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AN INSTRUCTIONAL STRATEGY FOR

UNDERACHIEVERS

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TO

Arthur V. Leary, Jr., who will eventually understand what this work means,

Cheryl G. Leary, who understands more about what this work means,

Herbert J. Leary, Sr., who will not understand this work but will know what it means,

Cecelia B. Leary, who is always there,

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AN INSTRUCTIONAL STRATEGY FOR UNDERACHIEVERS

CHAPTER I

INTRODUCTION

More than 80 percent of the incoming freshmen at Southern University in New Orleans are lacking fundamental mathematical skills which are expected of high school graduates (Jolly, 1969). In an attempt to discover particular reasons underlying this lack of achievement, the Remedial Program at Southern University in New Orleans issued a questionnaire of 217 freshman students of the 1968-69 freshman class. The results revealed: a) 90% of the students listed mathematics as their worst subject, b) 99% indicated they could not solve problems, c) most were from large families and thus obligated to many chores after school hours (Jolly, 1969).

This problem is not peculiar to Southern University. A study conducted at Dillard University, also a predominantly Black institution and located in New Orleans, revealed similar findings (La Brant, 1967). In the spring of 1959, a segment of the Dillard University faculty began a study to investigate possible ways to remedy inadequate preparation of graduates of Black high schools in Louisiana that attended Dillard. By the summer of 1965 there were three programs in operation; however, the Prefreshman Program is the only one considered here.

In reviewing the scope of the mathematics in the 1965 Prefreshman Program at Dillard University and comparing it to the Developmental Studies Program (the remedial program) at Southern University in New Orleans for 1970, there is considerable evidence that "review" was the primary objective for both programs. This, of course, is how most remedial programs have been conducted.

While no one believed a brief session would compensate for long-time deficiencies, it still seemed reasonable that a normally intelligent young person, faced with some evidence of his needs and with opportunity for improvement could accomplish a great deal in a relatively short time (La Brant, 1967). This statement suggests an emphasis upon "teaching strategy" rather than "review" and the word "opportunity" in the above statement has a direct relationship to Benjamin S. Bloom's "Mastery Learning" technique (Bloom, 1971).

There is little research on remedial procedures at the freshman college level with Black students. There are, however, various programs presently in existence designed to review material previously not well learned in an effort to remediate. Since the word "remedial" seems to imply "prior exposure," then it seems that the task to accomplish would be to master what has been neglected. Since time is of essence in any remediation program, it would be interesting to observe the results of Bloom's "Mastery Learning" technique with a slight modification.

Statement of Problem

Mathematics 100 is the basic remedial mathematics course at Southern University in New Orleans. This course does not carry college credit, and is not listed under the Mathematics Department, but rather under the Developmental Studies Program which is the school's remedial program.

Because of the limited staff in this program, it is impossible to serve all the incoming freshmen with severe remedial problems in the first course. Therefore, many students must enroll in Mathematics 111, the next course in sequence, who would otherwise have enrolled in Mathematics 100. Criteria for enrollment in Math 100 include extremely low scores on the Cooperative Mathematics Pre-Test for College Students.

The problem has several parts:

1. To investigate differences in achievement between students using Bloom's "Mastery Learning" instructional technique (with modifications) and those exposed to traditional instruction.
2. To examine levels of achievement in Mathematics 111 for:
   a. Students repeating this course.
   b. Students having had Mathematics 100 previously.
   c. Students enrolled in Mathematics 111 for the first time.
3. To examine changes in attitudes of students toward mathematics, school, and mathematics 111.

Statement of Hypotheses

For convenience in stating the hypotheses in null form, Instructional Strategy A is Bloom's Mastery Learning technique (with modification) and Instructional Strategy B is traditional instructional methods.

Hypothesis 1:

There is no difference in level of achievement in Mathematics 111 between Instructional Strategy A and Instructional Strategy B.

Hypothesis 2:

There is no difference in level of achievement in Mathematics 111 between Instructional Strategy A and Instructional Strategy B when subjects have had Mathematics 100 prior to Mathematics 111.

Hypothesis 3:

There is no difference in level of achievement in Mathematics 111 between Instructional Strategy A and Instructional Strategy B when subjects are repeating Mathematics 111.

Hypothesis 4:

There is no difference in level of achievement in Mathematics 111 between Instructional Strategy A and Instructional Strategy B when subjects are enrolled in Mathematics 111 for the first time.

Hypothesis 5:

There is no difference in the change of attitude toward mathematics, school and Mathematics 111 between Instructional Strategy A and Instructional Strategy B.

Need for the Study

All incoming freshmen for the 1968-69 school year at Southern University in New Orleans were administered the Cooperative Mathematics Pre-Test for College Students (CMPTCS) by the Committee on Tests of the Mathematics Association of America. The test consisted of forty items of equal weight. Thus, forty is the highest possible score. Because of the correction for guessing formula, it is possible to receive a negative score. There were seven hundred fifty students taking this test and twenty-nine percent made scores ranging from minus seven to minus one, sixty-eight percent scored from zero to fourteen, two percent scored from fifteen to nineteen, and one percent scored twenty or better. The highest individual score was thirty-one (Jolly, 1969).

The information presented above indicates a probable high failure rate for any students taking mathematics at the college level. In the years preceding 1969 the rate of failure was extremely high. When the Developmental Studies Program began, the percentage of students passing remedial mathematics increased.

The instructional technique employed by the Developmental Studies Program is similar to procedures and techniques used at the secondary level with slow learners and underachievers. In the fall of 1971 there were two hundred and four (204) students enrolled in Developmental Studies Mathematics and of this number one hundred and thirty (130) passed, sixty-nine (69) failed and five (5) withdrew (Jolly, 1971).

While it is encouraging to witness the percentage of students passing the remedial freshman mathematics course in the light of performances on tests of the nature of CMPTCS, there is some question as to whether passing equals mastery or passing equals acquisition of minimum essential mathematical skills necessary for college level mathematics. In many colleges and universities across the country, college mathematics begins at a calculus level. On the basis of the author's past experiences it may be hypothesized that if students were re-tested with the original CMPTCS examination, the results would not be significantly different.

The greater portion of the freshman classes that arrive at Southern University in New Orleans each year come from low socioeconomic backgrounds. This, no doubt, produces what could be called a "disadvantaged" student. Duydan and Weaver (1971) describe the "disadvantage" in terms of two broad sets (i.e., environmentally and academically disadvantaged students) that are not disjointed. The academically disadvantaged students are subdivided into the "low achievers" (i.e., the pupil who ranks in the lower third of the student population on mathematics or general achievement), the "slow learner" (i.e., the student with an IQ of 75 to 90), and the "underachievers" who appear to have the ability to achieve at a higher level, but fail to do so. On the basis of the author's past experience it may be hypothesized that the students at Southern University in New Orleans are primarily of the third subdivision.

One of the major emphases in Bloom's "Mastery Learning" model is that each student is given sufficient time to master a unit (perform at A or B level on achievement tests) before proceeding to the next unit of instruction. This may be impractical in a remedial setting on a college campus. However, the rewarding results obtained when using the model in previous research makes it worthwhile to investigate every other aspect of the model while giving some time to acquire mastery. This study should be an asset to many small Black institutions where a great bulk of "underachievers" arrive each school year.

