DOCUMENT RESUME

ED 046 034 24 CG 006 114

AUTHOR	Nelson, Dennis E.; Jones, G. Brian
TITLE	Effects of Contingency Management and Quasi-Individualized Instruction on Academic Performance and Attitudes. Final Report.
INSTITUTION	American Institutes for Research in the Behavioral Sciences, Palo Alto, Calif.
SPONS AGENCY	Office of Education (DHEW), Washington, D.C.
BUREAU NO	BR-0-T-004
PUB DATE	Nov 70
GRANT	OEG-0-9-140004-0024(057)
NOTE	124p.
EDRS PRICE	EDRS Price MF-$0.65 HC-$6.58
DESCRIPTORS	*Academic Achievement, Attitudes, *Changing Attitudes, Culturally Disadvantaged, *Disadvantaged Youth, Educational Change, *Individualized Instruction, Instructional Innovation, *Instructional Programs, Student Improvement, Teaching Methods

ABSTRACT

This study postulated that if contingency management techniques were used to supplement an instructional system in which efforts toward individualization were being made, disadvantaged students would be influenced to produce more, and a higher quality of, academic behaviors and more favorable attitudes toward academically relevant concepts than would be produced by that instructional system alone or by conventional instruction. This report describes this study in terms of: (1) the problem and research strategy, including background and research techniques; (2) the experimental design and procedures, including treatment conditions, criterion instruments, and data collection; (3) results and discussion, including hypotheses on experimental versus control subjects, subjects "on" versus subjects "off" contingency management and individualized instruction versus control subjects, and subjects "on" versus subjects "off" contingency management; and (4) summary, conclusions, and implications. (Author/FM)

AIR-833-11/70-FR

BR 9-E-004
PA 24

ED 046034

FINAL REPORT

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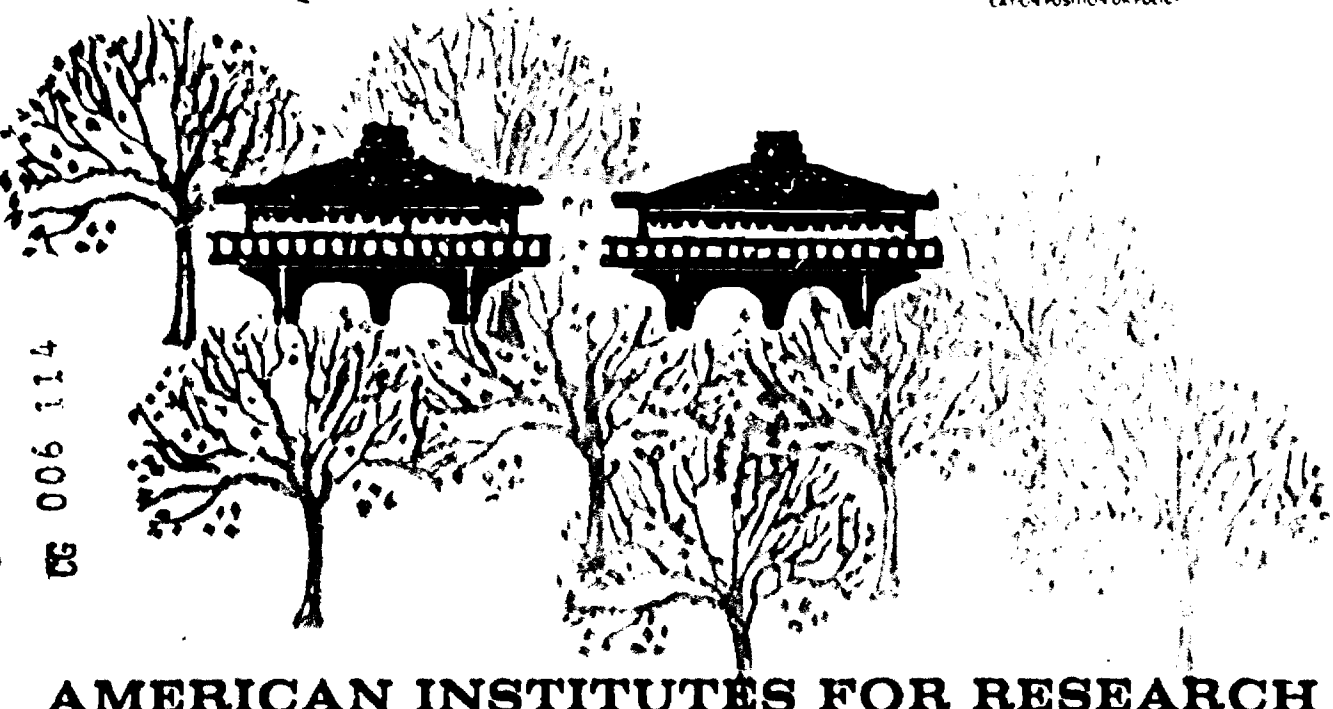
November 1970



OE 006 114

AMERICAN INSTITUTES FOR RESEARCH
Post Office Box 1113 / Palo Alto, California 94302

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AIR-833-11/70-FR

ED 046034

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Dennis E. Nelson

G. Brian Jones

American Institutes for Research
in the Behavioral Sciences

Palo Alto, California

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The project reported herein was performed pursuant to a grant from the U.S. Office of Education, Department of Health, Education, and Welfare. The opinions expressed, however, do not necessarily reflect the position or policy of the U.S. Office of Education, and no official endorsement by the U.S. Office of Education should be inferred.

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ACKNOWLEDGEMENTS

Several individuals and groups have contributed in a significant manner to the undertaking and successful completion of the research reported here. Gratitude is due the Region IX Office of Education in San Francisco, especially to Dr. Walter Hirsch and Mr. John Thorslev who particularly merit mention for the close cooperation they gave in working out needed modifications in the original proposal. These changes were necessary when difficulties were encountered in locating a suitable research site and in monitoring the carrying out of the proposed research.

Dr. Calvin D. Catterall, Coordinator, Counseling and Psychological Services for the Santa Clara Unified School District, and Mr. Charles Ackerman, Principal of Juan Cabrillo Intermediate School, proved to be innovative and extremely cooperative administrators who were more than willing to become involved in experimental activities, who provided an atmosphere where research could be carried out, and who gave time, effort, and resources in support of the project. Likewise, Mr. Herman Neufeld, the instructor of the two seventh-grade mathematics classes containing the experimental subjects, volunteered many hours in addition to his normal teaching schedule in order to solve various operational problems which confronted the study from time to time. Other school staff who receive our sincere acknowledgements include the two counselors at Cabrillo, Mr. William Schuster, and Mrs. Alice Falconer who were enthusiastic in their acceptance and support of the project, and Mr. Ronald Rodvald who served as the instructor of the two control classes after volunteering his classes as control participants and who adapted his instructional plans to project impositions on student time.

Additionally, the work of Mr. Harvey Low, who served as the student consultant in the activity area and as confidant of several of the students, was appreciated. Although not a member of the Cabrillo school staff, he was a valuable member of the A.I.R. staff for this particular project and he was characterized by his

ability to relate both to the students and to the school staff.

Encouragement, intellectual stimulation, and criticism as well as facilities and services necessary to accomplish the efforts which are summarized in this report were provided by the American Institutes for Research's Palo Alto office staff. Providing strong leadership and support as always was Dr. John C. Flanagan, Office Director. Other team members of the Guidance Research Program including Dr. Jack A. Hamilton and Mrs. Laurie B. Ganschow provided ideas and ready assistance in moments of crisis. Mrs. Frieda W. Barlogi, that program's administrative associate, along with Miss Luella B. Austin skillfully created a legible document from numerous drafts and revisions.

CHAPTER I

THE PROBLEM AND RESEARCH STRATEGY

THE PROBLEM

Background

Human learning has perhaps received more attention in psychological research than any other facet of behavior. How people learn, differences in the ease with which various kinds of material are learned, and attempts to stimulate people to learn faster or more efficiently are only some of the hundreds of areas of concern in this field of investigation. In an authoritative survey of learning theories and research, Bower (1966) has made the rather unabashed assertion that the law of reinforcement, or as it is sometimes referred to, the law of effect, "is the most important principle in all learning theory (p. 481)." This "law" presents a rule for shaping and cultivating specified behaviors and states that any learnable response which is followed by a reinforcing stimulus or event will be more likely to recur in the future. The terms "reinforce " and "reward" have often been used interchangeably and the withdrawal of a punishing state of affairs (negative reinforcement) or the non-conferral of a punishment have also been seen as rewarding to the learner. Thus, several kinds of events have been seen as reinforcing. The specific nature of reinforcing stimuli and reinforced responses and their intereactions have been subjected to a vast amount of both applied and basic research concerning the use of rewards and punishment in animal and human learning.

The theoretical issues surrounding the law of reinforcement surprisingly have not been numerous and complex in nature, and have ranged from those issues which assert that the definition of a reinforcer (i.e., anything following a response which strengthens that response) is circular and contributes nothing (Meehl, 1950), to questions about just what a reward is and whether

reinforcers are absolute or relative in their effects. On the latter issue those who take the absolute position dichotomize all stimuli as being either reinforcing or non-reinforcing while learning researchers who hold the relativity view (cf. Premack, 1959) hold that a particular stimulus or event may reinforce some responses while not reinforcing others. Many of these longstanding issues are still unresolved.

Hilgard and Bower (1966) assert that a major trend in non-applied learning research has been a shift away from settling theoretical controversies through the generation of supposedly comprehensive theories of learning, and toward investigations of highly specific hypotheses focusing on a more limited range of behavioral phenomena. Parallel to this shift, research on learning has become more applied than was previously the case. Whether concerned with the acquisition of language by retarded children, reading programs for the disadvantaged, or training programs in complex skills for industrial personnel, these efforts invariably have practical and rather immediate outcomes for educational problems.

As a major part of this trend toward the resolution of practical problems, recent developments in human learning technology, including those connected with programmed instruction and computer application in learning programs, have contributed to the coining of the phrase "behavioral engineering." This term has been applied to many of the efforts designed to bring the knowledge and methodology of available human learning research to bear on realistic problems in industrial, military, and public and private school settings. Theoretical concerns aside, there is ample data to warrant the observation that behavioral engineering has resulted in substantial progress toward the solution of such practical problems (Ulrich, et al, 1966). Much of this work apparently has proceeded quite successfully without becoming embroiled in still unsolved theoretical issues involving human learning. A primary concern of this new breed of technologist

has been to develop methods and techniques for the shaping and control of behavior. Much of the resultant effort has been associated with applications of reinforcement notions based on either the classical or operant conditioning theoretical models of learning.

An Important Problem

Those technologists who have been exploring and validating new approaches for shaping and controlling behavior have focused much attention on educational institutions ranging from public school classrooms, to special institutional groups of students with abnormal mental or physical characteristics, and to job training and correctional facilities. A prominent portion of such efforts in education has been directed at a student population identified by rubrics such as "culturally deprived," "disadvantaged," or "handicapped." Descriptions of such students and their backgrounds can be found in several sources (e.g., Bloom, et al, 1965; Gordon, 1965). There does appear to be some agreement that one of the major barriers in these children's attainment of an adequate education is their apparent lack of "motivation" to learn, -i.e., to see achievement and academic behaviors as important and desirable, and to put forth consistent effort to exhibit them. Thus the technologist's task has become one of finding effective ways to elicit academic behaviors from these students and subsequently to increase the quantity and quality of their responses. The problem they have been investigating then has centered on overcoming the lack of academic motivation reported for a variety of students, particularly those found in low ability and low socioeconomic groups.

