and his Dad. His father wants him to buy one car, his buddies are urging him to buy a different one and he has been thinking about another one. He should:

10. Buy what his father suggests.

A. MOST B. LEAST

11. Buy what he has been thinking about.

A. MOST B. LEAST

12. Buy what his buddies are telling him to get.

A. MOST B. LEAST

Turn to next page.

TEST IX

E. The pastor of the B.C.E. Bible Church has been urging his congregation to boycott some merchants along Tenth Street for unfair sales and hiring practices. Mr. and Mrs. Pitts have shopped at the stores for years and some of the merchants have been fairly nice to them. Mrs. Pitts does not want her family to go without the things they get at the store. However, their fellow church members all side with the pastor. If you were Mr. Pitts:

13. The family's feelings should determine the decision.

A. MOST B. LEAST

14. The goals of the members of the church should heavily influence your actions.

A. MOST B. LEAST

15. You should weigh the situation and make a decision based on your individual experiences.

A. MOST B. LEAST

AMONG THE FOLLOWING STATEMENTS CHOOSE THE ONE THAT IS "MOST LIKE YOU" (MOST) AND THE ONE THAT IS "LEAST LIKE YOU" (LEAST).

F. 16. To be free to do as I choose.

A. MOST B. LEAST

17. To follow the advice given to me by close relatives.

A. MOST B. LEAST

18. To have others support and agree with me.

A. MOST B. LEAST

 Turn to next page.

TEST IX

G. 19. To stick close to the standards developed in our family.
A. MOST B. LEAST

20. To stick firmly to my own opinions and beliefs.
A. MOST B. LEAST

21. To stick to the beliefs of my associates and fellow students.
A. MOST B. LEAST

H. 22. To make things for other people.
A. MOST B. LEAST

23. To spend time working on a family project.
A. MOST B. LEAST

24. To work on my own hobbies without assistance.
A. MOST B. LEAST

I. 25. To live my life as taught by my parents.
A. MOST B. LEAST

26. To be able to live my life exactly as I wish.
A. MOST B. LEAST

27. To have a way of life much like my friends.
A. MOST B. LEAST

J. 28. To be relatively unbound by social conventions.
A. MOST B. LEAST

29. To be praised and approved of by other people.
A. MOST B. LEAST

30. To gain the approval of my family.
A. MOST B. LEAST

TEST VIII

TEST VIII

DIRECTIONS

The following test is untimed.

Work quickly and give the first answer that comes to you.

Your first impression is important.

Do not spend a lot of time on any one question.

There are 32 items.

Fill in the space on the IBM card under the proper letter.

A = usually
B = sometimes
C = seldom
D = never

EXAMPLE:

I would make a good football player.
A. usually B. sometimes C. seldom D. never

1. A ● B O C O D O E O

In this case you believe you would "usually" be good as a football player.

DO NOT MARK IN TEST BOOKLET

TEST VIII

TEST VIII

1. I compete effectively in amateur sports.
   A. usually B. sometimes C. seldom D. never

2. I wait for an invitation to be seated in making a call on a supervisor in his office.
   A. usually B. sometimes C. seldom D. never

3. I am able to keep at a task which I set for myself.
   A. usually B. sometimes C. seldom D. never

4. I can be effective in settling a dispute between two parties.
   A. usually B. sometimes C. seldom D. never

5. I accept criticism without being deeply hurt.
   A. usually B. sometimes C. seldom D. never

6. I can maintain balance well enough to participate in water or snow skiing.
   A. usually B. sometimes C. seldom D. never

7. I set goals consistent with my own needs and abilities.
   A. usually B. sometimes C. seldom D. never

8. I can bring a group to some agreement.
   A. usually B. sometimes C. seldom D. never

9. I play the piano or other musical instrument.
   A. usually B. sometimes C. seldom D. never

10. I can jump rope for three minutes with less than three restarts.
    A. usually B. sometimes C. seldom D. never

11. I seldom fail to complete an assignment because of misjudging my ability to complete the task.
    A. usually B. sometimes C. seldom D. never

12. I compete effectively with other amateurs in such games as billiards, ping-pong, or dart-throwing.
    A. usually B. sometimes C. seldom D. never

 Turn to next page.

TEST VIII

TEST VIII

13. I influence others to join me in a cause.
A. usually B. sometimes C. seldom D. never

14. I can repair or work on an object with small parts.
A. usually B. sometimes C. seldom D. never

15. I would wait to be addressed by a supervisor rather than take the initiative in greeting.
A. usually B. sometimes C. seldom D. never

16. I reserve discussion of "personal" matters to either those who usually discuss such things or friends and relatives.
A. usually B. sometimes C. seldom D. never

17. I get people in disagreement to reach agreement.
A. usually B. sometimes C. seldom D. never

18. I am an adequate typist.
A. usually B. sometimes C. seldom D. never

19. I accurately predict my own prospects for success in most situations.
A. usually B. sometimes C. seldom D. never

20. I make minor household repairs.
A. usually B. sometimes C. seldom D. never

21. I am self-confident in assuming a new responsibility.
A. usually B. sometimes C. seldom D. never

22. I request permission before taking a seat by a stranger.
A. usually B. sometimes C. seldom D. never

23. I usually convince others that my opinions are right.
A. usually B. sometimes C. seldom D. never

24. I reserve use of first name greeting to friends and associates of similar status.
A. usually B. sometimes C. seldom D. never

TEST VIII

TEST VIII

25. I can give a good description of someone's personality after a short acquaintance.
A. usually B. sometimes C. seldom D. never

26. I am able to assess my own performance in a situation which I had not experienced before.
A. usually B. sometimes C. seldom D. never

27. I give directions in such a way that others would want to accept them.
A. usually B. sometimes C. seldom D. never

28. I can anticipate how well I will do in an activity.
A. usually B. sometimes C. seldom D. never

29. I wait to be introduced to a famous celebrity rather than introduce myself.
A. usually B. sometimes C. seldom D. never

30. I get others to do the things I think they should do.
A. usually B. sometimes C. seldom D. never

31. I do not borrow money from strangers.
A. usually B. sometimes C. seldom D. never

32. I can make a good salesman.
A. usually B. sometimes C. seldom D. never

TEST VII

TEST VII

DIRECTIONS

The following test is untimed.

Work quickly and give the first answer that comes to you.

Your first impression is important.

Do not spend a lot of time on any one question.

There are 40 items.

Fill in the space on the IBM card under the proper letter.

A = usually
B = sometimes
C = seldom
D = never

EXAMPLE:

I would make a good football player.
A. usually B. sometimes C. seldom D. never

1. A ● B O C O D O E O

In this case you believe you would "usually" be good as a football player.

DO NOT MARK IN TEST BOOKLET

TEST VII

1. I try to avoid saying things which hurt other's feelings.
   A. usually B. sometimes C. seldom D. never

2. I enjoy attending a good theatrical performance.
   A. usually B. sometimes C. seldom D. never

3. I am more likely to sacrifice an immediate gain than a principle.
   A. usually B. sometimes C. seldom D. never

4. I can effectively participate in a role-playing situation.
   A. usually B. sometimes C. seldom D. never

5. I "talk with my hands" as one means of communicating.
   A. usually B. sometimes C. seldom D. never

6. I consider the feelings of others.
   A. usually B. sometimes C. seldom D. never

7. I enjoy listening to a good concert.
   A. usually B. sometimes C. seldom D. never

8. I guide my conduct according to personal moral values.
   A. usually B. sometimes C. seldom D. never

9. I am a type of person who can understand how others feel.
   A. usually B. sometimes C. seldom D. never

10. I use "non-verbal" communication to make a point in a speech.
   A. usually B. sometimes C. seldom D. never

11. I am able to act in a stage play.
   A. usually B. sometimes C. seldom D. never

12. I ask personal favors from close friends and associates rather than from strangers or work supervisors.
   A. usually B. sometimes C. seldom D. never

13. I can understand how others feel.
   A. usually B. sometimes C. seldom D. never

TEST VII

14. I complete assignments when promised rather than delay them to achieve a personal goal.
A. usually B. sometimes C. seldom D. never

15. I enjoy eating exotic foods and foreign dishes.
A. usually B. sometimes C. seldom D. never

16. I enjoy telling jokes and stories at a party.
A. usually B. sometimes C. seldom D. never

17. I do not consider "cheating" even if it is for a good reason.
A. usually B. sometimes C. seldom D. never

18. I tell amusing stories at parties.
A. usually B. sometimes C. seldom D. never

19. I give up an immediate goal rather than give in on a principle.
A. usually B. sometimes C. seldom D. never

20. I understand how a person being punished would feel.
A. usually B. sometimes C. seldom D. never

21. I take part in amateur theatricals.
A. usually B. sometimes C. seldom D. never

22. I enjoy reading great works in literature.
A. usually B. sometimes C. seldom D. never

23. I can imitate a friend using only bodily movements and facial expressions.
A. usually B. sometimes C. seldom D. never

24. I understand my friends better than they understand me.
A. usually B. sometimes C. seldom D. never

25. I do "play a role" if asked to at a party.
A. usually B. sometimes C. seldom D. never

TEST VII

26. I show signs of blushing in an embarrassing situation.
A. usually B. sometimes C. seldom D. never

27. I am willing to give up a monetary gain to avoid a compromise of principles.
A. usually B. sometimes C. seldom D. never