CHAPTER II

THEORETICAL FRAMEWORK AND RELATED LITERATURE

Theoretical Framework

John B. Carroll's (1966) conceptual model of school learning suggests that any learner may learn a task at a particular level provided he spends the time needed to learn the task. Thus:

$$\text{Degree of Learning} = f\left(\frac{\text{time spent}}{\text{time needed}}\right)$$

Carroll further explains that "spending time" means actually spending time on the act of learning and is therefore not "elapsed time" but the time during which the person is oriented to the learning task and actively engaged in learning. The model is not adopted from any learning theorist but rather it is what Carroll refers to as a description of the economics of the school learning process and therefore takes the fact of learning for granted.

There are five variables in the model which come under the headings of (a) time needed for learning, and (b) time spent in learning. Under the heading of time needed for learning, the variables are aptitude, ability to understand instruction, and quality of instruction. Perseverance and time allowed (opportunity) are the two variables under the heading of time spent in learning. Carroll says the following:

a) time spent is determined by the time the learner is actively involved in learning (i.e., perseverance) and the total time he is allowed.

b) learning time required by each individual is determined by his aptitude for the task, quality of instruction, and ability to understand the instruction.

Carroll has defined many of the basic concepts in his model in terms of "time." For example, "aptitude" is defined in terms of the amount of time the learner needs to learn a particular task. A learner needing little time to learn a task is said to have high aptitude and vice versa. Although aptitude may be regarded as a function of many other variables, it is not of immediate concern in the model.

The ability to understand instruction is closely related to a combination of "general intelligence" and "verbal ability." Quality of instruction is the manner in which the teacher organizes and presents the task to be learned. The learner must be told what he is to learn and how he is to learn the task. Also, the task must be presented in such an order that every detail of the task and every step of the learning is sufficiently prepared for by some previous step. Quality of instruction is also determined by the characteristics of textbooks, films and other teaching aids.

Because of the manner in which Carroll defined aptitude, the amount of time needed to learn a task is not only a function of aptitude but also the quality of instruction. If the quality of instruction is anything less than optimal, then more time will be needed by the learner in order to learn the task. This additional time needed is therefore an inverse function of his ability to understand instruction.

Carroll suggests that the time allowed for learning is in most schools insufficient. Either the instruction is geared down for the benefit of the slow learner or the pace is at such a high rate that the pressures brought about cause the learner to lose motivation. He further implies that in the majority of the cases the learner often loses motivation as a consequence of the large amount of material to be taught, the availability of time to be distributed and the variation in the amounts of time the individual child needs for learning. If there is insufficient time allowed, it is reasonable to assume incomplete learning.

The variable "perseverance" as Carroll defines it is a function of what is generally considered as "motivation." Carroll lists many factors which may or may not prompt a desire to learn but the essential point is that "perseverance" may interact with the quality of instruction.

"Perseverance" is also measured in terms of time; consequently, if there is an insufficient allotment of time to attain mastery and the quality of instruction is poor, there will be a reduction in the degree of learning.

It is readily noticeable that the model involves five elements: Aptitude, ability to understand instruction, and perseverance are individual factors, while opportunity and quality of instruction are external in nature. Carroll has carefully defined aptitude, perseverance, and opportunity in terms of time, and, since he has linked ability to understand instructions to general intelligence and verbal ability, ability to understand can be measured by appropriate measuring devices. There is an ingenious interconnection with quality of instruction and the ability to understand variable. Therefore, by appropriate experimental manipulation, quality of instruction may be implicitly defined or indexed in terms of time.

Bloom (1971) operationalized Carroll's Model of School Learning with supportive ideas from Bruner (1966), Glaser (1968), Goodlad and Anderson (1959), Morrison (1926), Skinner (1954) and Suppes (1966). Put in its briefest form, the model proposed by Carroll (1963) makes it clear that if the students are normally distributed with respect to aptitude for some subject (mathematics, science, literature, or history, for example) and all the students are provided with exactly the same instruction (same in terms of amount and quality of instruction and time available for learning), the end result will be a normal distribution on an appropriate measure of achievement. Furthermore, the relations between aptitude and achievement will be fairly high (a correlation of +.70 or higher is to be expected if the aptitude and achievement measures are valid and reliable). Conversely, if the students are normally distributed with respect to aptitude but the kind and quality of instruction and the amount of time available for learning are made appropriate to the characteristics and needs of each student, the majority of students may be expected to achieve mastery of the subject. The relation between aptitude and achievement should approach zero (Bloom, 1971).

With the assistance of a group at the University of Chicago, Bloom has done research on the variables in Carroll's model. The group has attempted to develop a strategy for teaching and learning which would bring nearly all students to a level of mastery in learning any subject. The approach has been to supplement regular group instruction by using diagnostic procedures and alternative instructional methods and materials in such a way as to bring a large proportion of students to a predetermined standard of achievement (Bloom, 1971).

In developing mastery learning, one must be able to recognize when such learning has been achieved. Therefore, the specification of objectives and content of instruction is one way of informing both teacher and student of exact expectations. Further, the translation of objectives into evaluation procedures helps to further define what a student is expected to do upon completion of a course.

The first step in Bloom's operating procedure is to break a subject into smaller units of learning. This unit may be a chapter in the textbook or any well defined content of a course. However, he thinks of a unit in terms of not more than two weeks of learning activity. The idea of the breakdown of learning activity into units came from the ideas of Gagné (1965) and Bloom (1956) in which each unit is a link in a hierarchy of learning tasks.

The second step in the procedure is to administer brief diagnostic progress tests to determine if each student has mastered the unit. Bloom adopted the term "formative evaluation" from Scriver (1967) in referring to these diagnostic tests. If the student has mastered the unit, the formative test should serve as reinforcement to the learning in that the study approach is adequate. If the student has not mastered the unit as indicated by the formative test, it is essential that the diagnosis be accompanied by specific instructions (prescription) to the student to correct weaknesses. Bloom (1971) also suggested that the formative test should <u>not</u> be assigned a grade but rather it should indicate <u>mastery</u> or <u>nonmastery</u>. His strongest argument for this is that consistent repetition of say a "C" grade may force the learner to accept a "C" grade as his "fate." Further, one may recognize competition as an inciting force for some students; it may also destroy much learning if it serves as a primary emphasis.

The third step in the procedure is followed by the student only. It is the alternative learning resources. Even though alternatives are primarily student oriented, various types of aids help teachers modify their instruction to fit varying needs of students. The types of supplemental procedures found most useful by Bloom and his colleagues at the University of Chicago are: (a) group study, (b) tutorial help, (c) textbooks, (d) workbooks, and programmed instruction units, and (e) audiovisual methods and academic games. After the student has utilized the above supplemental aids (as prescribed), he is to be retested by use of similar formative test in order to determine if weaknesses have been corrected.

Related Literature

The extent to which the literature has been reviewed centers mainly around the variables in Carroll and Bloom's model. Much of the literature related to mastery learning is contained in James H. Block's book entitled *Mastery Learning: Theory and Practice*. This book serves as a good reference because of the difficulty in obtaining some of the literature from its primary sources. Because of this it will be necessary to cite Block (1971) when referring to certain studies. There are studies that have been done that are not only relevant to the model but also quite pertinent to Black students in general.

Biehler (1970) did a mastery learning strategy for teaching introductory undergraduate educational psychology. Students were given an option of learning under traditional grading system or a mastery grading system. Under the mastery system course objectives were given to each student and three tests were constructed from these objectives. The tests were normatively graded but a score at the level of A or B was used to indicate mastery performance. Students who failed to meet this standard has an opportunity to take an alternative test after sufficient time to review. Also, brief term papers were required on topics chosen by the students and the papers could be re-submitted if original quality was not at the appropriate level.