Most techniques or programs attempting to promote successful academic behaviors among "deprived" students face their greatest challenge when used with the very students they desire to help the most. So it is with most programs which attempt to individualize education. At least two major

assumptions of these programs are questionable in low and low-middle socio-economic milieus:

(1) If instructional experiences are developed and sequenced according to the characteristics of a particular student, he will complete the instructional process successfully.

(2) Having experienced success, the student will be stimulated to continue the behavior which produced the initial success.

Several ideas argue against such a smooth flow of events. In spite of the careful construction of learning methods and materials, initial success might never occur due to students' lack of effort; therefore potentially successful academic behaviors might never be exhibited. Even if exhibited in some quantity, academic behaviors might not be valued by these students and might be openly discouraged by other members of their culture.

Then again, even if these students have initial successful experiences, these might not be perceived as successful or as satisfying by such students. Given the background, previous learning history, and current reward system in the daily lives of these students, it should not be assumed that even if they had successful initial experiences in an academic activity that these would be perceived as successful. Neither can it be assumed that if these experiences were perceived as successful, that this would be sufficient stimulus to insure maintenance of appropriate learning behaviors in subsequent activities. Many disadvantaged students have not learned that successful academic activities can be perceived as rewarding and desirable. Additionally, these students often are predominantly "here and now" oriented and frequently do not possess abilities to delay gratification over an extended time such as is typically required in most conventional educational programs. For them, any rewards which accrue from academic activities are seldom tangible or immediate.

Orientation for the Current Study

Implications of recent work in the experimental analysis of behavior suggest that the students' self-defeating and unproductive behaviors are maintained by some form of reinforcement or reward from the environment. The groundwork for such implications was laid by the classic work of Skinner on operant conditioning procedures (Skinner, 1953; Skinner and Holland, 1961) and by the application of this work to a variety of human problem areas through studies which have been well sampled by Krasner and Ullman (1965) and Ullman and Krasner (1965). Such studies suggest that if reinforcement contingencies influencing student performance could be controlled and manipulated, behaviors which are inhibiting students from developing their potentials could go unrewarded and could be replaced through the acquisition and subsequent exhibition of more productive behaviors which will be maintained if they are sufficiently rewarded. If one accepts the assumptions basic to such studies, then Homme (1965) was correct in simplifying the solution to the problem of eliciting specified behaviors by postulating that the basic question to be considered is: "What reinforcers are available?" To this one might add the companion question of: "How does one decide in advance which, if any, reinforcers are sufficiently powerful to bring about a desired behavior change?"

Premack (1965) made a significant contribution to the practical utility of the reinforcement law and to the solution of the second question noted above by asserting that if one were to rank the preferred order of each of the activities or stimuli available to an organism, any particular event or activity could be used as reinforcement for activities or stimuli which were ranked lower than it was. This is the fundamental principle applied in the use of contingency management procedures. For example, if four available activities were ranked by a student in their order of preference for him, it could be predicted that the second activity would reinforce the third and fourth activities but not the first activity.

In other words, if a student were more likely to emit TV watching than study behavior under given circumstances, Premack's principle stipulated that by making the former behavior contingent on the latter a behavior manager will tend to increase the performance probability of study behaviors.

Applications of this approach as summarized by Premack (1963) have generally proven successful. More recently studies have been undertaken in which teacher behaviors such as attention, praise and proximity have successfully been made contingent upon positive social behaviors in the case of preschool children (Allen, et al, 1964). Similarly, Hawkins, et al, (1966) successfully trained mothers to use a form of contingency management to modify the demanding and aggressive behaviors of their children. In fact, Homme (1965) has gone beyond such attempts at influencing manifest performance and has even proposed that the technique be extended to thoughts and mental events by assuming that "private events" follow the same laws of influence and control as do public events or overt behaviors.

While applications of contingency management in controlling outwardly disruptive or socially deviant behaviors can be well documented, examples of experimental investigations utilizing the technique to increase the quantity and quality of specified academic behaviors are less available. Homme, et al (1963) increased certain academic behaviors in middle class preschoolers and in adolescent delinquents (Homme, 1964). Hall, Lund, and Jackson (1968) employed the technique to increase study behaviors as well as to eliminate disruptive behaviors among first- and third-grade students. Attention from the teacher was made contingent upon study behaviors. This study had the added value that it was carried out in a normal classroom and among students classifiable as culturally deprived or disadvantaged. However, on only six students from a total of two classrooms were the effects of this technique studied.

A major obstacle in the application of contingency management techniques is the assessment of each stimulus event's value for each individual to whom the procedures will be applied. Premack (1959) proposed a solution by suggesting the use of response rate in what is referred to as a "free operant" situation. That is, make a wide variety of activities and stimulation freely available to the individual and then, ascertain the frequency and duration with which each activity is selected and pursued. This approach provides an indication of each reinforcing event's desirability for that person. A less acceptable but still useful approach, especially with a range of activities well known to the individuals involved, is to record the individual's verbal reactions regarding his order of preference among several potentially reinforcing events. The problem with this approach is that the individual might be unaware of, or have had limited previous exposure to, some events which would in actuality be reinforcing to him.

Contingency management procedures offer unique advantages in culturally disadvantaged settings such as in those described in the previous section. When such procedures are applied, the students are made aware of available rewards which are both tangible and immediate. In this study it was postulated that by using contingency management techniques to supplement an instructional system where efforts toward individualization are being made, this combination would influence students to produce more, and a higher quality of, academic behavior and more favorable attitudes than would be produced by that instructional system alone. To investigate this postulate, an experimental design was needed which permitted exploration of the efficacy of contingency management for improving students' academic performance.

THIS STUDY'S RESEARCH STRATEGY

Research Purpose and Experimental Techniques

Though several alternate approaches based on learning research findings could have been employed as potential solutions to the problem of finding ways to increase the quantity and quality of student academic performance, the research reported here used a technique based on Premack's notions of concentrating on the availability of reinforcers in the environment. Homme (1967) referred to the application of techniques based on Premack's notions as "a critical bit of technology called contingency management." In addition, he observed that contingency management and operant conditioning were not the same thing, rather the former was derived from the latter. The major advantage of contingency management is embodied in the distinction that it can be effectively used by individuals who in daily life must deal with a large number of tasks, who very much need a way of gaining some control over selected portions of these tasks, and who have neither the time nor perhaps the inclination to become knowledgeable in the theory and skillful in the methodology of operant conditioning. The essence of contingency management is captured in the following statement made to the student: "execute some amount of low probability behavior; then you may immediately engage in some high probability behavior for a specified time" (Homme, undated, pp. 3-4). Small but definite contracts can be arranged between each student and the contingency manager. The fulfillment of each contract must be followed quickly by a reinforcing experience.

The particular application of this technique as explored in this investigation involved having students select activities which they believed were reinforcing to them and subsequently permitting them to earn time which they could use in those activities after fulfilling specific contracts for academic behaviors. The design

used in this investigation attempted to study the impact of this technique in settings which fulfilled all of the following criteria since no previous study had satisfied all, or even most, of these constraints:

(1) to involve substantial numbers of students;

(2) to be conducted within the context of a regular classroom as opposed to within a special education classroom or an institution;

(3) To be implemented with students from a wide range of ability and socioeconomic levels, especially students at and below middle levels;

(4) to include students at age levels above the primary grades;

(5) to employ experimental treatment reversals in order to test the impact of the contingency management technique both when it was presented to each experimental subject and it was removed from him; and

(6) to focus on the increase of students' quantity and quality of academic performance as well as the nature and degree of their attitude changes.

This investigation was designed to explore the advantages of pairing contingency management techniques with a preliminary attempt to individualize instruction in order to bring about positive changes in students' academic behaviors and attitudes. The effectiveness of this pairing and of each of the two components themselves was evaluated. In order to explain why individualized instruction was also studied, a brief description of the development of a related prototype of an individualized educational system is presented in the next section. From this next section, it should be clear why a pairing of these two components made a more valuable contribution to knowledge than would have been made if contingency management and a more conventional approach to instruction had been combined.

Project PLAN's Approach to Individualizing Education

On the basis of results from many research studies on training and education, American Institutes for Research in cooperation with the Westinghouse Learning Corporation and 14 school districts initiated Project PLAN (Program for Learning According to Needs). This project was a major attempt to implement instructional objectives and strategies in a program of individualized education for grades 1-12 using commercially available instructional materials, current teachers, and current classroom facilities and equipment (Flanagan, 1967). Even though it has many unique features which set it off as one of the most significant current educational innovations, PLAN is not the only program attempting to individualize American education to student needs. Many such attempts are being made and it is predicted that these efforts will characterize the major educational changes explored throughout the 1970's. Therefore, this proposed study was formulated on a rationale and experimental design which would permit application of its results to most current and future systems of individualized education as well as to Project PLAN.

Evidence has accumulated to show that the ideas embodied in programs which try to individualize education are having positive effects on students, administrators, teachers, and parents. However, it is also evident that for some students, what has been accomplished is not sufficient. Nowhere is this more apparent than at the intermediate and secondary levels in schools in low and low-middle socio-economic areas. By the time "disadvantaged students" enter secondary school, a history of failure and frustration is long established, and many of them cease trying or resist further attempts of others to assist in their educational growth. Many such students lack academic skills and interests and often their own home and community associates fail to encourage or support the importance of education and achievement.

The research reported here attempted to evaluate the effectiveness of one technique which might partially help counteract and overcome factors working against

the success of such students. Though changes in research site availability prevented focusing exclusively upon students from a disadvantaged population, the students actually participating in the study represented a wide variety of ability, socioeconomic, and motivational levels thus increasing the generalizability of the study's results. In addition, the setting which was selected for this study facilitated generalization of the research results to conventional, as well as to individualized, instructional settings because the teacher involved was attempting to individualize instruction within a conventional educational system. It was also intended that the findings of this study with intermediate students would have important implications for secondary students especially where major attempts are being made to individualize education. The actual design of this study and the procedures used in implementing this design are reported in the next chapter of this report.

CHAPTER II

EXPERIMENTAL DESIGN AND PROCEDURES

The problem under investigation involved the inadequate quantity and quality of academic behaviors exhibited by many students of average or below average abilities or students frcm lower-middle or low socioeconomic backgrounds even though these students were participating in innovative programs such as those incorporating features of individualized instruction. The approach proposed to resolve this problem included augmenting the individualized instructional program by allowing students to select activities which they found enjoyable and subsequently making students' participation in these activities contingent upon the exhibition of the desired academic behavior.

EXPERIMENTAL DESIGN

Subjects

The study was designed for use in a departmentalized instructional setting at the secondary level. Owing to the non-availability of the originally designated research site, additional contacts for sites were made at the upper intermediate grade level as well as the secondary level. A favorable research site was found at Cabrillo Intermediate School in Santa Clara Unified School District of California. Mathematics was the academic area chosen for the investigation. All four classes of seventh-grade mathematics were selected for participation in the study. Two of these classes, totaling 65 students, served as the experimental group while a similar number of students in the remaining two classes served as the control group. The student body of Cabrillo, while diverse in its personal characteristics, contains a large percentage of Mexican-American students and is predominantly made up of students with low-middle or low socioeconomic status. The two

experimental classes were under the direction of the same teacher, while a second teacher was in charge of both control classes. As one part of the quasi-experimental design of this investigation, each student in the experimental classes served as his own control; that is, statistical comparisons were made between each student's attitudes and performance under two different treatment conditions: (1) a quasi-individualized instructional setting and (2) this same condition with the addition of contingency management. Since the control students experienced neither of these two treatment conditions, because they remained under conventional instruction, comparisons were possible between their changes in achievement and attitudes over the treatment period and the changes experienced by students exposed to the two conditions.