28. I do not usually compromise a principle for personal gain.
A. usually B. sometimes C. seldom D. never

29. I can effectively illustrate the behavior of a deaf-mute using various movements and actions.
A. usually B. sometimes C. seldom D. never

30. I enjoy reading poetry.
A. usually B. sometimes C. seldom D. never

31. I communicate well in a "charades" game.
A. usually B. sometimes C. seldom D. never

32. I am able to offer criticism without offending another person.
A. usually B. sometimes C. seldom D. never

33. I pretend to be someone other than myself.
A. usually B. sometimes C. seldom D. never

34. I enjoy viewing a display of modern art.
A. usually B. sometimes C. seldom D. never

35. I use facial expressions in showing various emotions.
A. usually B. sometimes C. seldom D. never

36. I discuss art and painting with friends.
A. usually B. sometimes C. seldom D. never

37. I can imitate a famous movie star before a group.
A. usually B. sometimes C. seldom D. never

TEST VII

38. I enjoy going to a symphony or opera.
A. usually B. sometimes C. seldom D. never

39. I shrug my shoulders when saying "I don't know."
A. usually B. sometimes C. seldom D. never

40. I fulfill an obligation even if assumed under unfair circumstances.
A. usually B. sometimes C. seldom D. never

APPENDIX B

COURSE DESCRIPTION AND REQUIREMENTS FOR FOUNDATIONS OF NATURAL AND LIFE SCIENCES, WINTER SESSION 1972

FOUNDATIONS OF NATURAL AND LIFE SCIENCE

Course Requirements

FNS 150 - 4 Credits

OBJECTIVE:

This course will emphasize the volution and interdependency of important concepts and methods of inquiry in mathematics, physics, chemistry, astronomy, biology, and ecology. The course will demonstrate how differing cultural environments and previous scientific and technical knowledge led to different methods of inquiry and how these have resulted in varying interpretations of physical phenomena.

REQUIREMENTS:

1. Each student will evaluate himself on bi-weekly written and/or oral presentations prepared in answer to questions about the subject matter studied throughout the period. Questions for self-evaluation appear on the topic handout sheet available at the check-out desk of "C" carrel arcade, second floor, "C" building. Written answers to questions are to be handed in at the time bi-weekly tests are taken.

2. Extra credit may be earned by:

   A. Participation in an independent group study or project. The group will be determined by community of interest, with the size of the group varying with the project selected. Each student will submit a report individually in order to get the extra credit.

   B. Contracted project or individual study. The student decides what area of work he wishes to study and contracts with the instructor for the topic, type of work, and completion date.

   C. Each student may read and report on at least one book or five articles per semester in addition to his required reading. Additional credit will be granted for quality reporting and evaluating, both oral and written, up to a total of three books or fifteen articles or any combination of books or articles. The articles must be from the LRC reserve list or approved by the instructor.

D. Participation in one field trip is required but will carry additional credit of .6 point, plus whatever credit id earned from the examination covering the field trip (see Requirements above). Additional extra credit may be earned by proof of attendance, by oral or written evaluation, at special lectures and/or field trips planned by other departments in the area of science, on this campus.

GRADES:

The student's final grade will be computed on the basis of his total point accumulation. See accompanying scale.

It is to be understood that attendance at all class meetings both total and sectional is required.

It is the responsibility of the student to notify the instructor of his absence. No make-up tests or quizzes will be given. If you miss one test, the next test will count double. However, you may miss only one test. Any further tests missed will be assigned a 0 and included in the point total calculation.

Method of Calculation of Final Grade:

1. The accompanying scale will be used in computing all grades.

2. Bi-weekly examinations will be added up and an average calculated.

3. The final examination will be averaged in with the average of the bi-weekly examinations.

4. Any extra credit points will be added to the point count obtained from steps 2 and 3 above.

5. .1 point will be added for completing and handing in each laboratory report.

6. .1 point will be added for completing and handing in all self-evaluation questions from the topic sheets.

7. .1 point will be added for evidence of having completed all carrel arcade assignments and taking all post tests.

8. Compare total of points as calculated in steps 2 through 7 with the accompanying scale to find letter grade.

FSN PROGRAM FLOW CARDS:

Program flow cards are your insurance that steps you have completed in the course will be given credit. Here is how they work:

1. In Carrel Arcade "C" there is a box with FSN sections organized in sequence and the cards for the current week filed alphabetically by section.

2. Each student picks up his card on or after the Thursday the current topic begins.

3. Each assignment in the Carrel Arcade must be indicated by a time-in/time-out stamp from the timeclock located at the desk of the "C" Arcade. See the paraprofessional at the Arcade for instructions as to how this is done.

4. Each assignment in the IPLL must be acknowledged by both the test score and the special IPLL stamp.

5. On or before the following Thursday, the old week's card must be placed in the FSN drop box in "C" Arcade and the new week's card picked up.

LABORATORY:

The Foundations of Natural and Life Science laboratory is located in Room A-103 and will be open from 8:00 a.m. to 5:00 p.m. Tuesday and Thursday of each week, with the exception of the field trip week. Admittance to the laboratory will be gained only by a laboratory admittance card, available at the "C" Carrel Arcade along with the new topic outline and assignment sheet on the first day of a topic assignment and all days following. Since only 28 people will be allowed to be in the laboratory at one time, it is well to get the laboratory admittance card as soon as possible so that the day and time you desire will be available. Cards are passed out on a "first come, first served" basis, and THERE WILL BE NO EXCEPTIONS. Laboratory reports are due in at the end of the laboratory period for which they are assigned; a laboratory period will be considered to be the period of time for which cards are issued each week.

POINT SCORING SYSTEM

90 - 100	=	4.0	A
89	=	3.9	
88	=	3.8	
87	=	3.7	
86	=	3.6	
85	=	3.5	B
84	=	3.4	
83	=	3.3	
82	=	3.2	
81	=	3.1	
80	=	3.0	
79	=	2.9	
78	=	2.8	
77	=	2.7	
76	=	2.6	
75	=	2.5	C
74	=	2.4	
73	=	2.3	
72	=	2.2	
71	=	2.1	
70	=	2.0	
69	=	1.9	
68	=	1.8	
67	=	1.7	
66	=	1.6	
65	=	1.5	D
64	=	1.4	
63	=	1.3	
62	=	1.2	
61	=	1.1	
60	=	1.0	
59 - 50	=	.9	
49 - 40	=	.8	E
39 - 30	=	.7	
29 - 0	=	0.0	

Additional credit may be earned in the following amounts:

Supplementary Reading	=	.3
Lectures and Field Trips	=	.6

Performance Goal 1	The student will be able to identify the discipline in relation to a problem.
Performance Goal 2	The student will be able to define the parameters of the disciplines of the natural and life sciences, particularly astronomy, biology, chemistry, geology, and physics.
Performance Goal 3	The study will be able to relate the state and philosophy of the disciplines today with its historic evolution and its future thrust.
Performance Goal 4	The student will be able to differentiate between pure science and its application as a technology.
Performance Goal 5	The student will be able to identify the methods of inquiry peculiar to each of the disciplines as well as those common to the sciences such as the following: a. Observation of Phenomena b. Ordering of Data c. Determining Variables d. Experimentation e. Generalizing and Evaluating Observed Data f. Determining and Evaluating Predictability.

OAKLAND COMMUNITY COLLEGE
FOUNDATIONS OF NATURAL AND LIFE SCIENCE
WINTER CALENDAR, 1972

WEEK OF	TOPIC	LAB EXPERIMENT	IPLL ASSIGNMENT	CARREL ARCADE ASSIGNMENT	FILMS
Jan 10-14, 1972	Scope of Science	Grab Bag	Scientific Notation Frames 973-1193, Part 8	Optional: View Video Tapes	Frames of Reference (OCC - 198)
Jan 17-23, 1972	Physical Measurements	Lab Manual: 1-1, 2-1	Numbers & Units for Science, pp. 178-184	Audio Tape: Fusion & Fission; An Appraisal	Measurements of the Speed of Light; Shape of the Earth
Jan 24-28, 1972	Symbolic Notation	Chemical & Physical Changes Lab Manual: 14-3, 14-4	Chemical Symbols	Optional: View Video Tapes	Introducing Chemistry (U of M)
Jan 31-Feb 4, 1972	Stoichiometry	Lab Manual: Percent Composition, 25-1		Audio Tapes: "The Chemical Accelerator"	Introducing
Feb 7-11, 1972	Kinetic Molecular Theory	Problem Solving	Basic Assumptions of Kinetic Molecular Theory (Moore)	Optional: View Video Tapes	Kinetic Molecular Theory (OCC-81)
Feb 14-18, 1972	Motion	Lab Manual: 3-1	Program on Newton's Laws of Motion		Introduction to Reaction Kinetics (OCC-448)
Feb 21-25, 1972	Categorized Description & Taxonomy	Putting Things Together Taxonomically	Naming Organic Compounds	Optional: View Video Tapes	
Feb 28-March 3, 1972	Alkanes, Alkenes, Alkynes	Preparation of an Alcohol			
March 6-13, 1972	Chemical Equilibrium	Lab Manual: 21-2	Molecular Equilibrium, pp. 3-42	Optional: View Video Tapes	Chemical Equilibrium (OCC-449) Equilibrium (UofM) Chemical Change (U of M)