The results showed that the second effort for those students who had to retake a test or re-submit a paper was especially effective both cognitively and affectively. Over 90 percent of the new students enrolling in the new course chose the mastery grading system.

McBride (1971) conducted a mastery learning study at Indiana University of Pennsylvania on two classes of mathematics majors enrolled in an analytic geometry and calculus course. The experimental group received copies of objectives for eight separate units of instruction. Both the experimental and control groups instruction was identical with exception of the formative tests and special sessions given to the experimental group. They were both given pre and post achievement tests to determine if the objectives of each unit were mastered by the individual student. Mastery was set at A or B grade levels. If mastery was not attained, the results of the formative tests were given to the student along with a supplementary diagnostic sheet which offered suggestions for further study. Students had the option to take a second formative test after correcting deficiencies if desired. Also, all available aids for correcting deficiencies were optionial.

The analysis of the results of the achievement test indicated that the experimental group performed significantly better than the control group at the end of the experimental period. Also, members of the experimental group did seek assistance from the classroom instructor but did not take advantage of the graduate assistant as an aid for correcting deficiencies.

Collins (cited in Block, 1971) conducted a study in freshman mathematics to investigate the effectiveness of Bloom's mastery learning strategy. The research involved two classes of a modern algebra course for Liberal Arts majors and two classes of a calculus course for Engineering and Science majors. One class in each of the two courses served as the experimental group and the other as the control group. For the experimental groups, objectives were given to the students for each unit, each class session and each assignment. During each of the class meetings five to ten minutes were given to solve a problem related to the preceding class meeting or assignment and discussion and questions followed. Mastery and non-mastery learners used the same text, received the same assignments, covered the same material and took the same unit tests.

For the modern algebra classes, 75 percent of the mastery group achieved the mastery criterion of an A or B grade. In the calculus classes, 65 percent of the mastery group achieved the criterion.

Brookover, _et al_. (1964), did a study to investigate self-concept and school achievement. The study was based on the view that self-concept is developed through interaction with others whom a person may feel is important to him and that these interactions influence further behavior. The major focus was on academic achievement and self-concept of academic ability. The most important findings were: (a) general self-concept and academic performance were positively and significantly related, (b) a student's self-concept in each of various subjects was related to his perception of how other persons evaluated him as a student.

This study is quite interesting for a number of reasons. First, there is implication that a change in self-concept could lead to a change in academic performance. Second, there is an idea of general self-concept and specific self-concept. Therefore, a change in a specific self-concept is a specific subject may change academic performance in that subject.

Aucesian (cited in Block, 1971) conducted a study using a version of Carroll's "Model of School Learning" with a graduate level course in test theory. Here again the goal was to produce mastery of the subject by the greater percentage of students within a time allotment of ten weeks. The course content was divided into five units each covering two weeks of learning activity. After each unit, the student was given diagnostic-progress tests which were used to provide feedback to both the teacher and student in an effort to evaluate the adequacy of the teaching-learning process. The test served to point out specific weaknesses and prescribed resources to overcome difficulties. Mastery over the course content was evaluated by a final achievement examination which was graded.

The results of this study, when compared to students enrolled in the course in the previous year, revealed that 50% of the sample achieved an A grade score while only 30% did so previously. This was indicated by a parallel examination given to the experimental group. Also, the correlation between total hours of weekly study and achievement was slightly negative. This was attributed to the effectiveness of the feedback instruments. Along with this, there was less variability on achievement scores over time as indicated by the diagnostic instruments.

The study done by Anthony (cited in Block, 1971) was an effort to link classroom environment and achievement together and show the correlation between the two. He found that the partial correlation of the Educational Environmental Index with post-achievement average was +.64, holding prior achievement constant. He found similar results when the Educational

Environmental Index was based on 14 selected process characteristics. It is interesting to note that these 14 variables can be grouped into the following three categories: (a) instructional varieties in materials and techniques used in class, (b) types of feedback available to teachers and students, and (c) variety and frequency of reinforcements used by the teacher. Categories (a) and (b) support the quality of instruction variable in Bloom and Carroll's model. Category (c) emphasizes the importance of reinforcement in human learning.

Ausubel (1964) proposes that learning deficits found in the culturally deprived children are generally caused by lack of opportunities to learn the necessary skills at an early age. Because of this, he feels that the benefits of later environmental stimulation can never be equal to those of an earlier period. To compensate for these deficiencies, Ausubel recommends emphasis on mastery in the teaching-learning process with consideration of the child's state of readiness when dealing with the instruction to be presented. Also, he stresses sequentially arranged learning tasks appropriate to the level of development where each task should be mastered before an attempt of the following task. He considers successful achievement on the sub-task as basis for the development of intensive motivation for learning. This paper has significant implications since most of the subjects in this study are the products of culturally deprived areas in New Orleans.

Carroll (cited in Block, 1971) did a study on some of the variables in his model. He studied the influence of sex, intelligence, and quality of instruction on learning rates, learning efficiency, perseverance, and interest. Two self-instruction booklets were prepared to teach rules about verbs of an artificial language. Booklet A was of "high quality of instruction," which presented each rule, tested it before presentation of the next rule and referred the student to pages where his mistakes were fully explained. Booklet B was of "low quality of instruction," which presented too much information at one time in a disorganized manner; also, the explanations of mistakes were inadequate. Carroll found that: (a) the time to reach the criterion was significantly related to intelligence but not sex, (b) poor quality of instruction affected the high--as well as the low--intelligence students, (c) poor quality of instruction may decrease perseverance for high--and low--intelligence students, (d) there was inefficient learning with insufficient opportunity (time), especially for low-intelligence subjects when quality of instruction was poor and (e) interest is a negligible factor.

The study by Kersh (cited in Block, 1971) investigated the effectiveness of John Carroll's model on a sample of six fifth-grade classes from a socio-economically disadvantaged population and six fifth-grade classes from an advantaged population. Activities centered around arithmetic classes where diagnostic tests based on the objectives of the instruction were administered after each unit of instruction. Students were directed to alternative learning resources on the basis of unit test scores. After one week's opportunity to use the resources, a retest was administered which was to provide positive reinforcement to students who had used the alternative resources. The strategy was an attempt to encourage the subjects to master the learning throughout the investigation. In this study, the disadvantaged classes performed as well as the advantaged control classes.

Coleman (1966) conducted a large scale study to assess the progress of

American public schools towards bringing about educational opportunities for all students. The report did examine, among other things, the critical factors affecting the education and achievement of minority students. Educational opportunity was assessed by measuring achievement in certain intellectual skills such as reading, writing, calculating and problem solving on a sample of pupils at grades 1, 3, 6, 9, and 12. The achievement test was not considered to be "culture free" but the contents of the test were designed to measure the skills which are most important for getting a job and advancing to a better one. The average Black pupil scored distinctly lower on these tests at every level than the average Caucasian pupil with the exception of the Oriental Americans and a few others. Not only that, there is the complication that deficiency in achievement becomes progressively greater for minority students at higher grade levels. Coleman (1966) further explains that for most minority groups, and most particularly the Black, schools provide little opportunity to overcome this initial deficiency. Since the schools do not provide the opportunity to overcome deficiencies, there was speculation as to whether some process operated to sort less qualified teachers into schools more frequently attended by minority groups. It was found that there exist a similarity between race of teacher and race of student in the structure of the American public education. This indicated a sorting mechanism did exist such that certain types of teachers were found in certain types of schools. This research points up the difficulties inherent to the task of remediation of Black students as well as other minority groups at the college level when deficiencies are constantly being compounded year after year.