Each of the 65 experimental students was randomly assigned to one of two treatment conditions. Since the effect of the sex of the subjects was not investigated in this study, no attempt was made to randomly assign students by sex. Subsequent to this initial random assignment, the treatment condition to which a particular student was assigned was reversed at intervals of three weeks. The only exception to this procedure occurred during the last month of the school year when, in order to balance out exposure to the treatments, it was necessary to reduce the treatment time to two-week periods. Since two complete classes of students were used as the control treatment, no random assignment of subjects was attempted in these classes. Table I summarizes the assignment of subjects for this study.

TABLE I

DISTRIBUTION OF SUBJECTS BY TREATMENT CONDITION

AND TREATMENT TIME PERIOD

TREATMENT PERIODS	EXPERIMENTAL TREATMENTS		CONTROL TREATMENT
	QUASI-INDIVIDUALIZED INSTRUCTION	QUASI-INDIVIDUALIZED INSTRUCTION AND CONTINGENCY MANAGEMENT	CONVENTIONAL INSTRUCTION
FIRST THREE WEEKS	Experimental Group A 32 Subjects from Two Classes	Experimental Group B 31 Subjects from Two Classes	Control Classes 57 Subjects--Two Complete Classes
SECOND THREE WEEKS (CONTINUED ROTATION FOR TWO THREE-WEEK AND TWO TWO-WEEK PERIODS THEREAFTER)	Experimental Group B	Experimental Group A	Same Subjects--No Changes

Experimental Treatment Corditions

1. Quasi-Individualized Instruction.

A quasi-individualized instructional system was built around two sets of instructional materials for the seventh-grade mathematics curriculum. Students judged by the teacher to have high mathematics ability, used individualized units based on Dolciani's (1969) *School Mathematics: Book I.* The program for students of below average ability relied upon Denholm and Blank's (1969) *Mathematics Structure and Skills* as a basic source of instruction. Just prior to the initiation of this study both of these texts were selected as the new approved mathematics texts for seventh graders in the State of California for the 1970-71 school year.

For each text, the material in each chapter was formulated into what was designated a Cabrillo Learning Unit (CLU). Each CLU was an approximation in function and format to the TLU's in Project PLAN described earlier. Two representative examples of CLU's, one for each text, comprise Appendix A. The CLU format basically informed the student of the topic and objectives on which he would be working, and the materials and activities which would be used to achieve those objectives. The use of CLU's served to provide some form of self-instructional learning package on which each student could work with minimal leadership or intervention from the teacher. Each student in each instructional group moved through the respective materials at his own rate. A CLU was designed by organizing each mathematics chapter into specific meaningful sections.

An instructional objective was designated for each of these sections and a one-item "check-off problem," an example of which is included in Appendix B, was formulated for each section to assist the student to monitor his own progress as he moved through a learning unit. The student attempted these check-offs as he felt he was ready for them. On the following day, he received feedback regarding his performance so that he could then evaluate

the quality and rate of his progress. Upon successful completion of a learning unit, if a student decided he was prepared, he contacted the teacher to take the appropriate "end-of-unit test," composed of exercises sampled from the text. After a brief teacher check regarding his work in the chapter, and if he received teacher approval, the student was free to take the test. Appendix C contains a sample test from each of the two mathematics texts. Again, a one-day time period was maintained for relaying the test results back to the student. When the student received a score of from 90 to 100 on an end-of-unit test, he continued on to the next CLU. A score of 80 to 90 normally brought about a recommendation from the teacher that some review be undertaken of the material in the CLU. Finally, a score below 80, usually resulted in the recommendation that the student give considerable additional study to the CLU and subsequently retake the end-of-unit test. Thus in the above manner each student was exposed to a quasi-individualized instructional system featuring specific instructional objectives, instructional materials geared to some degree to his ability level and through which he could progress at this own rate, unit check-points and final tests keyed to unit objectives, and rapid feedback of test results.

At the beginning of the investigation it was not anticipated that students would complete either of the basic texts in use since students started on these materials about half-way through the school year. However, as a precautionary measure it was decided that any students who completed the Denholm and Blank text would be routed to three chapters of the Dolciani text containing material not found in any form within the other text. With respect to students using the high ability instructional materials based on Dolciani's text, cooperation was obtained from Project PLAN to make available copies of seventh-grade "enrichment" modules from the PLAN curriculum. Five modules were scheduled as possible additional units for students in this group.

2. Quasi-Individualized Instruction and Contingency Management.

The implementation of contingency management requires that subjects have an opportunity to indicate in some manner what activities or events are reinforcing to them given a free operant situation. Subsequently, contractual arrangements are made whereby participation in the activities chosen is made contingent upon the exhibition of specified amounts of the behaviors, hopefully, desirable to both student and experimenter. The application of this general paradigm as it was applied in this investigation is described below.

Six weeks prior to the introduction of the individualized procedures and materials, and three months prior to the actual initiation of the experimental period, the students in the two experimental classrooms were visited by a research assistant who informed them that a survey was being taken of student interests. Each student responded to a reinforcement menu similar to that used by Homme (1965). A copy of this instrument called a "Preferred Activities Survey" is included as Appendix D. Students were asked to indicate the activities in which they would like to engage during school time if the facilities and time were available. After checking all the activities in which they would be interested, they were asked to respond to the menu a second time and to indicate the three activities they most wanted to do. They were told that they could add any activities in which they were interested but which were not on the menu. These responses were subsequently analyzed and formed the basis for the purchase of equipment and materials for student use as reinforcing activities.

Just prior to the beginning of the experimental period a portable classroom, in the form of a 10' x 55' trailer, was opened adjacent to the school building in which the mathematics classes were being held. This trailer called the Activity Area contained equipment and materials for a wide variety of the activities previously chosen by the students. The variety and nature of the activities were limited only by the practical consideration of available space in the Activity Area. The trailer was arranged in such a manner as to

allow a maximum number of activities to go on simultaneously with minimal interference.

Though it was impossible to provide every activity the students selected, included in the possible experiences open to them in the Activity Area were: reading of current magazines of interest or other materials selected from a small library of adolescent literature; listening to hi-fi; playing games such as electric football, chess or checkers; building models; working on a variety of hobbies and crafts; watching television; and conversing with each other or a consultant hired to manage the Activity Area. Students were allowed to choose other activities if these could be organized.

The consultant was hired from the community to manage the activity area from 8:00 a.m. to 3:00 p.m. each school day. His function was primarily of a facilitative nature, since he was available to talk with the students, to help them implement their activities, and to assist them in spending only the earned amount of time in the Activity Area. On the final school day prior to beginning the experimental period, students were introduced to the consultant, were taken in small groups on a brief tour of the activity area, and were given an explanation of the procedures to be implemented during the following week. They were shown the possible activities available in the Activity Area and were given a question-and-answer session in order to make certain that they understood both what they would be required to do to earn reinforcement time in the trailer and any other procedures necessary to participate in the contingency management process.

Table II illustrates just what academic behaviors were designated as necessary in order for students to earn certain amounts of time in the Activity Area. Note that the times differ for the two sets of instructional materials. These differences were introduced deliberately in an effort to equalize the earnings possible in each of the two sets of materials. The inequalities

TABLE II

SUGGESTED VALUES OF PARTICULAR ACADEMIC BEHAVIORS FOR EARNED TIME IN THE ACTIVITY AREA

Behavior	Time Earned (Dolciani Materials)	Time Earned (Denholm-Blank Materials)
Amount of Material Covered		
Completed one educational objective	5 minutes	5 minutes
Quality of Learning		
Chapter test results indicated student answered 90 to 100% of the items correctly	30 minutes	15 minutes
Chapter test results indicated student answered 80 to 90% of the items correctly	20 minutes	10 minutes
Chapter test results indicated student answered below 80% of the items correctly	10 minutes	5 minutes
One test previously not passed was subsequently retaken and passed	5 minutes	5 minutes

which had to be adjusted were due to differences in the length of material in each set.

Time clocks were installed in the mathematics classroom and in the Activity Area to facilitate accurate accounting of earned time, and to insure a minimum of lost time between the regular classroom and the Activity Area. The only rules governing the earning and spending of time were that time could be "saved" up to the maximum of one hour, and that when any earned time was spent it had to be used during the hours of the school when one of the two experimental classes was in session.

Whenever a student working under the contingency management condition completed one of the listed academic behaviors, he had to indicate this to the teacher, who after briefly double-checking to confirm that the behavior in question had indeed been achieved, indicated on the student's time card that he had earned so many minutes in the Activity Area. The student then could choose either to check out with his card at the classroom time clock and to go to the Activity Area to spend this earned time, or to accumulate this time for later use.

If the student elected to spend his time immediately, he went to the Activity Area and checked his card on the time clock located there. All cards were placed in a pocket board while the students were in the area and the consultant kept a general check on the amount of time remaining for each student. Students were urged not to overspend their earned time since they were charged for it and were required to earn the overspent time without extra compensation. Students were free to choose any one or several of the available activities in each visit to the Activity Area.

Control Condition

3. Conventional Instruction

The students in the two seventh-grade mathematics classes serving as the control group continued on without any changes being introduced in their materials or procedures. The value of this group lay in its similarity to the experimental subject population. Their performance and attitudes were compared with those of the experimental subjects before and after the experimental groups experienced the individualized instructional program and the contingency management conditions.

Criterion Instruments

A variety of criterion devices yielding criterion information on student academic attitudes and performance was utilized.

1. Standardized Achievement Tests (MA). A standardized achievement test battery in mathematics, the California Test of Basic Skills was administered. Three subtests in this instrument include: Arithmetic Concepts, Arithmetic Computations, and Arithmetic Applications. Raw scores of the number of correct items on each of these three tests were used as criterion measures. A copy of Form Q of the test appears as Appendix E. A parallel form of this test, Form R, was given prior to the initiation of the experimental period and Form Q was administered following the conclusion of that period.
2. End-of-Unit Tests (UT). A separate test was developed for each chapter in each of the two tests basic to the instructional materials used in this study. These tests were composed of a number of objective items. The percentage of problems answered correctly on each test and the number of such tests taken by each student were recorded as criterion measures. Appendix C contains a sample of one of these tests, the scores of which were used to assess the quality of each experimental subject's academic efforts.

3. Educational Objectives Completed (EOC). In order to check the quantity of experimental subjects' academic efforts, the number of educational objectives completed by each student was recorded. The actual criterion used here was the number of one-item check-off problems completed by each student since the successful completion of each problem was synonymous with the completion of one educational objective in a learning unit.