WEEK OF	TOPIC	LAB EXPERIMENT	IPLL ASSIGNMENT	CARREL ARCADE ASSIGNMENT	FILMS
March 15-27, 1972	Circulatory, Skeletal & Digestive Systems	Heartbeat Test for Carbohydrates, Fats, Proteins	Basic Concepts of Anatomy & Physiology, pp. 316-346	Optional: Slide-Sound: Circulation View Video Tapes	Heart & Circulation (OCC-121) Heart Disease (118) Alimentary Tract (35) Digestion of Foods (36)
March 29-April 10, 1972	The Planet Earth	Map Reading Field Trip	Temac - Geology Unit, pp. 96-120 Glaciers Geological Time Scale	Tapes: "Brine Pools in the Red Sea" "Oil in the Sea" Video: Lecture	Universe (210) Secrets of the Ice (269) Hidden Earth (252) Flaming Sky (166)
April 12-14, 1972	Review				
April 17-20, 1972	FINAL EXAM				

FOUNDATIONS OF NATURAL AND LIFE SCIENCE
150
TEST SCHEDULE, WINTER 1972

TEST	DATE	TOPICS COVERED
#1	Jan. 21, 1972	Scope of Science & Physical Measurements
#2	Feb. 4, 1972	Symbolic Notation & Stoichiometry
#3	Feb. 18, 1972	Kinetic Molecular Theory & Notation
#4	Mar. 3, 1972	Taxonomy & Naming Organic Compounds
#5	Mar. 13, 1972 (Monday)	Chemical Equilibrium
#6	Mar. 27, 1972 (Monday)	Circulatory, Skeletal & Digestive Systems
#7	April 10,1972 (Monday)	Planet Earth
FINAL EXAM	APRIL 17-20, 1972	ALL OF THE ABOVE

DEPARTMENT OF FOUNDATIONAL STUDIES
NATURAL AND LIFE SCIENCE

THE SCOPE OF SCIENCE

"A science can be thought of as a body of information grounded in factural descriptions, generalizations, laws and theories based upon systematic inquiry involving observation and experimentation in the world to which the body of knowledge pertains."

Performance Goals

Students should be able to:

1. Construct a definition of the words: Science, natural science, biology, chemistry, physics, astronomy, geology, physiology, and zoology.

2. Identify a situation involving the natural and life sciences from a list of written situations.

3. Describe in writing the distinction between organic and inorganic matter.

4. Construct a brief explanation of how the natural sciences and life sciences are subdivided.

Questions

1. What constitutes the structure of the natural sciences?

2. What are some similarities and differences among the various disciplines that compose the natural sciences?

3. Can autonomous disciplines be integrated or synthesized?

4. What constitutes the structure of the life sciences?

5. What is meant by "inorganic" matter? What is "organic" matter?

	Media
1. Work the following program: Scientific Notation, F 973-1193, Part 8	IPLL
2. Read Chapters I and II, pp. 3 - 36.	Textbook
3. Answer questions on handout sheet.	Handout
4. Go to lab and complete "Grab Bag Experiment" outlined for you.	Lab
5. View the following films: "Frames of Reference" (198)	"C" Arcade

The LRC has a reference shelf which has been set aside for your convenience to study on your own. You will find it has the books pertaining to this subject placed on reserve for your use.

DEPARTMENT OF FOUNDATIONAL STUDIES
NATURAL AND LIFE SCIENCE

PHYSICAL MEASUREMENTS

"Factual descriptions provided by the natural sciences are those experienced through physical measurements; i.e., quantitative assessments of material objects expressed in terms of agreed upon standard units of mass, length, and time."

Performance Goals

Students should be able to:

1. Read measuring devices that directly to indirectly are applied to the properties of mass, length, and time.

2. Demonstrate skill in the metric system using different length, mass, area, and volume units.

3. Demonstrate skill with exponential numbers.

4. Describe in writing how to convert English units to metric units.

5. Demonstrate skills in converting ^{o}C to ^{o}F to ^{o}K temperature scales.

6. Describe in writing how to convert to any temperature scale.

Questions

1. Why does man need to measure?

2. What kind of tools does he use for measuring?

3. How does an astronomer measure light from a star?

4. What are the units of mass, length, time and volume in a metric system?

5. What is scientific notation?

6. Distinguish between centigrade, fahrenheit, and absolute (Kelvin) temperature scales.

	Media
1. Answer question on handout sheet.	Handout
2. Go to lab and complete experiments in the laboratory manual: 1-1 and 2-1	Lab
3. Work the following programs: "Numbers and Units for Science" pp. 178-184	IPLL
4. Listen to Audio tape: "Fusion & Fission; an Appraisal"	"C" Arcade
5. View the following films: "Shape of the Earth"	"C" Arcade
"Measurement of the Speed of Light"	"C" Arcade
6. Use Appendix - pp. 535-548	Text Book

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OAKLAND COMMUNITY COLLEGE
FOUNDATIONS OF NATURAL AND LIFE SCIENCE

SYMBOLIC NOTATIONS

"The ultimate goal of a science is a theoretical symbolic understanding of the qualitative symbolic phenomena included in the world under examination."

Performance Goals

Students should be able to:

1. Translate observed phenomena into theoretical symbolic statements.
2. Identify a situation involving a chemical and physical change.
3. Identify the elements essential to life.
4. Construct a definition of the words photosynthesis and respiration.
5. Describe in writing how symbols are involved in a particular experiment.

Questions

1. Discuss how green plants hold the key to the living world.
2. How may symbols combine to explain a phenomena? Cite examples to support your answer.
3. What is meant by the law of conservation of mass? Is it always conserved?
4. Describe the process of photosynthesis. Describe the process of respiration. How do they differ?
5. What systems of shorthand are used in mathematics, chemistry, physics, and biology? Cite examples.

	Media
1. Go to lab and complete experiments in the laboratory manual: 14-3 and 14-4	Lab
2. Work the following programs: "Chemical Symbols"	IPLL
3. Complete questions on handout sheet.	Handout
4. View the following films: "Introducing Chemistry"	"C" Arcade Textbook
5. Listen to audio tape: "The Chemical Accelerator" pp. 229-235	"C" Arcade Textbook

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OAKLAND COMMUNITY COLLEGE
FOUNDATIONS OF NATURAL AND LIFE SCIENCE

STOICHIOMETRY

Performance Goals:

Student should be able to:

1. Define Stoichiometry in writing.
2. Find the simplest formula for a compound.
3. Find the molecular weight and the formula weight of a compound.
4. Determine the relationships between the weights of reactants and products in a reaction.

Questions:

Do all questions and problems (No's. 1-21) on pp. 374-375 in the text.

	Media
1. Read pp. 361-375	Textbook
2. Do lab exercise: 25-1 in Lab Manual	A-103

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DEPARTMENT OF FOUNDATIONAL STUDIES
NATURAL AND LIFE SCIENCE

KINETIC MOLECULAR THEORY

"The fact that the Ideal Gas Law can be used to summarize reasonably accurately the physical behavior of all gases, whatever their degree of molecular complexity, is a clear indication that the gaseous state of matter is a relatively simple one to attempt to treat from a theoretical point of view."

Performance Goals

Students should be able to:

1. Explain and describe in writing the basic assumptions of the kinetic molecular theory.

2. Identify a situation involving Dalton's Law of partial pressure.

3. Identify a situation involving a general relation of Boyle's Law, Charles' Law and Avogadro's Principle between volume, pressure, temperature and number of moles of a gas sample.

4. Construct a practical model of a molecule moving in a box and describe the molecular speed, number of collisions per second with the walls of the box, average collision with the wall in producing the pressure found in the box, and the average kinetic energy of the molecule.

Questions

1. A flask of CO_2 is collected over water at a total pressure of 740 mm of mercury. If the partial pressure of the water vapor is 15 mm of H_g, what is the pressure exerted by the CO_2?

2. Suppose a gas, measured under a pressure indicated by a barometric reading of 720 mm, has a volume of 620 ml. What volume will this gas occupy under standard pressure (760 mm), with the temperature constant?

3. The volume of a certain gas, when measured at a temperature of $70^{o}C$, is 640 ml. What is its volume at $10^{o}C$?

4. A gas measured 1000 ml at a temperature of $50^{o}C$ and under a pressure of 740 mm. What volume will it occupy at a temperature of $27^{o}C$ and under a pressure of 760 mm?

5. Consider a 5 liter balloon filled with .05 moles of helium (He) gas and heated from 400°K to 1600°K. Compare quantitatively in terms of <u>factor changes</u> the following:

   a) Number of Moles
   b) Average collision with the wall in producing the pressure.
   c) Volume
   d) Absolute Temperature
   e) Mass
   f) Molecular speed of the molecules.
   g) Average momentum, and
   h) Number of collisions per second.

	Media
1. Answer questions on handout sheet.	Handout
2. View the following films: "Kinetic Molecular Theory" (81) "Introduction to Reaction Kinetics" (448) "Transplant Technique"	"C" Arcade
3. Listen to the following tape: "The Chemical Accelerator"	"C" Arcade
4. Problem session.	Lab
5. Work the following programs: 1. Basic Assumptions of Kinetic Molecular Theory 2. The Gas Laws 3. The Principles of Chemistry #6, pp. 93-114	IPLL

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OAKLAND COMMUNITY COLLEGE
FOUNDATIONS OF NATURAL AND LIFE SCIENCE

MOTION

Performance Goals:

The student will be able to:

1. Define, either orally or in wriring, Newton's three laws of motion.

2. Work problems relating mass, velocity, acceleration, and force.

3. Show or devise a practical demonstration using motion.

4. Relate impulse and kinetic energy, using any medium he chooses, but writing a description of the relationship, using symbols.