Boyd (1952) conducted a study to assess whether there was a measurable difference in level of aspiration between Caucasian and Black children of the same intelligence level. It was carried out in a non-segregated elementary school in Portland, Oregon. Twenty-five Black and twenty-five Caucasian children were matched for age, economic status and I.Q. Level of aspiration was measured in two ways. A target test and an arithmetic test were administered between actual score and that expected for the next trial by the child. Also, a questionnaire designed to get a verbalization regarding future hopes and plans was used. The results obtained indicated that the Black group had the higher level of aspiration in both the test situation and the questionnaire responses.

The paper by Brazzid (1962) reported a six-week readiness program for twenty-six Black first-grade children. The program included parent meetings once a week, thirty minutes of educational television watched in the home and a readiness program to develop vocabulary, perception, word reasoning, and ability to follow directions. At the end of six weeks the experimental class was at the 50th percentile on readiness as measured by the Metropolitan Readiness Test, while the three nonexperimental classes in the same school were at the 15th percentile. Also, the intelligence quotient measurement after seven months was 106.5, while the general expectation for the group was 90.

Much of the research on the disadvantaged child seems to support the notion that school achievement is characterized by a cumulative-deficit phenomenon. Hope for the deprived child lies in the correction of basic weaknesses in curriculum and school practices.

CHAPTER III

DESIGN OF STUDY

Description of Instructional Strategy

Both the experimental and control groups were taught the same material from the text Fundamental Mathematics by Thomas Wade and Howard Taylor. The material covered came from the first two and one-half chapters of the text. Although both groups were taught with the assistance of an overhead projector, the control group was taught primarily by the lecture method. Lectures in the experimental group were audio-taped for later playback and review.

At the first class meeting, the experimental group was informed that it was necessary to master the course in order to acquire success in remaining college courses in mathematics. More than this, the instructor emphasized the necessity for Blacks to equip themselves with fundamental skills needed in this ever-changing technological society. A portion of the time was spent discussing the merits of verbalizing difficulties as soon as they might arise. The group was then informed that the course would be divided into units and each member would receive a copy of objectives for each unit. It was further explained that the set of unit objectives represented the objectives for the duration of the course. Finally, the experimental group was given an explanation of how the course would be conducted. They were told that diagnostic tests will be given at the end of each unit taught and would be graded with an "M" or "N" indicating mastery or non-mastery. The "M" (mastery) grade indicates achievement performance at 80% level or above which is the desired level of performance. If mastery was not accomplished, the students were informed that the following corrective procedures were available and were encouraged to make use of them.

1. Tutor--a senior student majority in mathematics and physics served as tutor. He was available two hours a day Monday through Friday.
2. Group sessions (three persons)--students were asked to divide themselves into groups of three. Each group was identified by a letter of the alphabet and assigned a group leader. Whenever a group would meet, the group leader was asked to inform the instructor of the persons meeting, material covered, and time spent.
3. Program test--Programmed Beginning Algebra by Drooyan and Wooton and A Program in Contemporary Algebra by Heimer, et al., were available for use from the secretary of the Mathematics Department.
4. Conference with instructor--the instructor held regularly scheduled office hours throughout the week.
5. Audio tapes of lectures--after each class meeting, the audio tapes were placed in the listening room of the library.

It was announced to the experimental group that they would have the opportunity to take a re-test over each unit test if an "N" grade was received. However, this test had to be taken prior to the next scheduled unit test.

Preparation of Objectives

Mager (1962) defines an objective as "an intent communicated by a statement describing a proposed change in a learner--a statement of what the learner is to be like when he has successfully completed a learning experience" (p.3). Meaningful stated objectives will always convey to the reader the instructional intent of the writer. Further, the statement that communicates best will eliminate misinterpretation. Such a statement should describe the desired behavior to the learner. Mager feels this may be accomplished if the objective identifies the terminal behavior, describe the conditions under which it is to occur, and if it specifies the criteria of acceptable performance. Although a single objective may very well possess all three of these items, it is not a necessary condition to describe the desired behavior. The major intent is to communicate intended educational outcomes, which may lead to many statements in order to describe all the intended outcomes (see Appendix A).

One of the most important reasons for stating objectives that demonstrate specific terminal behavior is that the learner eventually must be evaluated. Tests or examinations are the usual instruments that convey the degree of successful achievement of the objectives. Therefore, if a test is to be useful, it must measure performance strictly in terms of some goals. The items for the achievement test (see Appendix B) in this study were taken from the objectives of each unit.

Preparation of Attitude Scale

The behavior of a person in a situation could very well depend on what the situation means to the person. The measuring of "meaning" is undoubtedly a complex matter, but an attempt was made to assess the attitudes of subjects toward three concepts before and after the experiment. The concepts were mathematics, school, and the course used for the study

(Mathematics 111).

Osgood, et al. (1957) developed an attitude scale which is called a semantic differential. The attitude scale used in this study is a modified version of Osgood's semantic differential in that the theoretical explanation for the construction of the instrument was not followed. Essentially, the subjects in this study were provided with three concepts to be differentiated and a set of bipolar scales against which to do it. The task is to indicate for each item (pairing of a concept with a scale) the intensity and direction of association on a seven-step scale. One of the more important aspects of Osgood's method lies in the selection of the descriptive polar terms (adjectives) since direction from the origin and distance from the origin identifies with the quality and intensity of meaning.

The adjectives for the bipolar scales used in the instrument (see Appendix C) were selected from a study conducted by Osgood. In this study, approximately two-hundred undergraduate subjects were asked to write down after each stimulus noun the first descriptive adjective that occurred to them. An analysis of the study revealed that certain adjectives occurred more frequently regardless of stimulus words which had appeared. The purpose of the study was to set up a measuring instrument applicable to most people and concepts in general (Osgood, et al., 1957).

The instrument was administered immediately after the pre- and post-achievement test was given to each group.

The Sample

The subjects for this study were freshman students of Southern University in New Orleans who enrolled in Mathematics 111 for the spring semester of

1972. On enrollment day, two sections of Mathematics 111 were set aside for the study. The students enrolled in the usual manner but an effort was made to channel ten (10) students who were taking the course for the first time, ten (10) repeating, and ten (10) having had Mathematics 100 to each of the two sections.

The original experimental and control groups contained twenty-five (25) and twenty-six (26) students respectively, because of various rearrangements in class schedules. Due to absences on either the pre-test or the post-test or re-arrangements in course schedules, evaluations were conducted on sixteen (16) subjects in the experimental group and eleven (11) subjects in the control group. Each group contained about half male and half female subjects. A coin was flipped in order to determine which of the two groups would serve as experimental and control groups.

TABLE 1

MEANS AND STANDARD DEVIATIONS FOR SCORES ON CMPTCS

	Means	Range	Standard Deviations
Experimental (N=15)	2.53	-2 to 10	4.08
Control (N=13)	3.31	-2 to 9	3.35

Although the CMPTCS scores for all subjects were not available, Table 1 shows means and standard deviations for fifteen (15) subjects in the experimental group and thirteen (13) subjects in the control group. The scores in each group had a range from minus two (-2) to ten (10) and minus two (-2) to nine (9) respectively.