4. Semantic Differential (SD). Each student responded to a semantic differential device designed to assess the subjective meaning of concepts relevant to education and academic behaviors. This device was designed particularly for this study and appears in Part I of Appendix F. The technique developed by Osgood (1955-1957), utilizes a series of seven-point adjective scales such as hot-cold and small-large, along which a person rates various concepts. In the present study, academically related concepts such as teachers, classes, myself as a student and similar items were used. This technique has been put to a number of interesting usages and has been shown to yield valuable results on how students view their academic environment (Nelson, 1970). Each of the 10 concepts included in the device was paired with 5 evaluative scales giving for each of the 10 concepts a range in possible scores from 5 to 35. The lower scores here denoted a more positive or more favorable association held by the subject with respect to the particular concept or word phrase being evaluated. Three administrations of this device were undertaken. These included a pre-experimental administration and subsequent administrations when a student was on the contingency management treatment.

5. Academic Attitude Inventory (AAI). This instrument was designed to assess each student's attitudes primarily toward mathematics. Part II of Appendix F provides a copy of this device. Included in the AAI were 30 attitudinal statements counterbalanced as to direction so that to agree with some items indicated a positive attitude while that same response to other items portrayed a negative attitude. The student was requested to express his agreement or disagreement with each statement along a five-point scale thus yielding a possible range of scores from 30 (if the individual expressed a very negative attitude on all items) to 150 (if the five possible points were awarded on each statement thus indicating an extremely positive attitude toward the particular academic area under investigation). This instrument was likewise administered on three occasions; namely, prior to the initiation of the experimental period, once while a student was under exposure to contingency management, and once while he was operating without such exposure.
6. Days Absent (A). A record was also kept of the number of days each student was absent, both while he was exposed to the contingency management procedures and to the individualized instructional system without contingency management.

Hypotheses

It was hypothesized that:

1. Seventh-grade students in the two experimental classes will exhibit a greater increase in standardized mathematics test scores and greater changes toward positive attitude test scores between the pre-experimental and final administration of these instruments than will similar students in the two control classes.

2. Seventh-grade students when they are exposed to contingency management procedures will exhibit more positive attitude test scores than they will when they are not exposed to such procedures regardless of the sequence in which such exposure occurs, and both of these sets of scores will be more positive than will those attained by students in the two control classes.
3. Seventh-grade students when they are assigned to contingency management procedures will attain a higher score on end-of-unit tests, will achieve a greater number of educational objectives, will exhibit more favorable scores on both attitudinal instruments, and will have fewer days of absence than they will when they are not exposed to contingency management procedures.

No differential effects due to sex were hypothesized.

EXPERIMENTAL PROCEDURES

Site Selection Procedures

Substantial effort was expended to locate a school site which would fulfill the student and instructional system requirements outlined earlier. Although several schools were contacted, they either failed to meet some of the most important requirements or were reluctant to participate in the experiment due to its highly innovative nature. It seemed evident that some administrators were concerned over possible public and parental response to a program which allowed a wide variety of recreational activities during school time in spite of the fact that such activity would be earned through academic performance. The original site for this investigation was a predominantly black, low socioeconomic secondary school in the Bay Area and was involved in the experimental implementation of Project PLAN. However, due to racial strife the school was closed for an extended period and the atmosphere and conditions

at the school would have made such a research project unfeasible. Later, however, a site conducive to the research herein reported was found. The Santa Clara Unified School District which had been heavily committed to Project PLAN at several grade levels, but due to economic austerity had reduced their involvement to only the fourth and fifth academic levels, was chosen as the research district. Officials at both the district and school levels were most enthusiastic about the project and provided the utmost cooperation.

Cabrillo Intermediate School, the site of the investigation, draws its student body from a wide variety of socioeconomic areas but predominantly from the lower-middle and upper-lower strata and has a substantial number of Mexican-American students as part of its enrollment. However, no system of individualized instruction was currently in operation at the school even though the particular teacher for the two experimental classes had training in individualized education programs and one year of experience developing materials for such programs.

Treatment Procedures

Two teachers who had previously been on leave of absence from the Santa Clara Unified School District in order to participate in the development of the PLAN mathematics curriculum and the materials associated with it were hired as consultants to develop a quasi-individualized instructional program for use in the two experimental classrooms. Their work involved the following tasks: writing specific instructional objectives in behavioral terms for the seventh-grade mathematics curriculum; organizing instructional materials into learning units which would be approximately equivalent in instructional time

to that demanded by modules in the PLAN system; developing short tests for each objective in order to help students progress successfully through each learning unit; and developing end-of-unit, self-administered tests to assess the attainment of each group of objectives representing one chapter of work. Such tests were highly similar in form and function to end-of-module tests in the PLAN system. To achieve some progress toward accommodating wide student differences in ability and learning styles, two different sets of instructional materials varying in difficulty level and in approach were placed in the individualized unit format. While such a program together with the teacher acting as a tutor and consultant, did enable students to progress on their own and at their own individual rates, it obviously lacked many of the more sophisticated features of a comprehensive computer-managed system such as PLAN.

The efforts just outlined were accomplished during the opening three and one-half months of the school year. Following the Christmas recess, the new instructional system was introduced in the two experimental classrooms while the two control classes continued on in a conventional manner. Appendix G contains the content of the "Presentation to Students on Contingency Management." Following the introduction of the new materials and procedures in the two experimental classrooms and after a three-week period during which base-rate data were collected, the two treatment conditions described earlier were implemented. For the remainder of the school year, approximately four months, the two experimental groups of students alternated in their exposure to contingency management procedures at intervals of three weeks in duration and two weeks later. This procedure facilitated a comparison of each experimental student's academic performance and attitudes while he experienced the contingency management condition with his performance and attitudes while he participated in the individualized instructional program without contingency management.

Data Collection Procedures

During the four-week base-rate period prior to the initiation of contingency management procedures, an individual achievement record was kept for each student in what were to be the experimental classes. This record included the date on which the student completed each unit of work and the score he achieved on its end-of-unit test. Such data provided information on the rate at which academic work was covered during this period as well as evidence of the quality of the academic achievement. During this same period, both the Semantic Differential device and the Academic Attitude Inventory were administered to all students in both the experimental and the control classes. These same two instruments were likewise administered two times during the experimental period itself. These later two administrations were separated by approximately three weeks thus providing attitudinal data on all of the students in the experimental classes both while they were being exposed to contingency management procedures and while they were operating under the individualized instructional program.

Finally, during the last week of the pre-experimental period, the three arithmetic subtests of Form R of the California Test of Basic Skills were administered to each student enrolled in the four mathematics classes participating in this study. Similar subtests from Form Q of this test were administered during the week immediately following the conclusion of the experimental period. Each administration of the two attitudinal devices consumed one class period while each administration of the three mathematics achievement subtests necessitated two class periods. Since the two experimental classes met at different times during the school day, administration of all criterion instruments was carried out in these classes on the same days. Likewise, testing was carried out in the two control classes on the same days, but on different days than those used for testing in the experimental classes.

During the experimental period itself, a chart was kept on a wall in the experimental classroom. This contained an individual record for each student indicating the date on which he completed each instructional objective and each end-of-unit test as well as the score achieved on each test. While these records served the purpose of providing rapid and observable feedback to the students on the exact amount of time which they had earned in the Activity Area and the academic behavior for which the time had been earned, the records also functioned as a convenient summary of the achievement data for each student. Information on the attendance of each student was collected throughout the entire experimental period.

Statistical Procedures

As a preliminary analysis, a program from the Bio Medical (BMD) computer program library (Dixon, 1967) was run. To check on the accuracy of the recording of data and to provide ranges, means, and standard deviations for each of the dependent variables, BMD 07D was conducted. This program provided a correlational study of all dependent variables. This analysis gave an indication of the uniqueness of each of the dependent variables.

After this preliminary analysis, data relevant to each of the hypotheses listed earlier were analyzed. Hypothesis #1 was tested through the use of a series of analyses of covariance. Scores on the pre-experimental administration of each of the three mathematics achievement subtests, of each of the 10 concepts from the semantic differential instrument, and of the AAI inventory were used as covariates. Thus BMD 04V was run a total of 14 times. The testing of Hypothesis #2 required use of BMD program 08V, a versatile one-way analysis of variance program. With regard to this hypothesis, the scores of the experimental students on the second and third administrations of the two attitude devices were grouped according to the sequence in which the students were exposed to contingency management techniques. That is, attitudinal

scores were grouped into exposure-no exposure and no exposure-exposure categories. An analysis of variance was carried out to see if indeed the order in which students were exposed to the contingency management techniques did make a difference in their scores on the attitude devices. Since it was predicted that it was the condition (i.e., contingency management and individualized instruction vs. individualized instruction) under which students were functioning that would make the difference and not the order of exposure to contingency management, no relationship (i.e., no significant interaction effects) between order of exposure and attitude scores was expected. If the data supported this prediction, it was planned that scores of all experimental students on the second and third administrations of the two attitudinal devices would be combined by treatment condition in order to test the complete relationship stated in Hypothesis #2.

Finally, the one-way analysis of variance program was also used as the main statistical procedure for investigating the remaining hypothesis. For Hypothesis #3, experimental subjects' scores on end-of-unit tests and attitude instruments, their attendance records, and the number of educational objectives they completed while they were on and off the contingency management treatment condition were compared using this statistical procedure.

CHAPTER III

RESULTS AND DISCUSSION

RESULTS

As was noted in Chapter II, BMD program 07D was included in the data analyses to check on the accuracy of the data recorded and to obtain histograms outlining the distribution of each variable. This analysis indicated that the data were accurate so that subsequent statistical procedures for each of the four research hypotheses could be employed.

Hypothesis #1: Experimental vs. Control Subjects

Hypothesis #1 was tested through the use of BMD program 04V which performed an analysis of covariance procedure. Ten of fourteen of these covariance analyses compared scores made by the experimental and control students on the first and last administrations of the Semantic Differential's ten educational concepts. Three more of these fourteen analyses made similar comparisons of subjects' pre- and post-treatment scores on the three mathematics achievement subtests, while the final analysis involved a comparison of scores on the Academic Attitude Inventory. In each case scores on the first administration of each of these instruments were used as covariates.

On only one of the ten Semantic Differential concepts analyzed was an F-ratio at a desired level of significance obtained. As indicated in Table III this finding occurred on the concept "myself as a student" and indicated that the control students scored significantly ($p<.05$) lower than the experimental students. Note that lower absolute score values on this instrument represent positive connotative meansings to subjects. However, a similar comparison of scores on the Academic Attitude Inventory resulted in a significant ($p<.02$) difference in the direction predicted in Hypothesis #1 (cf. Table IV). That is,

TABLE III

ANALYSIS OF COVARIANCE RESULTS FOR SEMANTIC DIFFERENTIAL CONCEPT "MYSELF AS A STUDENT" AND TWO LEVELS OF TREATMENT (EXPERIMENTAL VS. CONTROL)

Source	Sum of Squares	df	Mean Squares	F	Level of Significance
Treatment (Between)	54438.00	1	54438.00	4.65	p<.05
Error (Within)	1183380.00	101	11716.63		
Treatment and Error (Total)	1237818.00	102			

Note: Experimental Subjects Post-Treatment Mean Score: 220.65
Control Subjects Post-Treatment Mean Score: 267.05

attitudes of the experimental subjects toward their mathematics class and the teaching and learning procedures used in it were more favorable than were similar kinds of attitudes among control subjects.

In regard to mathematics achievement scores, two of three analyses of covariance yielded F-ratios at levels beyond those levels set as critical for this study. However, these results were in the opposite direction from that which was hypothesized, even though the mean scores of both groups increased. As illustrated in Table V, Arithmetic Concepts and Arithmetic Computations scores of control students were significantly larger ($p < .01$ in both cases) than were scores of the experimental subjects.