5. Use a pendulum to show the relationship between kinetic energy and potential energy.

Questions:

1. Sunlight takes about 8-1/2 minutes to get to the surface of the earth from the sun, a distance of about 1.50×10^8 kilometers of 9.3×10^7 miles. What is the speed of light in kilometers per second and miles per second?

2. The speed of sound in air is about 1100 feet per second. If a bolt of lightning strikes one mile from you, how long will the sound take to reach you?

3. A car moving at 80 kilometers per second is brought to a stop in 3 seconds. The car has a mass of 1100 kilograms. What was the average acceleration during the 3 second period?

4. Using the example above, how much kinetic energy is absorbed into the brakes of the car?

5. A stone dropped from a cliff falls with an acceleration of 9.8 m/sec^2. How fast will the stone be moving 5 seconds after it is dropped?

Program of Study

Assignment	Media
1. Read Text: pp. 37-61	Home
2. View Motion Picture: "Straight Line Kinematics"	"C" Arcade
3. Do Lab exercise 3-1	A-103
4. Work Program: "Newton's Laws of Motion"	IPLL

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OAKLAND COMMUNITY COLLEGE
FOUNDATIONS OF NATURAL AND LIFE SCIENCE

CATEGORIZED DESCRIPTION AND TAXONOMY

"Someone dumped a thousand different coins in a pile and asked you to arrange them in some systemic way. How would you begin?"

Performance Goals

Students should be able to:

1. Construct a hierarchy of the animal kingdom.
2. Construct a brief explanation of this classification system and give an example of each phyla.
3. Construct a hierarchy of the traditional classification of the plant kingdom.
4. Describe in writing how a list of plants and animals may be classified.
5. Construct a definition of the word taxonomy.
6. Classify chemical compounds, inorganic and organic.

Questions

1. How can the principles of scientific classification be made useful in areas outside of biological study?
2. What are some specialized branches of biology?
3. What kind of work would you expect a taxonomist to be doing?
4. Name the classification groups from the largest to the smallest.
5. What do we call the specialized branch of biology which deals with the naming and classification of plants and animals?
6. Name the Alkanes that are commonly found in gasolene.
7. What is the difference between an Alkane and an Aklene; an Alkyne?

Assignments	Media
1. Answer questions on handout sheet.	Handout
2. a) fill in classification sheet: "Putting Things Together Taxonomically" (Pick up sheet in Lab) b) preparation of an alcohol	LRC Lab
3. Work Program: "Naming Organic Compounds" pp. 1-80	IPLL
4. View Film: "Classifying Plants and Animals"	"C" Arcade
5. Listen to Tape: "Nobel, Nerves and Noradrenaline"	"C" Arcade
6. (Optional) View video tapes to review	"C" Arcade

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DEPARTMENT OF FOUNDATIONAL STUDIES
NATURAL AND LIFE SCIENCE

CHEMICAL EQUILIBRIUM

"In ordinary conversation the word equilibrium suggests a stable, or at least a steady, condition produced by balancing the forces that tend to act in different directions. The general idea of equilibrium as a balance between two changes opposing each other has the same general meaning in chemistry although there are some important distinctions."

Performance Goals

Students should be able to:

1. Describe in writing the distinction between statis and dynamic equilibrium.
2. Construct a definition of Le Chatelier's principle.
3. Identify some of the possible changes that may alter an equilibrium system.
4. Describe in writing a mass action expression for certain chemical reactions.
5. Construct a practical model under the influence of equilibrium conditions and explain how the equilibrium state is affected by changes in terms of Le Chatelier's principle.

Questions

1. What is actually happening when equilibrium is reached?
2. What is meant by the Law of Mass Action?
3. What is dynamic equilibrium? Static equilibrium?
4. Draw a graph to show how equilibrium is attained.
5. Write a mass action expression for the following chemical reactions:

   a. $C_2H_{4\,(g)} + 3\ O_{2\,(g)} \rightleftharpoons 2\ CO_{2\,(g)} + 2\ H_2O_{(g)}$

   b. $2\ H_2O_{(g)} \rightleftharpoons 2\ H_{2\,(g)} + O_{2\,(g)}$

   c. $N_{2\,(g)} + O_{2\,(g)} \rightleftharpoons 2\ NO_{(g)}$

6. Consider the equilibrium system consisting of N_2, O_2 and NO in a sealed container at constant temperature. The net reaction is: $N_{2(g)} + O_{2(g)} \rightleftharpoons 2\ NO_{(g)}$. Explain how the equilibrium state is affected in terms of Le Chatelier's principle by the following changes:

   a. Addition of N_2 to the container.

   b. Removal of NO from the container.

   c. Addition of a catalyst.

   d. Removal of O_2 from the container.

Program	Location
1. Read Text: Chapter 21, pp. 293-310.	Text
2. Answer questions on handout sheet.	Home
3. Go to lab and complete experiment 21-1 first and 21-2 second.	Lab
4. Listen to Tape: "Molecules in Space."	"C" Arcade
5. Read programmed materials. a. Molecular Equilibrium, pp. 3-42. b. Chemical Principles, pp. 331-344. c. Principles of Chemistry (#8), pp. 79-143.	IPLL
6. View Motion Pictures: a. "Chemical Equilibrium" b. "Equilibrium" c. "Chemical Change"	"C" Arcade

References

See LRC Reference Shelf

DEPARTMENT OF FOUNDATIONAL STUDIES
NATURAL AND LIFE SCIENCE

THE CIRCULATORY, SKELETAL AND DIGESTIVE SYSTEMS

"The cells in man's body are bathed in a solution called tissue fluid. This fluid is piped through his body and circulated with a pump, the heart. If the pump stops working, man's cells are in the same predicament as a sponge would be when thrown up on the beach."

Performance Goals

Students should be able to:

1. Trace the circulation of the blood through the body.
2. Describe in writing how blood clots.
3. Describe in writing the difference between plasma and corpuscles.
4. Identify the components of blood plasma and identify the solid components of blood.
5. Construct a model of the heart and identify its parts.
6. Be able to identify the anatomy of the gastro-intestinal system.
7. Describe the actions of enzymes on food.
8. Identify the various glands involved in the digestive system, along with their secretions.
9. Describe the process of digestion from intake to excretion.
10. Relate the process of absorption into the bloodstream to the processes of breakdown occurring in the G-I tract.
11. Name and locate the bones of the skull.
12. Name and locate the bones of the spine.
13. Describe the different joints and their typical locations.

14. Relate major bones and portions of the circulatory system.

15. Describe the two girdles and the sexual differences.

Questions

1. What materials are found in blood plasma?

2. What condition in the body does a high white-blood count usually indicate?

3. Distinguish between an artery and a vein.

4. Trace the blood from the right toe to the left index finger.

5. Describe how you would go about performing a heart transplant.

6. What is the origin of the cells found in blood?

7. Name and locate anatomically the sphincters of the gastro-intestinal system.

8. Name the glands associated with the digestive system, starting at the mouth and ending at the ascending colon.

9. Name the enzymes used in the digestive process and identify the gland which secretes each.

10. Name the separate parts of the gastro-intestinal system.

11. Name and locate the bones of the skull.

12. Name the bones of the backbone in order from skull to coccyx.

13. Describe the articulation in all joints from: 1) the shoulder to the most distal phalanz; 2) from the left hip to the left big toe.

14. Which bones have holes in them to allow circulatory involvement? Which have grooves in them to accommodate veins and/or arteries?

15. Discuss the differences typically encountered in the construction of: a) the elbow joint, b) the pectoral girdle, and c) the pelvic girdle from the standpoint of sexual difference.

PROGRAM OF STUDY

Assignment	Media
1. Work the Program: Basic Concepts of Anatomy and Physiology, pp. 316-346	IPLL
2. View Motion Pictures:	
a. Heart and Circulation	"C" Arcade
b. Heart Disease	" "
c. Alimentary Tract	" "
d. Digestion of Foods	" "
3. Do Lab Experiments:	
1. Heartbeat	A-103
2. Tests for Carbohydrates, Proteins, Fats	A-103
4. Listen to Audio Tape: "Microbes To Food"	"C" Arcade
5. View Video Tapes: (Optional)	
a. Skeletal System	"C" Arcade
b. Circulatory System	" "
c. Digestive System	" "
6. Fill in blanks of "The Story Of Ike And Mike"	"C" Arcade
7. Complete questions on handout sheet	Home

OAKLAND COMMUNITY COLLEGE
FOUNDATIONS OF NATURAL AND LIFE SCIENCE

THE PLANET EARTH

"The firmament displays wonders, but Planet Earth is our home."

Performance Goals

Students should be able to:

1. Understand and use a selected list of words peculiar to geology.
2. Point out specific land features in Oakland County.
3. Construct a history of the glaciation of Oakland County.
4. Describe the major forces of weathering and land formation.
5. Explain the structure of the interior of the earth.
6. Read a topographic map.

Questions

1. Define: Fosse, esker, moraine, outwash, till, fault, fold, uplift, and metamorphism.
2. Write a brief description of the events which led to the current land form of Oakland County.
3. Trace a river from its rise in mountains to its formation of a delta.
4. Describe and explain the importance of isostasy.