Data Collection

The before mentioned achievement test (see Appendix B) which was derived by the author from the unit objectives was given as the pre- and post-test for each group. Each item on the fifty-four (54) item test had a weighted value of one (1). The pre-test was given on the second class meeting and the post-test was given one week after the last unit of instruction for each group.

The achievement test was prepared by selecting items based on the specifically stated objectives of each unit. Mager's (1962) approach to stating objectives is also a means of providing identification of test items appropriate to the evaluation of the objective.

Since each item of unit tests was of the multiple-choice type, students who did not receive an "M" (mastery) grade were encouraged to visit with the instructor for a first analysis of the test. Those who did visit were then directed to one or more of the available aids as needed. A visit with the instructor was not a pre-requisite for using the other four (4) available resources. Therefore, the logs that were kept are indicators of resource usage throughout the period of the study.

CHAPTER IV

PRESENTATION AND ANALYSIS OF DATA

Pre-Test Data

Table 2 shows means and standard deviations on the pre-test scores for the two groups. As evidenced by this table, the experimental group entered at a slightly higher level than the control group.

TABLE 2

MEANS AND STANDARD DEVIATIONS ON PRE-TEST OF ACHIEVEMENT

	Experimental			Control		
	N	Mean	Standard Deviation	N	Mean	Standard Deviation
Had Mathematics 110	6	26.333	6.282	3	24.000	2.000
Repeating Mathematics 111	4	26.500	7.234	3	23.333	6.807
First Enrollment Mathematics 111	6	31.500	4.722	5	29.000	7.348

What is particularly interesting are the rather high standard deviations in most cells which indicates that there was a considerable degree of variability within each group as well as each cell.

Intra-Experimental Data

Although the members of the control group were not informed of the additional aids available, they were encouraged to visit with the instructor during office hours. Table 3 indicates special help sessions with the instructor throughout the experimental study as well as special sessions with the tutor.

TABLE 3

SPECIAL HELP SESSIONS

Number of sessions with individual experimental group members	5
Number of sessions with individual control group members	5
Total hours spent with experimental group members	1.75
Total hours spent with control group members	1.33
Total hours spent with tutor in special sessions	1.25

The results in Table 3 indicate a lack of motivation or perseverance by members of the experimental group. The extent to which the other aids were used leads to the same conclusion. Throughout the entire study only two persons visited the listening room of the library to hear a review of the audio tapes. Group sessions never did take place and the programmed text was never used.

Post-Test Data

Even though members of the experimental group did not use the available aids to any significant degree, their scores were somewhat higher on the post-test. Table 4 shows means and standard deviations for each group.

TABLE 4

MEANS AND STANDARD DEVIATIONS ON POST-TEST OF ACHIEVEMENT

	Experimental			Control		
	N	Mean	Standard Deviation	N	Mean	Standard Deviation
Had Mathematics 110	6	35.833	7.935	3	21.667	7.767
Repeating Mathematics 111	4	32.250	7.974	3	32.000	9.165
First Enrollment Mathematics 111	6	41.500	5.394	5	33.200	8.228

Since the standard deviations on the pre-test and the post-test for both groups are high, it appears that both groups maintained the same degree of variability, the major difference being the higher scores by members of the experimental group. An additional observation is that members of the experimental group who were enrolled in Mathematics 111 for the first time scored higher and the scores clustered closer around the mean.

Table 5 shows the results of the achievement post-test in a different form. Grades were assigned on the basis of 90% to 100%, A; 80% to 89%, B; 70% to 79%, C; 60% to 69%, D; below 60%, F.

TABLE 5

GRADE DISTRIBUTION FOR ACHIEVEMENT TEST

	Grade	Experimental	Control
Had Mathematics 110	A	0	0
	B	1	0
	C	2	0
	D	0	0
	F	3	3
Repeating Mathematics 111	A	0	0
	B	0	0
	C	1	1
	D	1	0
	F	2	2
First Enrollment Mathematics 111	A	0	0
	B	4	0
	C	1	2
	D	0	1
	F	1	2

Pre- vs. Post-Test Comparison

If subjects cannot be randomly assigned to experimental groups or experimental cells for factorial designs, they are considered intact groups. For intact groups with a pre-test-post-test control group design, an analysis of covariance with pre-test scores as the covariate is the preferable test of significance (Campbell and Stanly, 1963). Table 6 shows the results of the analysis of covariance produced from a program written by Elliot Cramer titled Program MANOVA.

TABLE 6

ANALYSIS OF COVARIANCE OF PRE-TEST AND POST-TEST ACHIEVEMENT SCORES

Source	SS	DF	MS	F	P Less Than
Within Cells	475.638	20	23.782		
B (Groups)	17.833	2	8.917	0.375	0.692
A (Experimental-Control)	180.032	1	180.032	7.570	0.012
BA	200.883	2	100.441	4.223	0.030

The results indicate significance due to the experimental condition (hypothesis one) but no significant difference in groups. The conclusion drawn here is that the instructional strategy did affect achievement at the end of the experimental period. Significance due to interaction indicates a unique combination of experimental effects with groups.

In order to test hypotheses two, three, and four, it was necessary to rearrange the data to perform a one-way analysis of covariance for each of the three groups. Tables 7, 8 and 9 indicate these results.

TABLE 7

ANALYSIS OF COVARIANCE--MATHEMATICS 110

Source	SS	DF	MS	F	P Less Than
Within Cells	285.783	6	47.631		
A	281.498	1	281.498	5.910	0.051

TABLE 8

ANALYSIS OF COVARIANCE--REPEATING MATHEMATICS 111

Source	SS	DF	MS	F	P Less Than
Within Cells	41.358	4	10.340		
A	17.682	1	17.682	1.710	0.261

TABLE 9

ANALYSIS OF COVARIANCE--FIRST ENROLLMENT MATHEMATICS 111

Source	SS	DF	MS	F	P Less Than
Within Cells	138.736	8	17.342		
A	93.278	1	93.278	5.379	0.049

As shown by the tables, the instructional strategy did affect achievement for those who were enrolled for the first time. It should be pointed out how close students enrolled in Mathematics 110 came to significance.

The scales of the attitude instrument were assigned a value of one through seven. Therefore, on each continuum, four was considered a neutral score. Scores to the left of the neutral point were considered positive towards the particular concept while those to the right were considered negative. Table 10 shows means and standard deviations of difference scores (post score minus pre score) for each group. Tables 11 and 12 indicate scores obtained for both groups.

TABLE 10

MEANS AND STANDARD DEVIATIONS OF DIFFERENCE SCORES ON ATTITUDE SCALE

	Experimental			Control		
Concepts	N	Mean	Standard Deviation	N	Mean	Standard Deviation
Mathematics	6	-7.31	5.47	3	-3.36	10.40
School	4	-2.25	7.99	3	-3.91	13.09
Mathematics 111	6	-7.25	12.87	5	-3.28	13.71

To test to see if the experimental group differed from the control group on attitude change (hypothesis 5), three independent sample t-tests were computed on the difference scores. For the concept of mathematics, $t = 1.1079$, $p > .05$. For the concept of school, $t = 0.4099$, $p > .05$. For the concept of Mathematics 111, $t = 0.7694$, $p > .05$. Thus, there was no significant difference on attitude change between the two groups.