Hypothesis #2: Subjects "On" vs. Subjects "Off" Contingency Management and Individualized Instruction vs. Control Subjects.

This hypothesis predicted that experimental students' attitudinal scores would be higher when these students were being exposed to contingency management

TABLE IV

ANALYSIS OF COVARIANCE RESULTS FOR ACADEMIC ATTITUDE INVENTORY AND TWO LEVELS OF TREATMENT (EXPERIMENTAL VS. CONTROL)

Source	Sum of Squares	df	Mean Squares	F	Level of Significance
Treatment (Between)	2581.42	1	2581.42	6.87	p<.02
Error (Within)	37969.08	101	375.93		
Treatment and Error (Total)	40550.50	102			

Note: Experimental Subjects Post-Treatment Mean Score: 116.01
Control Subjects Post-Treatment Mean Score: 106.01

procedures than would be their scores when they were not being exposed and that both sets of scores would be above those of control students. This prediction necessitated a two-step analysis using BMD program 08V since repeated administrations of the attitude measures had been given. The first step was to determine if there was an interaction effect between the time at which a subject was exposed to contingency management and his attitude scores. In order to conduct this step, the results of the experimental and control subjects on the second and third administrations of both the Semantic Differential and the Academic Inventory were grouped as indicated in Table VI. Scores for subjects in cells A and B were combined and then compared by one-way analyses of variance with the combined scores of subjects in cells D and E. Similarly scores of subjects in cells C and F were compared on each of the 10 Semantic Differential concepts

TABLE V

ANALYSIS OF COVARIANCE RESULTS FOR THREE STANDARDIZED MATHEMATICS ACHIEVEMENT SUBTESTS AND TWO LEVELS OF TREATMENT (EXPERIMENTA'. VS. CONTROL)

Subtest	Source	Sum of Squares	df	Mean Squares	F	Level of Significance
Arithmetic Concepts	Treatment (Between)	406.22	1	406.22	8.19	p<.01
	Error (Within)	5458.08	110	49.62		
	Treatment and Error (Total)	5864.30	111			
Arithmetic Computations	Treatment (Between)	203.02	1	203.02	8.58	p<.01
	Error (Within)	2485.69	105	23.67		
	Treatment and Error (Total)	2688.70	106			
Arithmetic Applications	Treatment (Between)	10.70	1	10.70	1.04	p>.10
	Error (Within)	1093.66	106	10.32		
	Treatment and Error (Total)	1104.36	107			

Note: Post-Treatment Mean Scores

Subtests	Experimental Subjects Mean Score	Control Subjects Mean Score
Arithmetic Concepts	27.34	31.15
Arithmetic Computations	19.30	22.06
Arithmetic Applications	12.76	13.39

TABLE VI

SUBJECT GROUPS FOR REPEATED ADMINISTRATIONS OF ACADEMIC ATTITUDE INVENTORY AND SEMANTIC DIFFERENTIAL

Subject Group	Second Administration	Third Administration
Experimental Subjects Group 1	A on-contingency management	D off-contingency management
Experimental Subjects Group 2	B off-contingency management	E on-contingency management
Control Subjects	C conventional instruction	F conventional instruction

and on the total score from the Academic Attitude Inventory.

Only one of the resultant 22 comparisons displayed a statistically significant difference in attitude scores at $p<.05$. This occurred on the Semantic Differential concept "myself as a student," a finding which would be expected as a result of chance factors alone since so many tests of significance were conducted on the Semantic Differential data. Thus for both attitude measures, no interaction effect was found between the time of the attitude test administrations and the attitude scores for experimental and control subjects. Since it was determined that the sequence of subjects' exposure to the Semantic Differential did not appear to be a confounding variable, scores on the second and third administrations of this instrument were grouped according to treatment (i.e., "on" contingency management, "off" contingency management, and control condition) in order to ascertain whether contingency management had any effect on subjects' attitudes. Subjects in cells A and E of Table VI were combined to form the "on contingency management" group while subjects in cells B and D were used as the "off contingency management" group. Control subjects' scores in cells C and F also were combined for this instrument.

Similar combinations were made for results on the Academic Attitude Inventory for all subjects except those in the control group. This exception was

made because the difference between the mean scores for control subjects on the second and third administrations of the AAI tended to be fairly large (cf. Table VII). Separate comparisons were made between the control group scores on each of the second and third administrations of this instrument and scores of experimental subjects grouped into the "on contingency management" and "off contingency management" treatment conditions. The BMD program 08V was employed to conduct one-way analyses of variance for all comparisons needed to complete the investigation of Hypothesis #2.

Table VIII reports only those results from the repeated analyses of variance which attained statistical significance beyond the $p<.10$ level. In both cases where results on the AAI were investigated, desired levels of significan occurred. Inspection of the mean scores reported in Table VII suggests that the predictions of Hypothesis #2 were partially supported by these data. The attitude scores of experimental subjects exposed to contingency management and individusalized instruction were significantly higher than were similar scores of control students not so exposed. However, since no significant differences were found between scores of subjects in the two contingency management groups the part of Hypothesis #2 which predicted such differences was not supported.

In regard to results of similar analyses carried out with Semantic Differential scores, only two of ten comparisons produced F-ratios at the .10 level of significance and neither of these reached the desired level of $p<.05$. These results obtained on the concepts "math" and "myself as a student" did not lend sufficient support to Hypothesis #2.

TABLE VII

N'S, MEANS, AND STANDARD DEVIATIONS FOR TWO ATTITUDE MEASURES AND THREE LEVELS OF TREATMENT ("ON" VS. "OFF" CONTINGENCY MANAGEMENT VS. CONTROL)

Attitude Measures	Subject "On" Contingency Management N=56		Subject "Off" Contingency Management N=61		Control Subjects N=107	
	$\bar{X}$	SD	$\bar{X}$	SD	$\bar{X}$	SD
Semantic Differential Concepts:						
Math	2.26	1.08	2.34	1.14	2.67	1.24
Teachers	2.80	1.53	2.75	1.45	2.79	1.32
Studying	2.87	1.41	2.78	1.37	2.99	1.21
Tests	3.05	1.53	2.87	1.55	3.00	1.28
Classes	2.80	1.41	2.75	1.53	2.81	1.22
Grades	2.83	1.43	2.91	1.57	2.89	1.32
Myself as a Student	2.41	1.03	2.28	1.11	2.65	1.10
The Ideal Student	2.42	1.18	2.28	0.94	2.62	1.17
School	2.84	1.50	2.80	1.56	2.88	1.31
Learning	2.39	1.20	2.29	1.22	2.53	1.13
Academic Attitude Inventory					N=55	
- second administration	117.16	17.86	117.67	18.43	108.62	18.35
					N=52	
- third administration	117.16	17.87	117.67	18.43	105.89	18.35

TABLE VIII

SELECTED ANALYSIS OF VARIANCE RESULTS FOR TWO ATTITUDE MEASURES AND THREE LEVELS OF TREATMENT ("ON" VS. "OFF" CONTINGENCY MANAGEMENT VS. CONTROL)

Attitude Measures	Source	Sum of Squares	df	Mean Square	F	Level of Significance
Semantic Differential Concept: Math	Treatment (Between)	769.42	2	384.71	2.80	$p<.10$
	Error (Within)	30,361.66	221	137.38		
	Treatment and Error (Total)	31,131.08	223			
Semantic Differential Concept: Myself as a Student	Treatment (Between)	584.42	2	292.21	2.49	$p<.10$
	Error (Within)	25,926.25	221	117.31		
	Treatment and Error (Total)	26,510.67	223			
Academic Attitude Inventory - second administration	Treatment (Between)	2,910.92	2	1,455.46	4.38	$p<.05$
	Error (Within)	56,119.72	169	332.07		
	Treatment and Error (Total)	59,030.64	171			
Academic Attitude Inventory - third administration	Treatment (Between)	4,804.08	2	2,402.04	7.24	$p<.01$
	Error (Within)	55,110.06	166	331.99		
	Treatment and Error (Total)	59,914.14	168			

Hypothesis #3: Subjects "On" vs. Subjects "Off" Contingency Management

Continued use was made of the BMD 08V program in order to statistically investigate the comparisons implied in Hypothesis #3. Data on five dependent variables were analyzed through this procedure. First, in regard to scores obtained on end-of-unit tests which were used to check the quality of subjects' mathematics progress, it was hypothesized that subjects would on the average score higher on tests during periods of exposure to contingency management than they would during time of non-exposure. This prediction was explored in four ways each of which involved using each subject as his own control-i.e., comparing his performance "on" contingency management with his performance "off" contingency management. First, the test performance of subjects who began the rotating treatments "on" contingency management was averaged across their three times "on" and this average was compared with their averaged performance during their three times "off" contingency procedures. Second, a similar approach was used for subjects who initiated their involvement in this study by not being exposed to contingency management. Their test performance for three times "off" this treatment was compared to their test scores while "on" the technique for the same amount of time. These two analysis procedures were used in order to check for possible differential effects due to the manner in which subjects began the rotating treatment schedule.

In addition, an attempt was made to investigate the possibility that factors associated with the end of the school year or factors associated with the shorter (i.e., two weeks instead of three) time periods involved in the final experimental cycle might have washed out or obscured findings of significance. The third approach involved averaging subjects' performance across two treatments if they began "on" contingency management and comparing that average with their performance during their first two "off" periods. Finally, a similar comparison was made for subjects who started "off" the contingency technique. As indicated

by the mean scores reported in Table IX, subjects' end-of-unit test performance was consistently better while they were "on" than it was while they were "off" contingency management. However, the one-way analysis of variance data reported in Table X point out that these trends were not supported at the desired levels of statistical significance.