Assignments	Media
1. Map reading	A-103
2. Listen to the following tapes: "Hot Brine Pools In The Red Sea" "Oil In The Sea"	"C" Arcade " "
3. Work the following programs, all frames: Glaciers (by Bradner)	IPLL
4. Field Trip	Pamphlet & Car Pools
5. Complete questions on handout sheet	Handout
6. View the following films: "Secrets Of The Ice (269) "Hidden Earth" (252)	"C" Arcade " "

The LRC has a reference shelf which has been set aside for your convenience to study on your own. You will find it has the books pertaining to this subject placed on reserve for your use.

APPENDIX C

TESTS ASSOCIATED WITH THE PROGRAMED TEXTS

PROGRAM NO. 18 COPY_____PAGE____

NAMING ORGANIC COMPOUNDS

PRE-TEST FORM A

NAME_____ SCORE _____% DATE_____
(Print)

Match the statements in Column A with the terms in column B.
(For this test, I used column B, no._____)

	A	B (see separate sheet)
_____	1) 2-butyne	1) a
_____	2) 2,2-dimethyl butane	2) b
_____	3) methane	3) c
_____	4) 3-ethyl-2,3-dimethylpentane	4) d
_____	5) a homocyclic compound	5) e
_____	6) 1,3,5-hexatriene	6) f
_____	7) a heterocyclic compound	7) g
_____	8) 3,7-diehtyl-2,2-dimethyl-4-propylnonane	8) h
_____	9) 2-methyl-1,3-butadiene	9) i
_____	10) decane	10) j
_____	11) ethene	11) k
_____	12) 3,3,4-trimethylhexane	12) l
_____	13) 5-ethyl-2,4-dimethyloctane	13) m
_____	14) 4-ethyl-2-methyl-1-hexene	14) n
_____	15) 3-heptene	15) o
_____	16) Hexane	16) p
_____	17) 2,2-dimethyl-5-propyl-3-nonyne	17) q
_____	18) ethyne	18) r
_____	19) 3,3,4,4-tetramethyl-1,pentyle	19) s
_____	20) isobutane	20) t
		21) u
	(you may use	22) v
	Score = No. correct x 5 letters or the	23) w
	numbers)	24) x
		25) y

PROGRAM NO. 18 COPY_____PAGE_____

NAMING ORGANIC COMPOUNDS

PRE-TEST FORM B

NAME_____ SCORE_____% DATE_____
(Print)

Match the statements in column A with the terms in column B.
(For this test, I used column B, no._____)

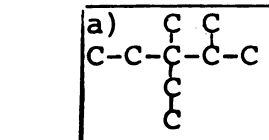
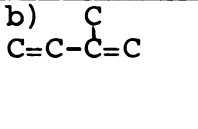
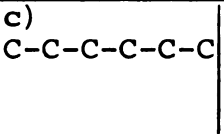
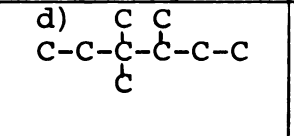
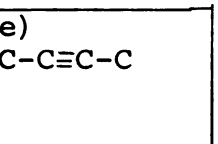
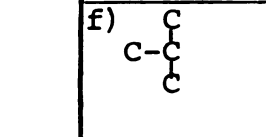
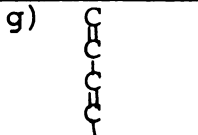
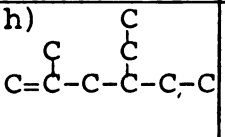
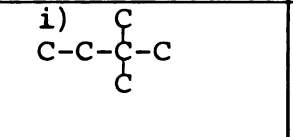
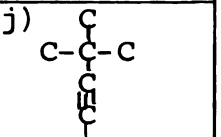
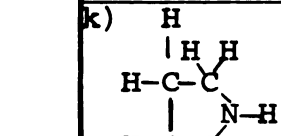
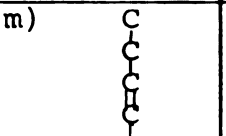
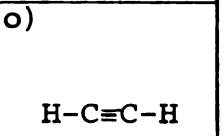
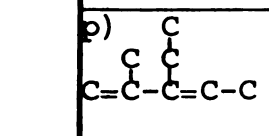
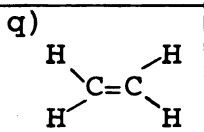
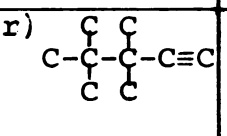
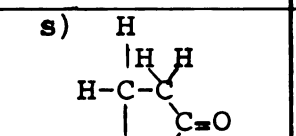
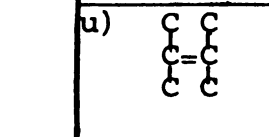
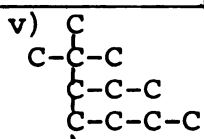
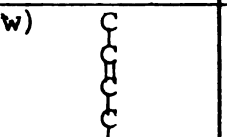
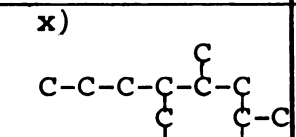
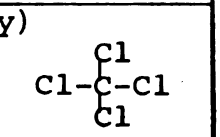
A	B (see separate sheet)
_____ 1) a homocyclic compound	1) a
_____ 2) 2-methyl-1,3-butadiene	2) b
_____ 3) 3,3,4-trimethylhexane	3) c
_____ 4) 2-butyne	4) d
_____ 5) 3-heptene	5) e
_____ 6) isobutane	6) f
_____ 7) 3,7-diethyl-2,2-dimethyl-4-propylnonane	7) g
_____ 8) ethene	8) h
_____ 9) 2,2-dimethylbutane	9) i
_____10) ethyne	10) j
_____11) 5-ethyl-2,4-dimethyloctane	11) k
_____12) 1,3,5-hexatriene	12) l
_____13) hexane	13) m
_____14) methane	14) n
_____15) decane	15) o
_____16) 3,3,4,4-tetramethyl-1-pentyne	16) p
_____17) a heterocyclic compound	17) q
_____18) 4-ethyl-2-methyl-1-hexene	18) r
_____19) 3-ethyl-2,3-dimethylpentane	19) s
_____20) 2,2-dimethyl-5-propyl-3 nonyne	20) t
	21) u
(you may use	22) v
Score = No. correct x 5 the letters or	23) w
the numbers)	24) x
	25) y

PROGRAM NO. 18

COLUMN B
(NO. 1)

NAMING ORGANIC COMPOUNDS

(DO NOT WRITE ON THIS SHEET)

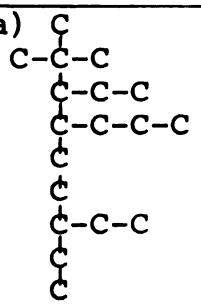
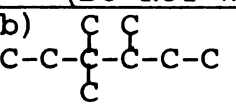
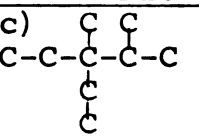
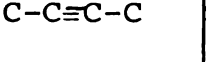
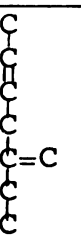
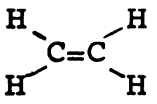
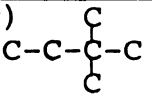
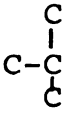
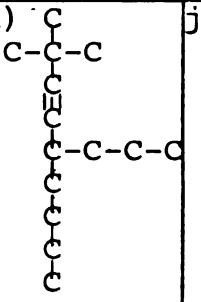
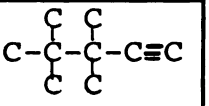
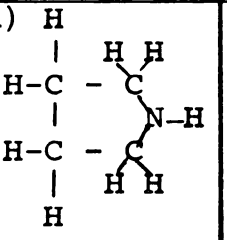
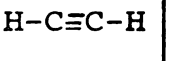
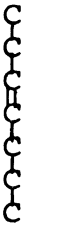
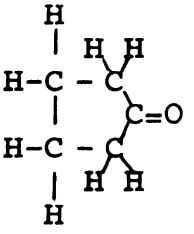
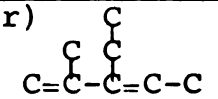
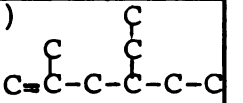
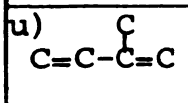
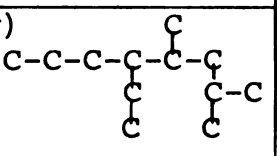
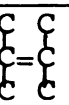
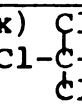
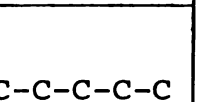
a) 	b) 	c) 	d) 	e) 
f) 	g) 	h) 	i) 	j) 
k) 	l) $C_{10}H_{22}$	m) 	n) CH_4	o) 
p) 	q) 	r) 	s) 	t) $C_{10}H_{18}$
u) 	v) 	w) 	x) 	y) 

PROGRAM NO. 18

COLUMN B
(No. 2)

NAMING ORGANIC COMPOUNDS

(DO NOT WRITE ON THIS SHEET)

a) 	b) 	c) 	d) 	e) 
f) 	g) 	h) 	i) 	j) 
k) $C_{10}H_{22}$	l) CH_4	m) 	n) 	o) 
p) 	q) 	r) 	s) $C_{10}H_{18}$	t) 
u) 	v) 	w) 	x) 	y) 

PROGRAM NO. 18 COPY_____ PAGE_____

NAMING ORGANIC COMPOUNDS

POST-TEST FORM A

NAME_____ SCORE_____% DATE_____
(Print)

Match the statements in column A with the terms in column B.
(For this test, I used column B, no._____)