Even though differential differences were not obtained between the two groups, both groups showed a more favorable attitude toward the concepts at the end of the study as indicated by the negative mean scores. It is also interesting to observe that for the experimental group, students having had Mathematics 110 and those enrolled in Mathematics 111 for the first time scored considerably higher (more favorable) than any of the others.

TABLE 11

ATTITUDE SCORES--EXPERIMENTAL GROUP

Post			Pre		
Mathematics	School	Mathematics 111	Mathematics	School	Mathematics 111
31	31	29	28	18	40
22	22	28	27	18	39
15	17	15	14	23	15
53	31	26	58	28	54
32	13	36	43	24	36
32	33	30	44	37	38
18	17	17	24	24	23
21	14	16	28	20	24
74	82	84	84	84	84
20	16	16	26	15	47
23	23	0	44	22	28
24	35	30	37	45	41
21	22	30	25	32	41
17	15	18	26	26	26
16	16	15	24	22	23
32	42	32	33	27	35

TABLE 12

ATTITUDE SCORES--CONTROL GROUP

Post			Pre		
Mathematics	School	Mathematics 111	Mathematics	School	Mathematics 111
14	17	12	28	21	19
22	12	18	39	48	48
18	20	27	23	19	25
21	24	17	17	26	16
29	29	29	36	39	37
41	42	41	36	43	48
22	17	24	31	24	31
62	37	52	61	27	47
19	21	16	29	32	31
63	15	73	43	12	48
13	26	12	18	12	14

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

This research was designed to investigate an instructional strategy for remedial Black college freshmen enrolled in a predominately Black institution. The period of the experimental study was the first eight weeks of the 1972 spring semester. The study was conducted at Southern University in New Orleans where a considerable number of freshman students are deficient in fundamental skills. Labeling Bloom's Mastery Learning technique (with modification) as Instructional Strategy A and traditional instruction methods as Instructional Strategy B, the design was chosen in order to test the following four hypotheses:

Hypothesis 1: There is no difference in level of achievement in Mathematics 111 between Instructional Strategy A and Instructional Strategy B.

Hypothesis 2: There is no difference in level of achievement in Mathematics 111 between Instructional Strategy A and Instructional Strategy B when subjects have had Mathematics 110 prior to Mathematics 111.

Hypothesis 3: There is no difference in level of achievement in Mathematics 111 between Instructional Strategy A and Instructional Strategy B when subjects are repeating Mathematics 111.

Hypothesis 4: There is no difference in level of achievement in Mathematics 111 between Instructional Strategy A and Instructional Strategy B when subjects are enrolled in Mathematics 111 for the first time.

Hypothesis 5: There is no difference in the change of attitude toward mathematics, school and Mathematics 111 between Instructional Strategy A and Instructional Strategy B.

Members of the experimental group were given a set of specific objectives for each of the seven units of instruction. Diagnostic tests were given to members of the experimental group to indicate progress towards mastering the objectives. Lectures for this group were audio-taped and classroom instruction involved extensive use of an overhead projector. An upper classman served as a tutor to assist in correcting deficiencies.

An achievement test and attitude scale were used to compare the two groups at the end of the experiment. Items for the achievement test were taken from the specifically stated objectives.

Conclusions

The results presented in the preceding chapter fail to support hypotheses 1 and 4. Since the scores on the achievement test were much higher for those students enrolled in Mathematics 111 for the first time, the instructional strategy seems more significant with respect to this group. While hypothesis 2 testing the Developmental Studies Program prior exposure indicated no significance at the .05 level, the probability was so close to .05 as to suggest that the technique may be useful for this group.

The fact that no significance was found when testing hypothesis 3 supports the hypothesis. Perhaps in interpreting the results, it could be said that there was a total lack of motivation since the subjects were repeating the course.

The lack of voluntary use of the available aids by the students in the experimental group is in conflict with many similar studies that have been conducted. However, since many of the students attending this institution are employed full-time, this may have produced very little opportunity.

The scores on the attitude scale for both groups were particularly interesting. Since there was an overall shift to favorable attitudes for both groups at the end of the experiment, the investigator feels that there was a lack of serious response by the subjects. At any rate, the tests for significances supports hypothesis 5.

Recommendations

There is a tremendous need for the improvement of techniques of instruction in schools where there is a concentration of underprivileged students. If more efforts were devoted to the lower grades, there would probably not be a need for methods similar to this investigation at the college level.

While conducting this study, there was considerable evidence of reading difficulties among the students. A strategy of this nature would certainly serve to help eliminate deficiencies in this area regardless of grade level.

This study should be replicated. More than this, it should be replicated at a minimum of a one semester course.

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APPENDIX A

OBJECTIVES

Unit I

Remark:

The objectives in this unit should be accomplished without the use of the textbook or any other aids.

1. To identify the definition of a set
2. To list the numbers of a set if the set has been specified
3. To identify equal sets
4. To identify a subset or subsets of a given set
5. To list all subsets of a given set
6. To identify proper subsets of a given set
7. To identify empty sets
8. To identify the intersection of two sets
9. To identify the union of two sets
10. To identify disjoint sets
11. To identify the set of natural numbers
12. To identify the uniqueness property of addition of natural numbers
13. To identify the commutative property of addition of the natural numbers
14. To identify the associative property of addition of the natural numbers
15. To identify the uniqueness property of multiplication of natural numbers

Unit I Cont.

16. To identify the commutative property of multiplication of natural numbers
17. To identify the associative property of multiplication of natural numbers
18. To identify the first either prime natural numbers
19. To write a natural number factored completely
20. To differentiate between even natural numbers and odd natural numbers
21. To identify the distributive property of natural numbers
22. To write a product of the form (a + b) (c + d) by the use of the distributive property of natural numbers.

OBJECTIVES

Unit II

Remark:

The objectives in this unit should be accomplished without the use of the textbook or any other aids.

1. To identify a variable
2. To identify universal sets
3. To identify algebraic expressions
4. To identify terms in an algebraic expression
5. To identify coefficients in algebraic expressions
6. To write algebraic expressions simplified by combining like terms
7. To identify monomials, binomials, trinomials, and multinomials
8. To factor and expand simple algebraic expressions
9. To translate given sentences into algebraic equations
10. To identify the divisor, dividend and the quotient in simple division problems
11. To divide whole numbers
12. To identify exponents and the significance of exponents
13. To identify that the operations of addition is <u>closed</u> under the set of natural numbers but not the operations of subtraction and division

OBJECTIVES

Unit III

Remark:

The objectives in this unit should be mastered without the use of the textbook or any other aids.

1. To identify an order relation in the set of natural numbers
2. To identify order properties in the set of natural numbers
3. To write the numbers for numerals in base systems other than base ten
4. To add in the binary numeral system
5. To multiply in binary numeral system
6. To identify what constitutes a number system by writing the properties of such a system

OBJECTIVES

Unit IV

Remark:

The objectives of this unit should be mastered without the use of the textbook or any other aids.

1. To identify open sentences
2. To unite the solution set for open sentences
3. To identify the set of negative integers
4. To identify the set I of integers
5. To write the absolute value definition
6. To illustrate by writing the addition and multiplication of integers

OBJECTIVES

Unit V

Remark:

The objectives of this unit should be mastered without the use of textbook or any other aids.