A second dependent variable used to investigate Hypothesis #3 was the number of educational objectives completed by each subject during each experimental period. As noted earlier, this dependent variable was used to assess the quantity of experimental subjects' academic work. The same series of four comparisons was made in relationship to this variable as were made for test averages. Once again, the data of Table IX signify that subjects consistently completed more educational objectives while "on" the contingency technique than they did when they were "off" it. Perhaps because the standard deviations matched this trend, a finding that was not the case in three of the four comparisons on the end-of-unit test data, some of the analysis of variance results portrayed in Table XI provided statistical support for the prediction expressed in Hypothesis #3. One of this set of four comparisons yielded an F-ratio at beyond the .01 level of significance while a second comparison attained the $p<.05$ level. Both cases involved the subjects who were exposed to contingency management after an enforced waiting period of three weeks. When their performance over all six time periods was analyzed, these subjects completed a significantly ($p<.01$) greater number of educational objectives during periods of exposure to contingency management than during period of non-exposure. This comparison was not quite as strong (i.e., reduced to $p<.05$) when the analysis was limited to their performance over the first four time periods. This finding suggests that the two shorter treatment periods at the end of the school year seemed to add to, rather than detract from, earlier performance trends. None of these statistically supportive results was found for subjects who were exposed to the contingency management

TABLE IX

N'S, MEANS, AND STANDARD DEVIATIONS FOR TWO DEPENDENT VARIABLES (UT AND EOC) AND TWO LEVELS OF TREATMENT ("ON" VS. "OFF" CONTINGENCY MANAGEMENT)

Dependent Variables and Analysis Procedures	Experimental Subjects Starting "On" Contingency Management						Experimental Subjects Starting "Off" Contingency Management					
	"On"			"Off"			"Off"			"On"		
	N	$\bar{X}$	SD	N	$\bar{X}$	SD	N	$\bar{X}$	SD	N	$\bar{X}$	SD
End-of-Unit Test Averages												
1 + 3 + 5	15	251.53	34.95				15	240.27	33.69			
2 + 4 + 6				15	246.93	24.00				15	244.00	38.35
1 + 3	25	166.36	21.40				17	156.00	28.60			
2 + 4				25	165.04	18.22				17	159.33	26.08
Educational Objectives Completed												
1 + 3 + 5	28	37.46	13.07				28	27.04	14.38			
2 + 4 + 6				28	35.82	17.48				28	35.71	13.36
1 + 3	18	50.33	17.16				27	36.44	18.15			
2 + 4				18	45.11	18.59				27	49.67	14.93

TABLE X

ANALYSIS OF VARIANCE RESULTS FOR END-OF-UNIT TEST AVERAGES
AND TWO LEVELS OF TREATMENT ("ON" VS. "OFF" CONTINGENCY MANAGEMENT)

End-of-Unit Test Analysis Procedures	Source	Sum of Squares	df	Mean Square	F	Level of Significance
"On" (1 + 3 + 5) vs. "Off" (2 + 4 + 6)	Treatment (Between)	158.70	1	158.70	0.57	N/S
	Error (Within)	3932.72	14	280.91		
	Treatment and Error (Total)	4091.42	15			
"Off" (1 + 3 + 5) vs. "On" (2 + 4 + 6)	Treatment (Between)	104.53	1	104.53	0.29	N/S
	Error (Within)	4974.37	14	355.31		
	Treatment and Error (Total)	5078.90	15			
"On" (1 + 3) vs. "Off" (2 + 4)	Treatment (Between)	21.78	1	21.78	0.17	N/S
	Error (Within)	3106.65	24	129.44		
	Treatment and Error (Total)	3128.44	25			
"Off" (1 + 3) vs. "On" (2 + 4)	Treatment (Between)	105.88	1	105.88	.30	N/S
	Error (Within)	5656.09	16	353.51		
	Treatment and Error (Total	5761.97	17			

TABLE XI

ANALYSIS OF VARIANCE RESULTS FOR EDUCATIONAL OBJECTIVES COMPLETED AND TWO LEVELS OF TREATMENT ("ON" VS. "OFF" CONTINGENCY MANAGEMENT)

Educational Objectives Completed Analysis Procedures	Source	Sum of Squares	df	Mean Square	F	Level of Significance
"On" (1 + 3 + 5) vs. "Off" (2 + 4 + 6)	Treatment (Between)	220.90	1	220.90	1.23	N/S
	Error (Within)	3389.01	19	178.37		
	Treatment and Error (Total)	3609.91	20			
"Off" (1 + 3 + 5) vs. "On" (2 + 4 + 6)	Treatment (Between)	2360.17	1	2360.17	9.78	$p<.01$
	Error (Within)	6276.22	26	241.39		
	Treatment and Error (Total)	8636.39	27			
"Off" (1 + 3) vs. "On" (2 + 4)	Treatment (Between)	37.79	1	37.79	0.33	N/S
	Error (Within)	3078.10	27	114.00		
	Treatment and Error (Total)	3115.89	28			
"Off" (1 + 3) vs. "On" (2 + 4)	Treatment (Between)	1054.45	1	1054.45	5.96	p</05
	Error (Within)	4779.96	27	177.04		
	Treatment and Error (Total)	5834.41	28			

procedures immediately upon the initiation of the experiment and who were not required to wait three weeks before participating in the activity area.

Due to both time and budget limitations, as well as to the belief that this dependent variable would be too gross a measure of differential treatment effects, only one overall analysis of variance was undertaken on the number of days absent for each of the experimental students while he or she did and did not have access to the activity area. When the attendance of all experimental subjects regardless of sequence of exposure to contingency management was investigated over all six time periods, an F-ratio at a desired level of significance was not obtained. Considering the small size of the F-ratio reported for this analysis in Table XII, it seems unlikely that separate analyses like the four conducted earlier for the UT and EOC variables would produce any more statistically significant results.

Hypothesis #3 was consistently supported by trends on two of the three dependent variables just presented. However, on these two variables, only in relation to the number of educational objectives completed was there any support for the prediction that the quantity and quality of subjects' work would be higher during periods of contingency management than it would be during periods of non-contingency management. And in this situation only those students who were restrained from contingency management participation during the initial three-week period responded in line with the prediction. Attitudinal data from the Semantic Differential and the Academic Attitude Inventory also were available to investigate Hypothesis #3. The analyses of these data have been previously presented under Hypothesis #2 where it was suggested that they provided no support for the prediction that subjects would have more favorable attitudes to academic-related topics and concepts when they experienced contingency management than they would when they did not have access to the activity area. Therefore, only limited, but still informative, support was obtained for Hypothesis #3.

TABLE XII

ANALYSIS OF VARIANCE RESULTS FOR DAYS ABSENT AND TWO LEVELS OF TREATMENT ("ON" VS. "OFF" CONTINGENCY MANAGEMENT)

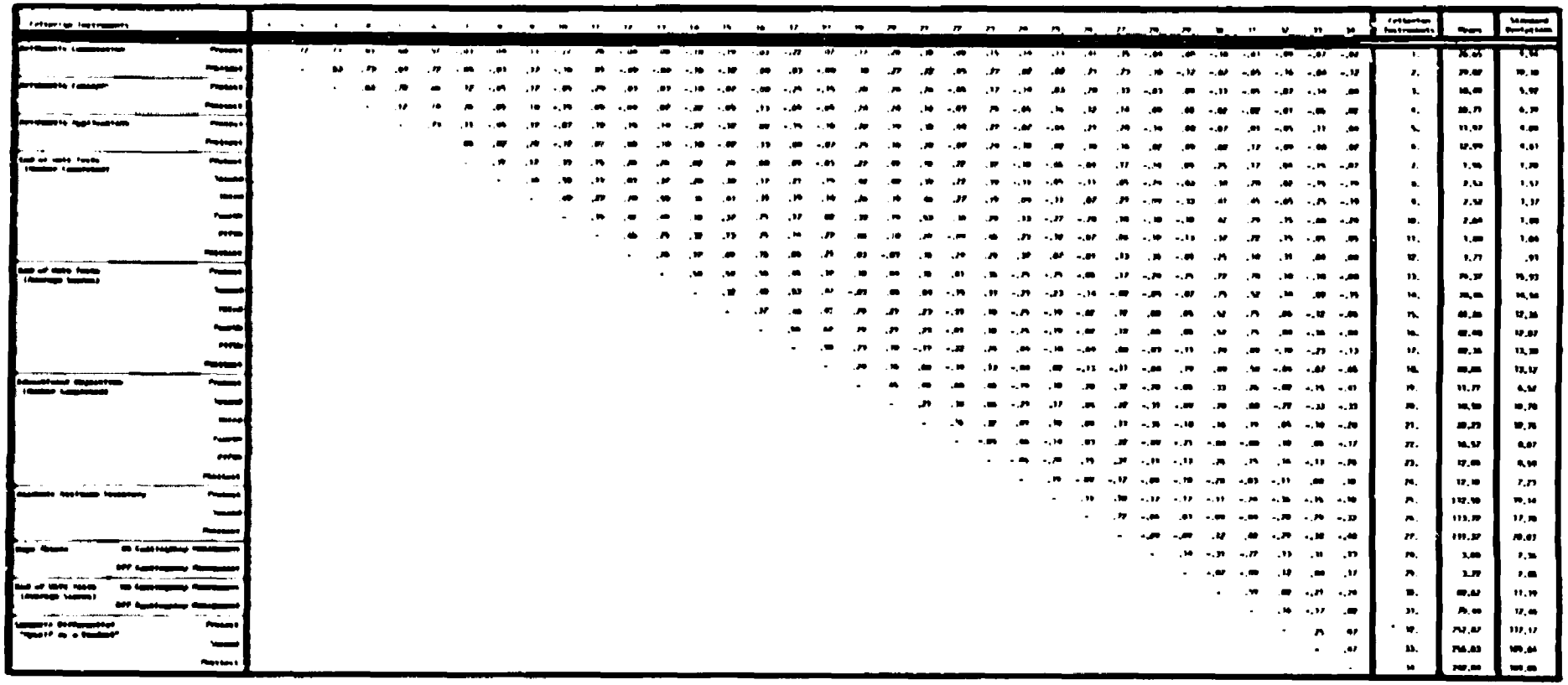
Source	Sum of Squares	df	Mean Square	F	Level of Significance
Treatment (Between)	2.91	1	2.91	.47	N/S
Error (Within)	268.08	43	6.23		
Treatment and Error (Total)	270.99	44			

Supplementary Results--Intercorrelation Matrix

As an additional statistical analysis, BMD program 03D was used to obtain intercorrelations of all variables so that it might be determined if indeed each dependent variable was measuring distinctive phenomena. Most of the results of this analysis are portrayed in Table XIII from which has been omitted correlational data for nine of the ten Semantic Differential concepts. Because the correlations displayed for the concept "myself as a student" are closely representative of those obtained for the other concepts, these data were omitted for space reasons. An investigation of Table XIII reveals what one would expect. For example, high correlations resulted between the three mathematics achievement subtests and between the pre- and post-experimental administrations of these instruments. One finding not anticipated was the rather consistently moderate negative intercorrelations between Semantic Differential concepts and scores on the Academic Attitude Inventory. Such relationships might have occurred if

TABLE XIII

INTERCORRELATION MATRIX, MEANS, AND STANDARD DEVIATIONS FOR ALL CRITERION INSTRUMENTS (EXCEPT NINE SEMANTIC DIFFERENTIAL CONCEPTS) ON ALL ADMINISTRATIONS



subjects had difficulty understanding the assessment procedures desired in the Semantic Differential instrument. Another plausible explanation might lie in the possibility that the Academic Attitude Inventory and the Semantic Differential actually measure different phenomena. While the statements that make up the AAI are directly aimed at assessing the individual's feeling toward a particular school class, its content, the teacher, and the procedures used in the class, the Semantic Differential purports to be a measurement of the connotative meanings of various concepts. Thus the affective feelings of a student toward a particular class and teacher might indeed be inversely related to a measure of the semantic meaning he attaches to those concepts. Both the phenomena being measured by these two devices and the level of abstraction at which the phenomena are located might be different.