	A	B (see separate sheet)
	1) 2,2-dimethyl butane	1) a
	2) 2-ethyl-1,4-hexadiene	2) b
	3) 3-ethyl-2,3-dimethylpentane	3) c
	4) 2-methyl-1,3-butadiene	4) d
	5) 3-ethyl-2-methyl-1,3-pentadiene	5) e
	6) decane	6) f
	7) 3,3,4-trimethylhexane	7) g
	8) 2-butyne	8) h
	9) 5-ethyl-2,4-dimethyloctane	9) i
	10) 4-ethyl-2-methyl-1-hexene	10) j
	11) 2,3-dimethyl-2-butene	11) k
	12) ethene	12) l
	13) 2,2-dimethyl-5-propyl-3-nonyne	13) m
	14) 3,3,4,4-tetramethyl-1-pentyne	14) n
	15) 6-methyl-3-nonyne (molecular formula)	15) o
	16) 3 heptene	16) p
	17) isobutane	17) q
	18) 3,7-diethyl-2,2-dimethyl-4-propylnonane	18) r
	19) 1,3,5-hexatriene	19) s
	20) Carbon tetrachloride	20) t
		21) u
		22) v
		23) w
		24) x
		25) y

Score = No. correct x 5

(you may use the letters or the numbers)

FOLD ON CENTERLINE FOR ANSWERS (FOLD IN)

PROGRAM NO. 18 COPY_____ PAGE_____

NAMING ORGANIC COMPOUNDS

POST-TEST FORM B

NAME_____ SCORE _____% DATE_____
(Print)

Match the statements in column A with the terms in column B. (For this test, I used column B, no._____)

A	B (see separate sheet)
_____ 1) 3-ethyl-2-methyl-1,3-pentadiene	1) a
_____ 2) 3,3,4,4-tetramethyl-1-pentyne	2) b
_____ 3) 5-ethyl-2,4-dimethyloctane	3) c
_____ 4) 3,7-diethyl-2,2-dimethyl-4-propylnonane	4) d
_____ 5) 2,2-dimethyl butane	5) e
_____ 6) isobutane	6) f
_____ 7) 4-ethyl-2-methyl-1-hexene	7) g
_____ 8) decane	8) h
_____ 9) 2,2-dimethyl-5-propyl-3-nonyne	9) i
_____10) 2-ethyl-1,4-hexadiene	10) j
_____11) 1,3,5-hexatriene	11) k
_____12) 6-methyl-3-nonyne(Molecular formula)	12) l
_____13) 3,3,4-trimethylhexane	13) m
_____14) 2,3-dimethyl-2-butene	14) n
_____15) Carbon tetrachloride	15) o
_____16) 3-ethyl-2,3-dimethylpentane	16) p
_____17) 3 heptene	17) q
_____18) 2-butyne	18) r
_____19) ethene	19) s
_____20) 2-methyl-1,3-butadiene	20) t
	21) u
Score = No. correct x 5 (you may use the letters or the numbers)	22) v
	23) w
	24) x
	25) y

PROGRAM NO. 20 COPY____ PAGE____

PRE-TEST NEWTON'S LAWS OF MOTION FORM A

NAME_____ SCORE____% DATE_____
(Print)

Match the statements in column A with the terms in column B. Items in column B may be used more than once.

	A	B
_____ 1)	Change of position with respect to a referent	1) 20n
_____ 2)	In figure A, if F = 20n, determine Fx.	2) 500 m/sec/sec
_____ 3)	Newton's second law.	3) 3n
_____ 4)	The vertical component of a vector.	4) 5 m/sec/sec
_____ 5)	A quantity with both magnitude and direction.	5) 1n
_____ 6)	Movement of a body along an axis.	6) motion & force
_____ 7)	In figure B, if F_1 = 20n, F_2 = 10n, determine R.	7) 35n
_____ 8)	Movement of a body around an axis.	8) force & gravity
_____ 9)	Change of rate of velocity.	9) vector quantity
_____10)	Newton's third law.	10) 4.44 m/sec/sec
_____11)	The horizontal component of a vector	11) equal
_____12)	An application of Newton's third law.	12) 17.5 n
_____13)	In figure E, if F = 50n, M = 10Kg, find a.	13) inertia
_____14)	Tendency of a body to resist a change in equilibrium.	14) 25n
_____15)	In figure C, if F_1 = 2n, F_2 = 1n, determine R.	15) speed
_____16)	A push or pull exerted on a body.	16) Fx
_____17)	In figure F, if F_1 = 50n, M = 10Kg, F_2 = 0, find a.	17) motion
_____18)	Every force is accompanied by an opposite &_____force.	18) jet engine
_____19)	Newton's laws of motion relate____.	19) 22.5 n
_____20)	In figure D, if F_1 = 20n, F_2 = 15n, determine R.	20) acceleration

A		B
		21) Fy

Scoring key: Score = No. correct x 5

25) None of these	28) Newton	22) action=reaction
26) rotational motion	29) mass	23) translational motion
27) unequal	30) force	24) F = ma

NEWTON'S LAWS (FIGURES)

FIGURE A

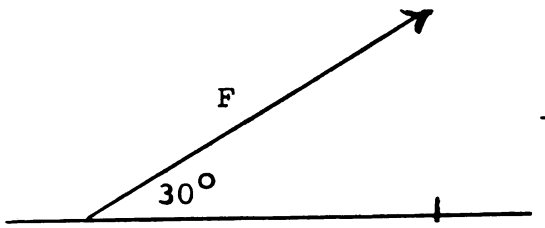


FIGURE B

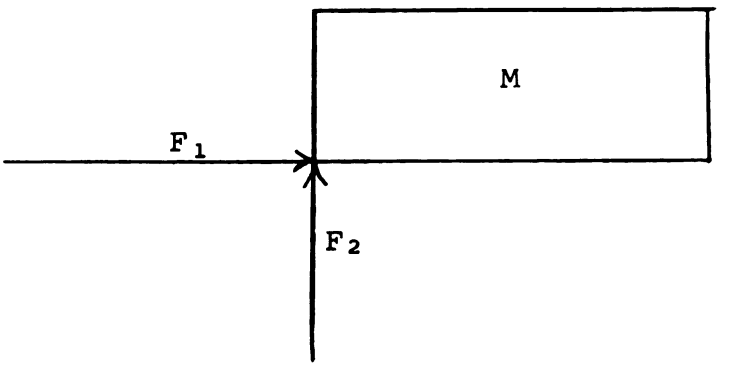


FIGURE C

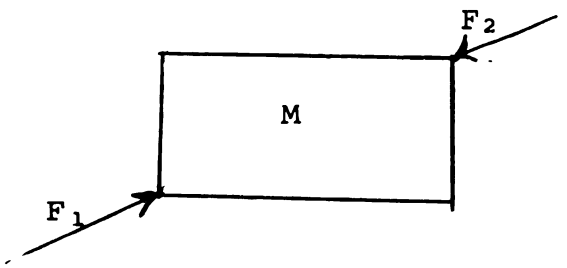


FIGURE D

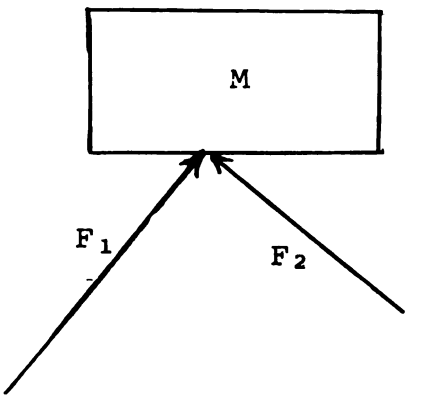


FIGURE E

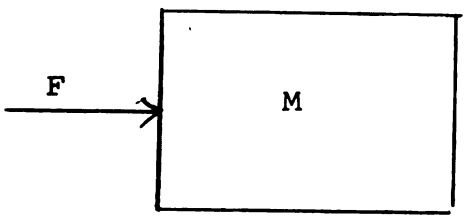
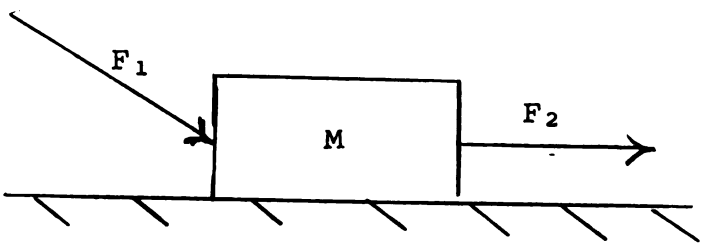


FIGURE F



PROGRAM NO. 20 COPY____ PAGE ____

NEWTON'S LAWS OF MOTION

PRE-TEST FORM B

NAME_____ SCORE_____% DATE_____
(Print)

Match the statements in column A with the terms in column B. Items in column B may be used more than once.