1. To illustrate by writing the difference and quotient of integers
2. To write the solution of the sentence of the type "-3 < x and x < 5" in the universe I and the universe N or some other specified universe
3. To write the solution of the sentence of the type "x > 3 or x < -2" in the universe I and the universe N or some other specified universe
4. To write the solution of the sentence of the type "x 6 or x = 9" in some specified universe
5. To write the properties of the set of integers

OBJECTIVES

Unit VI

Remark:

The objectives of this unit should be mastered without the use of the textbook or any other aids.

1. To identify the numerator and denominator in the fraction $\frac{a}{b}$ if a and b are integers and $b \neq 0$
2. To identify and write equivalent fractions of the form $\frac{a}{b} = \frac{c}{d}$ if and only if $ad = bc$
3. To write rational numbers in lowest form
4. To write the least common multiple of two or more integers
5. To add rational numbers
6. To multiply rational numbers
7. To add mixed numbers
8. To multiply mixed numbers

OBJECTIVES

Unit VII

Remark:

The objectives of this unit should be mastered without the use of the textbook or any other aids.

1. To subtract rational numbers
2. To divide rational numbers
3. To perform operations of addition, subtraction, multiplication, and division on algebraic expressions in rational forms

APPENDIX B

ACHIEVEMENT TEST

Name ______________________________ Date ______________________

Section ____________________

Directions:

An item may have more than one response which appears correct. You are to choose by <u>circling</u> the <u>best</u> response.

1. The word "set" in mathematics is synonymous with

    1. Collection
    2. Aggregate
    3. Class
    4. All of these

2. We generally use ________ to indicate a set.

    1. brackets
    2. parentheses
    3. braces
    4. quotation marks

3. Two sets are said to be equal if they contain

    1. the same number of elements.
    2. the same elements.
    3. different elements but the same number.
    4. either (1) or (2).

4. If A = {a, b, c} and B = {a, b} then,

    1. $A \subseteq B$
    2. $B \subseteq A$
    3. $A \nsubseteq B$
    4. $B \nsubseteq A$

5. The number of subsets of A = {1, 2, 3} are

    1. 3, since there are three elements in set A.
    2. 5.
    3. 8.
    4. 9.

6. If $A \subseteq B$ and $B \subseteq A$, then

    1. A equals B.
    2. B equals A.
    3. A not equal to B.
    4. 1 and 2.

7. The set of natural numbers may be

    1. {0, 1, 2, 3, ...} .
    2. {. . . -3, -2, -1, 0, 1, 2, 3, ...} .
    3. {1, 2, 3, ...} .
    4. None of these.

8. The empty set may be denoted as

    1. {0}
    2. { }
    3. $0\!\!\!\backslash$
    4. $\emptyset$
    5. 2 or 4

9. $\{1, 2, 3, 4\} \cup \{2, 3, 5\} =$

    1. {2, 3, 5}
    2. $\emptyset$
    3. {1, 2, 3, 4}
    4. {1, 2, 3, 4, 5}

10. If A is the set of distinct letters found in the word western, and B is the set of distinct letters found the the word west, then $A \cap B$ is

    1. {w, e, s, t, e, r, n}.
    2. {e, s, t}.
    3. {w, e, s, t}.
    4. None of these.

11. For any natural numbers a, b, $a \cdot b = b \cdot a$ indicates

    1. uniqueness of multiplication.
    2. nothing unless we know the values for a and b.
    3. associatively.
    4. commutativity.

12. If n is any natural number, then 2n is

    1. odd.
    2. even.
    3. may be odd or even depending on the value of n.
    4. none of these.

13. If $X = \{15, 17, 21, 45, 39, 42\}$, the number of prime numbers in X are

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

14. $\{a\} \varepsilon a$ is

    1. true.
    2. sometimes true.
    3. false.
    4. sometimes false.

15. For any natural numbers a, b, c, $a \cdot (b+c) = a \cdot b + a \cdot c$ indicates

    1. associative property.
    2. commutativity.
    3. distributive property.
    4. none of these.

16. For all natural numbers a and b, $(a+b)(a+b) = aa + 2ab + bb$ can be proved by using

    1. the commutative property only.
    2. the distributive property only.
    3. the commutative property and the distributive property.
    4. the replacement property, the commutative property and the distributive property.

17. A ___________ is a symbol that represents any member of a given set.

    1. constant
    2. number
    3. variable
    4. coefficient

18. The terms $2a + 3a$ are said to be __________ terms.

    1. constant
    2. like
    3. unlike
    4. similar

19. $4a + 3a = 7a$ by the

    1. associative property.
    2. distributive property.
    3. commutative property.
    4. definition of mathematics.

20. A sum of two or more terms in algebra is called a

    1. monomial.
    2. binomial.
    3. multinomial.
    4. trinomial.

21. The perimeter of a triangle with sides of length 4x, 3x, and 6x is

    1. $72x^3$.
    2. 13x.
    3. $13x^3$.
    4. impossible to determine unless we know the values of x.

22. The expression 3abc has

    1. 4 terms.
    2. 3 terms.
    3. 2 terms.
    4. 1 term.

23. In the expression (5 + 6)x, the coefficient is

    1. 5.
    2. 5 and 6.
    3. 6.
    4. 11.

24. In algebra, expressing a sum as a product is called

    1. factoring.
    2. expanding.
    3. combining.
    4. none of these.

25. The coefficient in the expression $3x^2$ is

    1. 2.
    2. x.
    3. 6.
    4. 3.

26. If a is any number, then a^0 equals

    1. 0.
    2. 1.
    3. -1.
    4. none of these.

27. In the expression a^n, a is called the

    1. exponent.
    2. power.
    3. base.
    4. root.

28. The sum 7by + 21bx may be factored to give the product

    1. $b(7y + 21x)$.
    2. $y(by + 3x)$.
    3. $7b(y + 3x)$.
    4. $(y + 3x)\ 7$.

29. The expression $xy + 3x + 2y + 6$ may be written as:

    1. $(x + 3)(y + 2)$.
    2. $(x + 2(y + 3)$.
    3. $(2x + 3)(y + 2)$.
    4. $(2y + 2)(x + 3)$.

30. If $a = 2$ and $b = 3$, the value for the expression $a(a + b) + 3$ is

    1. 13.
    2. 31.
    3. 16.
    4. none of these.

31. Assuming that a and b are natural numbers, which of the following expressions always represents a natural number: $a + b$; $a - b$; ab; $a \div b$?

    1. $a + b$.
    2. $a - b$ and $a \div b$.
    3. ab.
    4. ab and $a - b$.
    5. $a + b$ and ab.

32. Simplify the expression $2a^3 + a^2 + a + 4a^2$ by combining like terms.

    1. $a(2a^2 + a + 1 + 4a)$
    2. $a(2a^2 + 5a + 1)$
    3. $2a^3 + 5a^2 + a$
    4. $(2a^3 + a^2) + (4a^2 + a)$

33. $(9 - 4)^3 - 2$ ____________ $9 - (4 - 2)$.

    1. $=$
    2. $>$
    3. $<$
    4. $\neq$
    5. (3) or (4)

34. $(6 + 4) \cdot 5 - (8 \div 4) \div 4 =$

1. 74.
2. 50.
3. 47.
4. 40.

35. $(19xy + 4xyz) - (15xy + xyz) =$

1. $4xy - 3xyz$.
2. $-4xy + 3xyz$.
3. $4xy + 3xyz$.
4. $-4xy - 3xyz$.