Summary

Hypothesis #1 was confirmed by attitudinal data but not by standardized mathematics achievement data. Indeed, data from standardized mathematics achievement measures provided significant (both at $p<.01$) evidence directly opposite to that which was predicted by this hypothesis. The attitude data supported Hypothesis #1 indicated that on the Academic Attitude Inventory experimental subjects' attitudes toward their mathematics classes, teacher and materials increased significantly ($p<.02$) more during the experiment than did the attitudes of the control subjects. Data related to Hypothesis #2 indicated that the sequence of treatment exposure seemed to have no significant effect upon attitude scores and that only scores on the Academic Attitude Inventory provided partial support for the predictions stated in this hypothesis. Attitudinal scores of experimental students were significantly ($p<.05$ and $p<.01$) higher on the Academic Attitude Inventory than were scores of control students

regardless of time of experimental subjects treatment exposure but no significant differences occurred between experimental subjects' attitude scores when they were "on" and "off" contingency management. In regard to Hypothesis #3, the quality of experimental subjects' mathematics test performance consistently tended to be higher while they were "on" the contingency management procedure than while they were "off" it. However, none of these comparisons were sufficiently pronounced to reach desired levels of significance. Hypothesis #3 was partially supported in relation to the quantity of academic work experimental subjects accomplished as indicated by the number of educational objectives they completed. However, this support occurred only in the case of subjects who were required to wait for a three-week period before receiving any exposure to the contingency management treatment procedure. Even though once again there were consistent trends supporting the predicted difference for all experimental subjects, only the results of this group reached desired levels of significance ($p < .05$ and $p < .01$) indicating that these subjects completed more mathematics work when they were exposed to contingency management than when they were not exposed to this technique. No support was found for Hypothesis #3 on the basis of experimental subjects' attendance records or academic attitudes. Results on all three of these hypotheses will be discussed in more detail in the following section.

DISCUSSION

The prediction of Hypothesis #1 that significant differences favoring experimental subjects over control subjects would be found on two dependent variables (i.e., attitudes and mathematics achievement test results) occurred only on one of the two attitude instruments used in this study. Therefore, it can only be concluded that this hypothesis was supported by attitudinal data. Since the Academic Attitude Inventory was developed specifically for this study, the supportive results obtained on it were most encouraging. This suggests the advisability of tailoring attitude measures to the specific treatment variables being explored in research studies such as the current project rather than employing available instruments which have questionable relevance to those variables. However, the limitations of this strategy must be recognized since such innovative measures do not have the background of reliability and validity data which will permit much confidence being placed in their results.

Inconsistent responses between the Semantic Differential and the Academic Attitude Inventory were not entirely unexpected. As was noted in the previous section of this chapter, results collected relative to Hypothesis #1 indicated that on only one of the ten covariance analyses using Semantic Differential data was an F-ratio at or beyond the .10 level obtained, an incidence rate which could be attributed to chance alone. For both experimental and control subjects on this dependent variable changes in group means over time were in general confined to a narrow band located between the positive connotative portions of

two or three on its seven-point scale. The lack of results at desired levels of significance on this instrument may have occurred for at least two reasons. First, it may well be that if, as was discussed earlier, the Semantic Differential measures broad evaluative associations that the treatment experiences did not substantially alter the rather positive outlook this study's subjects had of a series of general school-related concepts. Second, it seems quite possible that the Semantic Differential is not a meaningful measure with students of this age level. There is a dearth of research on the Semantic Differential both in terms of changes needed in its directions and format in order to adapt it for use with students at the elementary level as well as validated applications among such students. More definitive investigations of this instrument are needed if future studies attempt to employ it for purposes similar to those for which it was used in this project.

The reversed results obtained in the standardized mathematics subtests warrant further discussion. These results contrary to those which were hypothesized occurred on two of three subtests, Arithmetic Computations and Arithmetic Concepts. An examination of changes in these instruments' mean scores over time indicates that both experimental and control made gains but the question remains as to why the control students made greater progress than did the experimental students. Several uncontrolled factors could have contributed to this progress. First, after the initial administration of the tests, the teacher in the classes designated as control might, inadvertently or purposefully, have geared his teaching toward skill areas assessed by these subtests. He certainly had more opportunity to do this since he was in no way obligated to lay out in advance exactly what instructional objectives would be covered. Such flexibility was not possible in the experimental classes where all the objectives had been established prior to the study. No monitoring of the instructional content of his classes was undertaken. Second, since no attempt

was made to parallel the instructional objectives in the experimental and control classes, it is possible that the objectives toward which the control subjects worked were closer to those covered by the two mathematics subtests than were the objectives of the experimental curriculum. No check was made on this possibility. The control students might well have improved in skills heavily weighted in the standardized mathematics subtests. The materials and procedures used in the experimental classes might have elicited different learnings than those measured by the standardized tests. In similar studies in the future, investigation should be made of the content and procedures of both experimental and control instructional systems before selection of achievement measures. If standardized achievement tests are to be used in such studies, determined efforts should be made to select ones which are academically "fair" to subjects in both groups.

Third, the teaching of the control teacher or the work habits of his students might have improved due to the operation of a Hawthorne effect, their knowledge of being involved in something unusual. Control subjects were tested, and since it was highly likely that most control students were acquainted with some of the experimental subjects, they probably knew they were involved in a study. A desire to compete with the other group of subjects could have altered their performance considerably.

In regard to Hypothesis #2, one of the clearest findings from the study was the significant F-ratios associated with experimental vs. control subjects' scores on the Academic Attitude Inventory on both the second and third administrations of this instrument. Therefore, it can be concluded that at least on the basis of AAI results one of the two predictions embodied in Hypothesis #2 was confirmed. It should not be assumed that this conclusion implies that these data supported the use of contingency management alone. Any comparisons involving experimental and control subjects in this study involve the close interaction of

individualized instruction and contingency management. Only when the two types of experimental groups are contrasted under the second part of Hypothesis #2 and all of Hypothesis #3 can the effects of these two independent variables be parcelled out.

In response to the important question of why attitudinal differences which were found on the AAI when experimental and control subjects' results were contrasted did not persist at desired levels when the "on" and "off" contingency management groups were compared, the following should be noted. The two administrations of this device took place only three or four weeks apart so that both groups by this time had had a considerable exposure to the treatment procedures and were assured of further exposure. Thus it might have been that such a short time was inadequate to allow for attitudinal shifts to the degree desired. A more plausible explanation might be that once students had participated in the contingency management procedures and had found them desirable, as indicated in the substantial favorable movement of AAI scores between first and second administrations, and had become somewhat accustomed to the necessity of taking turns at participating in the activity area, their attitudes toward the mathematics class, teacher, and activities were not substantially altered by being "off" the system for a three-week period. Possible explanations of the lack of similar supported evidence from the Semantic Differential would not differ from those presented above in the discussion of Hypothesis #1.

Perhaps the most interesting findings garnered from the study come from analyses undertaken in relation to Hypothesis #3. The consistent supportive data trends on the end-of-unit tests and the number of educational objectives completed certainly suggests that contingency management techniques have merit and warrant continued investigation. While the trends in test averages were not sufficiently strong to support the prediction that subjects would perform at a

higher quality level during periods when they could earn time in the activity center, the parallel prediction that they would actually engage in more academic work during periods of participation in contingency management was borne out, at least in the case of one group of experimental students. As was pointed out in the results portion of this chapter, the experimental group of students who by random determination were required to wait until the second three-week period of the investigation before they could participate in the activity center completed significantly more educational objectives than did the experimental group who were assigned to receive first exposure to the treatment.

These findings indicate that while the experimental students continued to perform about as well on their end-of-unit tests while "on" the system as they did while "off" contingency management, how much academic work they completed was differentially affected by these two treatment conditions. At least this is true of those students who had to wait for some period of time before actually participating in the activity area. The fact that the predicted differences were not replicated in both groups suggests that in future applications of contingency management it might be an effective strategy to arrange a delay period during which students know about the system and what will be expected of them, but yet have to forego immediate participation.

In the current study, perhaps some type of anticipation effect operated when subjects observed others performing according to contingency management procedures. Perhaps they spent less time actually engaging in academic work during the first three-week period but when it was their turn to gain access to the activity area, they expended more time and effort as a result of having had the procedures and rewards modeled for them by the previous group of subjects. An alternative explanation might be that they learned about the system by watching others participate and came to definite conclusions about what kind of behavior "paid off" and when it paid off. While these subjects

might have been surveying their academic material during their periods of non-exposure, they perhaps "saved up" their learning until the exhibition of it was rewarded. These results suggest a number of possible investigations to ascertain how pervasive is the effect of having students delay participation in contingency management techniques and to learn exactly what factors underlie the phenomenon itself.

Preliminary data analyses indicated that factors associated with the end of school year or with the necessity of ending the study with two-week treatment periods rather than continuing with three-week periods did not seem to influence subjects' performance or attitudes. The fact that Hypothesis #3 was not confirmed by the dependent variable of subjects' attendance and attitudes is not considered to be a serious threat to the supportive evidence on the two academically oriented variables just discussed. Possible explanations of the attitudinal results were presented in the discussion of Hypothesis #2. As previously noted also, it was concluded that the attendance variable was far too insensitive to detect the type of treatment effects desired in this investigation. In classes such as those in which this experiment was conducted, attendance variations across two-or three-week periods even in non-experimental times do not seem to be sufficiently extensive to evaluate the motivational impact of experimental treatments such as explored in this study. If these "explanations" of non-supportive results are accepted, the partial confirmation which was obtained for Hypothesis #3 becomes much more impressive.

CHAPTER IV

SUMMARY, CONCLUSIONS AND IMPLICATIONS

SUMMARY

Problem Definition

One prominent educational problem is inadequate educational achievement among so called "culturally deprived" or "disadvantaged" students. Even innovative programs such as attempts at individualized instruction have had difficulty producing substantial changes in the quantity and quality of academic behaviors in such students. One line of learning theory-based research suggests that reinforcers which are sufficiently powerful to change these students' behaviors can be found by allowing youth to select from available reinforcing activities and events in their environment those in which they prefer to engage. An application of this principle is found in the technique called contingency management, a procedure in which activities preferred by an individual are made immediately and directly contingent upon his exhibition of some desired behavior. This study postulated that if contingency management techniques were used to supplement an instructional system in which efforts toward individualization were being made, students would be influenced to produce more, and a higher quality of, academic behaviors and more favorable attitudes toward academically relevant concepts than would be produced by that instructional system alone or by conventional instruction.

Study Design and Procedures

Selected for participation in this study were students in all four classes of seventh-grade mathematics in a school containing a large Mexican-American population and a predominantly low-middle and low socioeconomic status student body. Two of these classes, 65 students, served as the experimental subjects while a similar number of students in the other two classes served as inactive

controls by remaining in a conventional instructional setting. In part of the design, each experimental subject served as his own control so that statistical comparisons using one-way analysis of variance and covariance procedures could be made between each students' attitudes and performance under two experimental treatment conditions. Using similar procedures, additional comparisons were made of changes in experimental and control subjects' achievement and attitudes over the treatment period.

The two experimental and one control treatment conditions were as follows:

E_1. Quasi-individualized instruction-individualized learning units and correlated tests for assessing student achievement of instructional objectives in each unit were developed for students of high and below average mathematics abilities. Each student proceeded through his ability-appropriate materials at his own rate and with minimal intervention from the teacher.

E_2. Quasi-individualized instruction and contingency management-experimental students randomly assigned to one of two groups alternated during three- and two-week periods in their exposure to treatment E_1 and to this treatment which gave them access to a portable trailer, the Activity Area, containing equipment and materials for a wide variety of reinforcing activities previously chosen by the students. During the time periods when students had access to the trailer, they were permitted to earn certain amounts of time in it if they successfully completed designated academic behaviors. A male "consultant" was available in the trailer to talk with students, to help them implement their activities, and to assist them in spending only the earned amount of time there.

C_1. Conventional instruction-students in the two control classes experienced their regular instructional program without the individualized units and contingency management.

The following criterion strategies yielding information on student academic performance and attitudes were utilized:

1. Standardized Mathematics Achievement Tests--the California Test of Basic Skills involving subtests of Arithmetic Concepts, Arithmetic Computations, and Arithmetic Applications was administered to all students before and after the treatment period.