	A	B
_____ 1)	Change of position with respect to a referent.	1) force & gravity
_____ 2)	In figure A, if F = 20n, determine Fx.	2) None of these
_____ 3)	Newton's second law.	3) Fx
_____ 4)	The vertical component of a vector.	4) unequal
_____ 5)	A quantity with both magnitude and direction.	5) 20n
_____ 6)	Movement of a body <u>along</u> an axis.	6) F = ma
_____ 7)	In figure B, if F_1 = 20n, F_2 = 10n, determine R.	7) vector quantity
_____ 8)	Movement of a body <u>around</u> an axis.	8) motion
_____ 9)	Change of rate of velocity.	9) 500m/sec/sec
_____10)	Newton's third law.	10) Newton
_____11)	The horizontal component of a vector.	11) jet engine
_____12)	An application of Newton's third law.	12) 4.44m/sec/sec
_____13)	In figure E, if F = 50n, M = 10Kg, find a.	13) 3n
_____14)	Tendency of a body to resist a change in equilibrium.	14) Translational motion
_____15)	In figure C, if F_1 = 2n, F_2 = 1n, determine R.	15) equal
_____16)	A push or pull exerted on a body.	16) Fy
_____17)	In figure F, if F_1 = 50n, M = 10Kg, F_2 = 0, find a.	17) 5 m/sec/sec
_____18)	Every force is accompanied by an opposite & force.	18) 17.5n

_____19) Newton's laws of motion relate___.

_____20) In figure F, if F_1 = 20n, F_2 = 15n, determine R.

Scoring key: Score = No. correct x 5

25) 22.5 n
26) motion & force
27) mass
28) 25n
29) action=reaction
30) 35n

19) acceleration
20) speed
21) force
22) ln
23) rotational motion
24) inertia

NEWTON'S LAWS (FIGURES)

FIGURE A

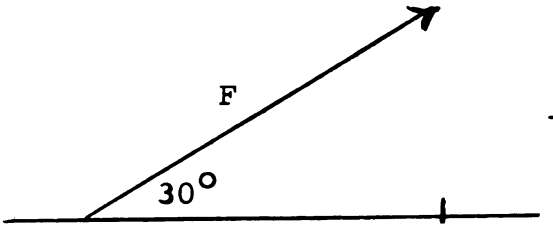


FIGURE B

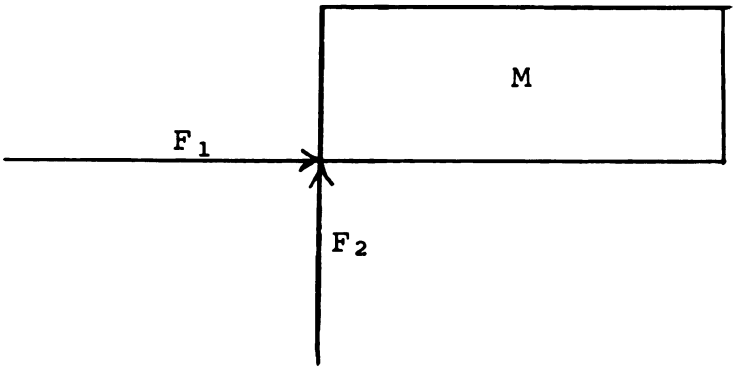


FIGURE C

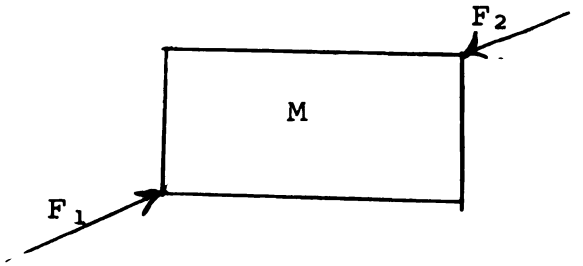


FIGURE D

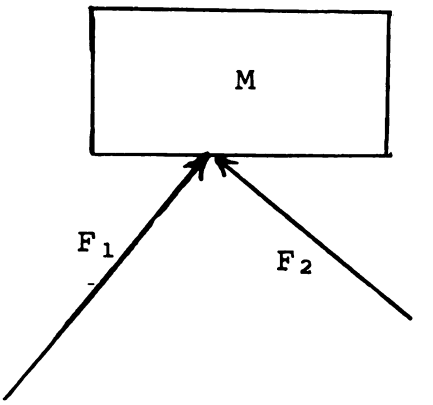


FIGURE E

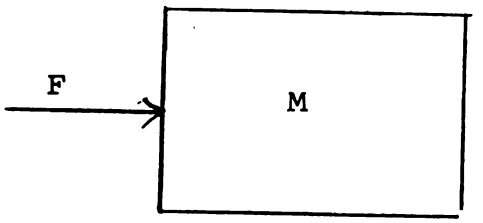
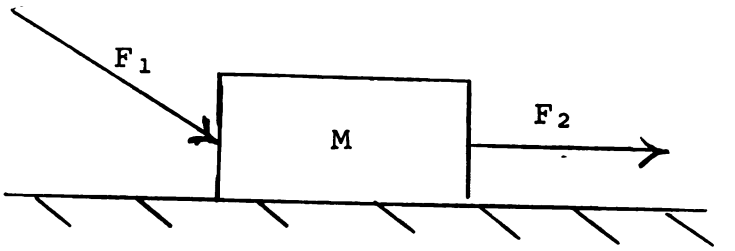


FIGURE F



PROGRAM NO.20 COPY____ PAGE_____

NEWTON'S LAWS OF MOTION

POST-TEST FORM A

NAME_____ SCORE_____% DATE_____
(Print)

Match the statements in column A with the terms in column B. Items in column B may be used more than once.

	A	B
_____ 1)	A quantity with both magnitude and direction.	1) motion
_____ 2)	Change of rate of velocity.	2) 25m/sec/sec
_____ 3)	In figure A, if F = 25n, determine Fy.	3) F = ma
_____ 4)	Movement of a body around an axis.	4) Translational motion
_____ 5)	Change of position with respect to a referent.	5) 4 m/sec/sec
_____ 6)	In figure B, if F_2 = 10n, F_1 = 20n, determine R.	6) action=reaction
_____ 7)	Tendency of a body to resist a change in equilibrium.	7) 50n
_____ 8)	Newton's laws of motion relate____.	8) Fx
_____ 9)	In figure C, if F_1 = 12n, F_2 = 8n, determine R.	9) inertia
_____10)	Every force is accompanied by an opposite & _____ force.	10) jet engine
_____11)	An application of Newton's third law.	11) 3.3m/sec/sec
_____12)	The vertical component of a vector.	12) unequal
_____13)	In figure D, if F_1 = 40n, F_2 = 30n, determine R.	13) Newton
_____14)	Newton's third law.	14) 21n
_____15)	A push or pull exerted on a body.	15) rotary lawn sprinkler
_____16)	In figure 4, if F = 50n, M = 25Kg, find a.	16) speed
_____17)	The horizontal component of a vector.	17) 4n

A	B
_____18) Movement of a body <u>along</u> an axis.	18) acceleration
_____19) In figure F, if F_1 = 10n, M = 5Kg, F_2 = 8n, find a.	19) vector quantity
_____20) Newton's second law.	20) force
	21) 11.75 n
	22) motion & force

<u>Scoring key</u>: Score = No. correct x 5

23) none of these
24) force & gravity
25) 20n
26) equal
27) 2 m/sec/sec
28) rotational motion
29) Fy
30) 22.5n

NEWTON'S LAWS (FIGURES)

FIGURE A

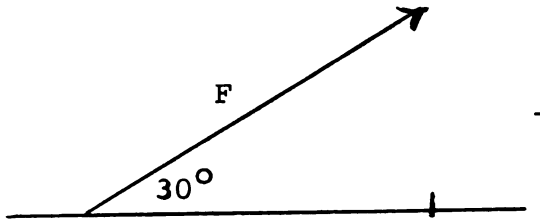


FIGURE B

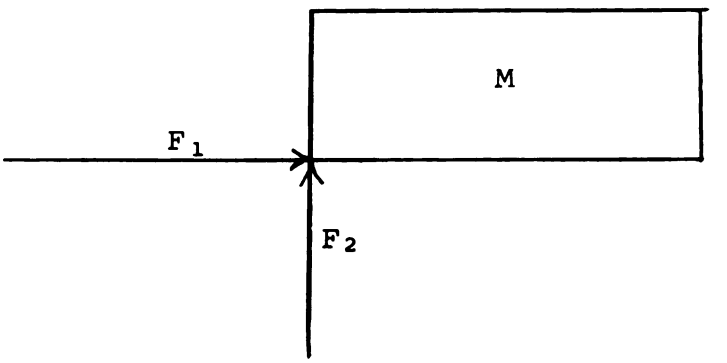


FIGURE C

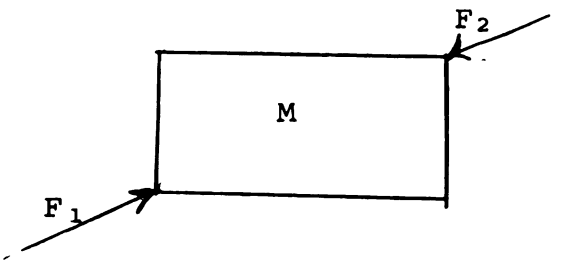


FIGURE D

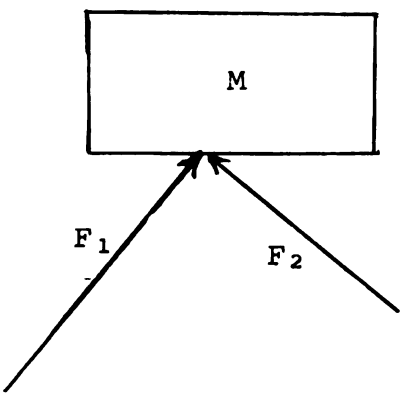


FIGURE E

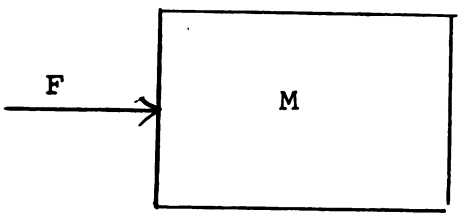
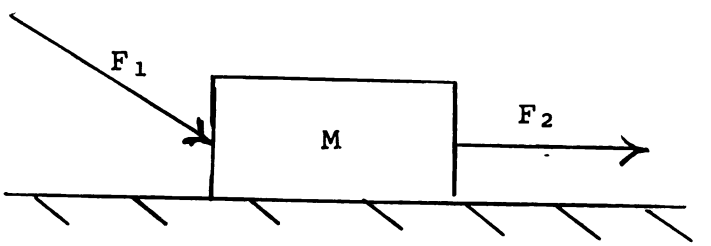


FIGURE F



PROGRAM NO. 20 COPY____PAGE___

NEWTON'S LAWS OF MOTION

POST-TEST FORM B

NAME_____ SCORE_____% DATE_____
(Print)

Match the statements in column A with the terms in column B. Items in column B may be used more than once.