36. For any natural numbers a, b, and c, if $a > b$, then $ac > bc$ is

1. true always.
2. false always.
3. true if c is greater than one.
4. true if the value for a, b, and c are large.

37. Four thousands + eight hundreds + 5 tens + 6 ones is the same as

1. 48,560.
2. 4,856.
3. 4.586.
4. .4586.

38. One (1) may be written as

1. 1^0.
2. 10^0.
3. 3^0.
4. all of these.

39. Given the numeral 243_5 in a base-five system, the numeral in the base-ten system that represents the same number is:

1. 37.
2. 73.
3. 3.7.
4. 7.3.

40. If the set S is a number system and there exist a member $e \varepsilon S$ with the property that for any $a \varepsilon S$, $a \cdot e = e \cdot a = a$, then

1. e is the identity element under multiplication.
2. a is the identity element under multiplication.
3. a and e serve as identity elements under multiplication.
4. $e = a$.

41. Given N is the set of natural numbers, then the solution set for $\{x \varepsilon N | 3x < 12\}$ is

    1. $\{0, 1, 2, 3\}$.
    2. $\{1, 2, 3\}$.
    3. $\{1, 2, 3, \ldots\}$.
    4. none of these.

42. Given N is the set of natural numbers and $a \varepsilon N$, the solution set for $\{x \varepsilon N | x + a = a\}$ is

    1. zero.
    2. $\{0\}$.
    3. $\emptyset$.
    4. N.

43. Given that A is the set of integers greater than -4,

    1. $0 \varepsilon A$.
    2. $-5 \varepsilon A$.
    3. $-3 \varepsilon A$.
    4. (1) and (3).

44. The $|-6|$ is

    1. less than the $|6|$.
    2. greater than the $|6|$.
    3. equal to the $|6|$.
    4. less than the $|-5|$.

45. $(-3) + 0 =$

    1. 3.
    2. (-3).
    3. -(-3).
    4. -(3).

46. If a = 2, b = -3 and e = -4, then $a^2 + b^2 + c^2$ equals

    1. 29.
    2. -29.
    3. -(-29).
    4. -(+29).

47. $(-a)0 =$

    1. (-a).
    2. a.
    3. 0.
    4. none of these.

48. $(-3)(-5) - (-2)(-5) =$

    1. 5.
    2. 25.
    3. (-25).
    4. -(-25).

49. $|-3|-|-3| =$

    1. 0.
    2. (-3).
    3. -(-3).
    4. 3.

50. One important distinction between the set I of integers and the set N of natural numbers is that the set I has

    1. an inverse for each $a \varepsilon I$.
    2. an identify element.
    3. many more subsets.
    4. a multiplicative inverse.

51. The sentence "a < x < b" means

    1. "a < x or x < b"
    2. "x may have any value"
    3. "a < x and x < b"
    4. none of these.

52. $\frac{9}{-27}$ expressed in lowest terms is

    1. $\frac{1}{3}$
    2. $\frac{1}{-3}$
    3. $\frac{-(-1)}{3}$
    4. $\frac{-1}{3}$

53. $\frac{a}{x+y} + \frac{b}{x+y} =$ Note: letter symbols represent positive integers

    1. $\frac{a\ b}{x+y}$
    2. $\frac{a+b}{a(x+y)}$
    3. $\frac{a+b}{x+y}$
    4. $\frac{a+b}{2x+y}$

54. $\frac{1}{a} + \frac{3}{ab} + \frac{2}{b} =$ Note: letter symbols represent positive integers

1. $\frac{6}{ab}$

2. $\frac{6}{a^2b^2}$

3. $\frac{6}{a^2b}$

4. None of these

APPENDIX C

ATTITUDE SCALE

Instructions

The purpose of this study is to measure the meanings of certain things to various people by having them judge them against a series of descriptive scales. In taking this test, please make your judgments on the basis of what these things mean to you. On each page of this booklet you will find a different concept to be judged and beneath it a set of scales. You are to rate the concept on each of these scales in order.

Here is how you are to use these scales:

If you feel that the concept at the top of the page is very closely related to one end of the scale, you should place your check-mark as follows:

fair _X_:___:___:___:___:___:___ unfair

or

fair ___:___:___:___:___:___:_X_ unfair

If you feel that the concept is quite closely related to one or the other end of the scale (but not extremely, you should place your check-mark as follows:

strong ___:_X_:___:___:___:___:___ weak

or

strong ___:___:___:___:___:_X_:___ weak

If the concept seems only slightly related to one side as opposed to the other side (but is not really neutral), then you should check as follows:

active ____:____:__X_:____:____:____:____ passive

or

active ____:____:____:____:_X__:____:____ passive

The direction toward which you check, of course, depends upon which of the two ends of the scale seem most characteristic of the thing you're judging. If you consider the concept to be neutral on the scale, both sides of the scale equally associated with the concept, or if the scale is completely irrelevant, unrelated to the concept, when you should place your check-mark in the middle space:

safe ____:____:____:__X_:____:____:____ dangerous

IMPORTANT: (1) Place your check-marks in the middle of spaces, not on the boundaries:

This Not This

____:____:____:__X_:____X____:____

(2) Be sure you check every scale for every concept--do not omit any.

(3) Never put more than one check-mark on a single scale.

Do not look back and forth through the items. Do not try to remember how you checked similar items earlier in the test. Make each item a separate and independent judgment. Work at fairly high speed through this test. Do not worry or puzzle over individual items. It is your first impressions, not immediate "feelings" about the items, that we want. On the other hand, please do not be careless, because we want your true impressions.

Mathematics

valuable ___:___:___:___:___:___:___ worthless

strong ___:___:___:___:___:___:___ weak

pleasant ___:___:___:___:___:___:___ unpleasant

sharp ___:___:___:___:___:___:___ dull

heavy ___:___:___:___:___:___:___ light

fair ___:___:___:___:___:___:___ unfair

fast ___:___:___:___:___:___:___ slow

deep ___:___:___:___:___:___:___ shallow

active ___:___:___:___:___:___:___ passive

nice ___:___:___:___:___:___:___ awful

beautiful ___:___:___:___:___:___:___ ugly

good ___:___:___:___:___:___:___ bad

School

valuable	___:___:___:___:___:___:___	worthless
strong	___:___:___:___:___:___:___	weak
pleasnat	___:___:___:___:___:___:___	unpleasant
sharp	___:___:___:___:___:___:___	dull
heavy	___:___:___:___:___:___:___	light
fair	___:___:___:___:___:___:___	unfair
fast	___:___:___:___:___:___:___	slow
deep	___:___:___:___:___:___:___	shallow
active	___:___:___:___:___:___:___	passive
nice	___:___:___:___:___:___:___	awful
beautiful	___:___:___:___:___:___:___	ugly
good	___:___:___:___:___:___:___	bad

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valuable	____:____:____:____:____:____:____	worthless
strong	____:____:____:____:____:____:____	weak
pleasant	____:____:____:____:____:____:____	unpleasant
sharp	____:____:____:____:____:____:____	dull
heavy	____:____:____:____:____:____:____	light
fair	____:____:____:____:____:____:____	unfair
fast	____:____:____:____:____:____:____	slow
deep	____:____:____:____:____:____:____	shallow
active	____:____:____:____:____:____:____	passive
nice	____:____:____:____:____:____:____	awful
beautiful	____:____:____:____:____:____:____	ugly
good	____:____:____:____:____:____:____	bad