	A	B
_____ 1)	A quantity with both magnitude and direction.	1) Fx
_____ 2)	Change of rate of velocity.	2) 20n
_____ 3)	In figure A, if F = 25n, determine Fy.	3) speed
_____ 4)	Movement of a body around an axis.	4) 2 m/sec/sec
_____ 5)	Change of position with respect to a referent.	5) motion
_____ 6)	In figure B, if F_2 = 10n, F_1 = 20n, determine R.	6) force & gravity
_____ 7)	Tendency of a body to resist a change in equilibrium.	7) Inertia
_____ 8)	Newton's laws of motion relate____.	8) 4n
_____ 9)	In figure C, if F_1 = 12n, F_2 = 8n, determine R.	9) 25 m/sec/sec
_____10)	Every force is accompanied by a opposite & _____ force.	10) rotational motion
_____11)	An application of Newton's third law.	11) acceleration
_____12)	The vertical component of a vector.	12) jet engine
_____13)	In figure D, if F_1 = 40n, F_2 = 30n, determine R.	13) F = ma
_____14)	Newton's third law	14) none of these
_____15)	A push or pull exerted on a body.	15) 3.3 m/sec/sec
_____16)	In Figure E, if F = 50n, M = 25Kg, find a.	16) 11.75n
_____17)	The horizontal component of a vector.	17) translational
_____18)	Movement of a body along an axis.	18) unequal

A		B
_____19) In figure F, if F_1 = 10n, M = 5Kg, F_2 = 3n, find a.		19) force
_____20) Newton's second law.		20) rotary lawn sprinkler
Scoring key: Score = No. correct x 5		21) 22.5 n
25) vector quantity	28) 21n	22) 4 m/sec/sec
26) action=reaction	29) motion & force	23) equal
27) Fy	30) 50n	24) Newton

NEWTON'S LAWS (FIGURES)

FIGURE A

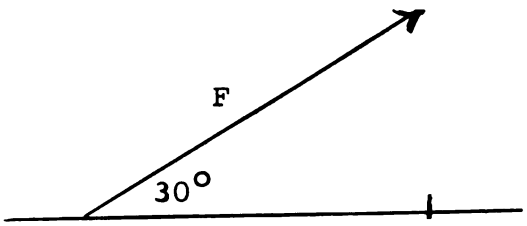


FIGURE B

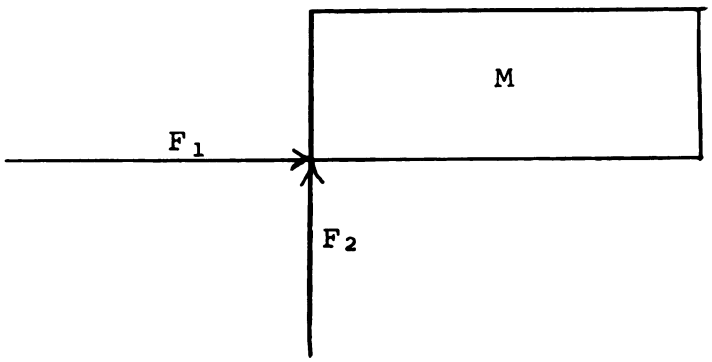


FIGURE C

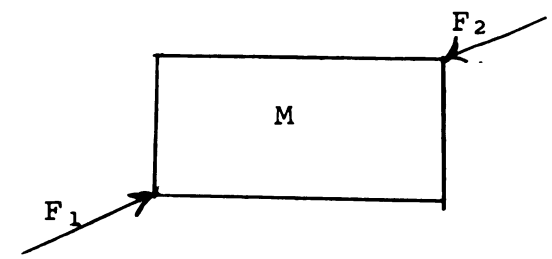


FIGURE D

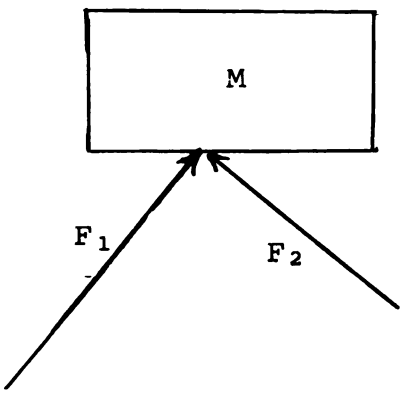


FIGURE E

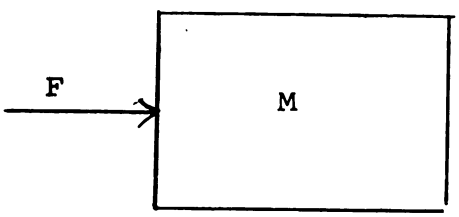
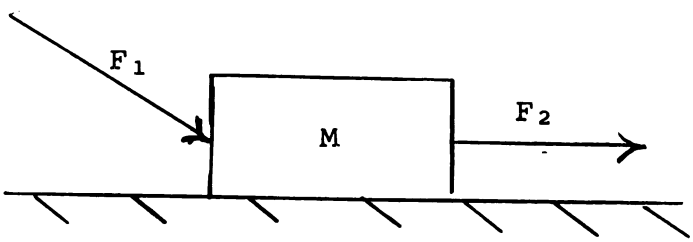


FIGURE F



APPENDIX D

KOLMOGOROV-SMIRNOV TESTS--WORK TABLES

WORK TABLES

KOLMOGOROV-SMIRNOV STATISTICAL TEST

The formula for determining the computed test value from the tables of Chapter IV, for the one-tailed test for two samples, at the .10 alpha level is

$$X^2 = 4D^2 \left[\frac{n_1 n_2}{n_1+n_2}\right]$$

The computations for each of the tables listed in Chapter IV follow.

Table 4.3

$$X^2 = 4D^2 \left[\frac{n_1 n_2}{n_1+n_2}\right]$$

$$= 4(.178)^2 \left[\frac{(8)(7)}{8+7}\right]$$

$$= 4(.03168) \left[\frac{(56)}{(56)}\right]$$

$$= (.12672)(3.733)$$

$$= .473$$

Table 4.4

$$X^2 = 4(.079)^2 \left[\frac{(9)(14)}{9+14}\right]$$

$$= 4(.006) \left[\frac{(126)}{(23)}\right]$$

$$= (.024)\ (5.478)$$

$$= .13147$$

Table 4.5

$$X^2 = 4(.475)^2 \left[\frac{(8)(5)}{8+5}\right]$$

$$= 4(.2256) \left[\frac{(40)}{(13)}\right]$$

$$= (.9024)\ (3.077)$$

$$= 2.7766$$

Table 4.6

$$X^2 = 4(.2137)^2 \left[\frac{(19)(13)}{9+13}\right]$$

$$= 4(.0456) \left[\frac{(117)}{(22)}\right]$$

$$= (.1824)\ (5.318)$$

$$= .97000$$

Table 4.7

$$X^2 = 4(.314)^2 \left[\frac{(7)(5)}{7+5}\right]$$

$$= 4(.098) \left[\frac{(35)}{(12)}\right]$$

$$= (.392)\ (2.916)$$

$$= 1.1430$$

Table 4.8

$$X^2 = 4(.269)^2 \left[\frac{(14)(13)}{14+13}\right]$$

$$= 4(.0723) \left[\frac{(182)}{(27)}\right]$$

$$= (.2892)\ (6.740)$$

$$= 1.949$$

Table 4.9

$$X^2 = 4(.25)^2 \left[\frac{(8)(5)}{8+5}\right]$$

$$= 4(.0625) \left[\frac{(40)}{(13)}\right]$$

$$= (.250)\ (3.0769)$$

$$= .7692$$

Table 4.10

$$X^2 = 4(.383)^2 \left[\frac{(12)(5)}{12+5}\right]$$

$$= 4(.1467) \left[\frac{(60)}{(17)}\right]$$

$$= (.5868)\ (3.529)$$

$$= (2.07)$$

Table 4.11

$$X^2 = 4(.1333)^2 \left[\frac{(15)(5)}{15+5}\right]$$

$$= 4(.0177) \left[\frac{(75)}{(20)}\right]$$

$$= (.0708)\ (3.75)$$

$$= .2655$$

Table 4.12

$$X^2 = 4(.446)^2 \left[\frac{(26)(10)}{26+10}\right]$$

$$= 4(.199) \left[\frac{(260)}{(36)}\right]$$

$$= (.796)\ (7.222)$$

$$= 5.74888$$