2. End-of-Unit Tests--developed for each individualized mathematics unit were used to assess the quality of each experimental student's academic efforts throughout the treatment period.

3. Educational Objectives Completed--were recorded in order to check the quality of each experimental student's academic activities during the treatment period.

4. Semantic Differential--before, during, and after the treatment period, all students indicated the meaning 10 concepts related to education and specific academic behaviors had for them.

5. Academic Attitude Inventory--was administered at the same time as the Semantic Differential in order to assess more specific student attitudes on 30 statements related to mathematics, instructional procedures, and teachers involved in this study.

6. Days Absent--records were kept of the number of days each experimental subject was absent while he was alternately exposed to each of the two experimental treatment conditions.

The following hypotheses were investigated:

1. E_1 and E_2 students will exhibit greater increases in standardized mathematics test scores and greater changes toward positive attitude test scores between the pre-experimental and final administration of these instruments than will C_1 students.

2. When students are exposed to contingency management procedures, they will exhibit more positive attitude test scores than they will when they are not exposed to such procedures regardless of the sequence in which such exposure occurs, and both of these sets of scores will be more positive than will those attained by C_1 students.

3. When students are assigned to contingency management procedures, they will attain higher scores on end-of-unit tests, will achieve greater numbers of educational objectives, will exhibit more favorable scores on both attitudinal instruments, and will have fewer days of absence than they will when they are not exposed to contingency management procedures.

Results

Hypothesis #1 was confirmed by attitudinal data but not be standardized mathematics achievement data. Indeed, data from standardized mathematics achievement measures provided significant (both at $p<.01$) evidence directly opposite to that which was predicted by this hypothesis. The attitude data suggesting Hypothesis #1 indicated that on the Academic Attitude Inventory experimental subjects' attitudes toward their mathematics classes, teacher and materials increased significantly ($p<.02$) more during the experiment than did the attitudes of the control subjects. Data related to Hypothesis #2 indicated

that the sequence of treatment exposure seemed to have no significant effect upon attitude scores and that only scores on the Academic Attitude Inventory provided partial support for the predictions stated in this hypothesis. Attitudinal scores of experimental students were significantly ($p<.05$ and $p<.01$) higher on the Academic Attitude Inventory than were scores of control students regardless of time of experimental subjects' treatment exposure but no significant differences occurred between experimental subjects' attitude scores when they were "on" and "off" contingency management. In regard to Hypothesis #3, the quality of experimental subjects' mathematics test performance consistently tended to be higher while they were "on" the contingency management procedure than while they were "off" it. However, none of these comparisons were sufficiently pronounced to reach desired levels of significance. Hypothesis #3 was partially supported in relation to the quantity of academic work experimental subjects accomplished as indicated by the number of educational objectives they completed. However, this support occurred only in the case of subjects who were required to wait for a three-week period before receiving any exposure to the contingency management treatment procedure. Even though once again there were consistent trends supporting the predicted difference for all experimental subjects, only the results of this group reached desired levels of significance ($p<.05$ and $p<.01$) regardless of length of time of treatment exposure and this evidence indicated that these subjects completed more mathematics work when they were exposed to contingency management than when they were not exposed to this technique. No support was found for Hypothesis #3 on the basis of experimental subjects' attendance records or academic attitudes.

CONCLUSIONS

1. Experimental subjects exposed to individualized instruction and contingency management procedures exhibited more positive attitude changes on the Academic Attitude Inventory than did control students who continued on conventional instruction.

2. Subjects exposed in various time sequences to the contingency management procedure in the individualized instructional setting did not demonstrate greater positive score increases on the Semantic Differential scores than did control students.

3. Data from the three mathematics achievement subtests revealed that subjects exposed to individualized instruction and contingency managemen did not demonstrate greater increases in scores on these instruments than did control subjects. In fact, on two of the three subtests, the reverse results occurred.

4. The chronological sequence in which subjects were exposed to the contingency management procedure was found to have no effect of any significance upon their scores on either the Semantic Differential or the Academic Attitude Inventory.

5. With regard to scores on the Academic Attitude Inventory, experimental subjects exposed to individualized instruction and contingency management were found to make greater positive attitude changes than were made by the control students regardless of the sequence of exposure. However, there were no differences of significance between these experimental subjects' scores when they were "on" and their scores when they were "off" contingency management.

6. As for similar analyses of Semantic Differential data, no pertinent differences occurred between experimental and control subjects' scores or between the scores of experimental subjects during their exposure to the activity area and their scores during the non-exposure to that treatment.

7. Regardless of the chronological sequence of their exposure to the contingency management procedure, all experimental subjects tended to achieve higher end-of-unit test averages during periods of exposure to this treatment than they did during periods of non-exposure to this treatment. However, this trend was not supported at desired levels of statistical significance. This was true regardless of whether data from all six experimental periods of the investigation or only the initial four periods were utilized on the analysis process.

8. Experimental subjects taken as a composite group also tended to accomplish a greater amount of academic work (i.e., as indicated by the number of educational objectives they completed) while they were "on" contingency management than they did while they were "off" it. These trends were sufficiently strong to achieve significance only for one of the two groups of experimental subjects. Those subjects who were required to postpone their exposure to contingency management for the first three-week experimental period, while the remainder of the students participated, completed a greater number of educational objectives during periods of exposure to the contingency management procedure than they did during period of non-exposure. This finding held true regardless of whether all six experimental periods in the study or only the initial four periods were used in the data analysis.

9. Experimental subjects, taken as a single composite group, were found not to differ in the number of days they were officially absent fro

school while they were "on" and while they were "off" contingency management.

IMPLICATIONS OF THIS STUDY

The results of this investigation certainly do not provide overwhelming support for the use of contingency management with or without individualized instruction. However, there were clearcut data trends and significant F-ratios which (1) favored the combination of contingency management and individualized instruction over conventional instruction, and (2) indicated that subjects performed more and better academically when they were exposed to contingency management than they did when they did not have access to the activity area. These data suggest that both contingency management and individualized instruction can have relevance for the academic motivational problems of students in culturally disadvantaged areas. The reversed findings on the mathematics achievement measures should caution against accepting contingency management and similar incentive programs used in individualized instructional settings as a panacea for overcoming inadequate student achievement. However, the minimal evidence which this study provides in support of these techniques at least proclaims that further experimental investigations of their efficacy must be attempted.

If student attitudes continue to be an important dependent variable in such investigations, it would seem unwise to continue to employ the Semantic Differential unless it is extensively modified. On the other hand, data from the Academic Attitude Inventory designed for this investigation suggest that similar instruments might be desirable criterion measures. These data indicated that student experiences with contingency management procedures in the context of individualized instruction might continue to bring about positive movement in attitudes related to the specific subject matter, teachers, and

classroom activities if these techniques are tried in other settings. However, considerable additional work needs to be undertaken to test the validity and reliability of the Academic Attitude Inventory.

As for the question of the feasibility of actually implementing this type of experimental investigation in future studies, there seem to be no major barriers which have been highlighted by the present study. While the initial reaction of many school administrators might be negative due to both their misconceptions about what such a project actually involves and their wish to avoid any parental criticism that the project might involve procedures which are too permissive, these initial negative reactions can be changed by careful orientation discussions. Parental reactions can be opposite to what administrators anticipate. This seems to have happened in this current study since an informal follow-up assessing parents' attitudes to the modifications attempted in the experimental mathematics classes already has indicated that over 90% of the parents who responded were favorably disposed to what had occurred. If administrator and parent initial concerns can be overcome, there should be no further major obstacles preventing the effective implementation of such a project. For example, the consultant in charge of the activity area required very little training in order to perform the specific responsibilities requested of him in this study. Similarly, the teacher and students involved in the experimental classes seemed to adapt rapidly and with little difficulty to the procedures employed. However, in many schools the problems of availability of space and equipment can be deterrents, when similar studies are attempted.

The investigation reported here unquestionably had effects upon the entire staff and student body of the school. The activity center was an obvious addition to the campus environment and it sparked curiosity among both adults and students from the moment of its arrival. From the reports of the

activity center consultant and from the on-site observations of one of the investigators, it was apparent that many of the school's staff were more conscious of educational innovations than otherwise might have been the case, and considerable thinking was stimulated regarding the possible positive and negative results of this particular innovation. Many students from classes not involved in the study were desirous of participating and only one of the 65 experimental students had to be removed from the study. This student's disruptive behavior had been displayed for a considerable period prior to the initiation of the study and, therefore, was not perceived as a result of this project.

The experimental design used in this study introduced certain problems which future research projects should seek to avoid. First was the possible confounding effect of having both experimental groups of subjects in physical and social proximity during the study. Clearer separation of subjects, perhaps while maintaining the procedure of using each subject as his own control, should be made if further experimentation is attempted. Another possible flaw involved the current study's use of two- and three-week periods of treatment alternation. Changes in subjects' achievement, and particularly in attitudes might not vary significantly in such short spans of time. Thus, variations on this feature of the experimental design should be studied. A future study might well be better scheduled over the total school year with a longer baseline period for assessing normal academic behavior and with a buffer period between the conclusion of the study and the end of the school year.

REFERENCES

Allen, K. E., Hart, B. M., Buell, J. S., Harris, F. R., and Wolf, N. M. Effects of social reinforcement on isolate behavior of a nursery school child. *Child Development*, 1964, 35, 511-518.

Beilin, H., and Gotkin, G. Psychological issues in the development of mathematics curricula for socially disadvantaged children. In A. H. Passow, et al, (Eds.) *Education for the disadvantaged.* New York: Holt, Rinehart, and Winston, 1967, 287-306.

Bloom, B. S., Davis, A., and Hess, R. *Compensatory education for cultural deprivation.* New York: Holt, 1965.

Bower, G. H. Recent developments: The basic conditions of learning and retention. In E. R. Hilgard and G. H. Bower, *Theories of learning.* New York: Appleton-Century-Crofts, 1966.

Dixon, W. J. (Ed.) *Biomedical computer programs.* Los Angeles: Health Sciences and Computing Facility, 1967.

Dixon, W. J. (Ed.) *BMD Biomedical computer programs X-Series supplement,* Los Angeles: University of California Press, 1969.

Flanagan, J. C. Functional education for the seventies. *Phi Delta Kappan,* 1967, 49, 27-32.

Gordon, E. W. Characteristics of socially disadvantaged children. *Review of Educational Research,* 1965, 35, 377-389.

Hall, R., Lund, D. and Jackson, D. Effects of teacher attention on study behavior. *Journal of Applied Behavior Analysis,* 1968, 1, 1-12.

Hawkins, R. P., Peterson, R. F., Schweid, E., and Bijou, S. W. Behavior therapy in the home: Amelioration of problem parent-child relations with the parent in a therapeutic role. *Journal of Experimental Child Psychology,* 1966, 4, 99-107.

Hilgard, E. R. and Bower, G. H. *Theories of learning.* New York: Appleton-Century-Crofts, 1966.

Holland, J. G., and Skinner, B. F. *The analysis of behavior.* New York: McGraw-Hill, 1961.

Homme, L. E. A demonstration of the use of self-instructional and other teaching techniques for remedial instruction of low-achieving adolescents in reading and mathematics. Final Report. United States Office of Education, Contract No. OE-4-16-033, 1964.

Homme, L. E. Coverant control therapy: A special case of contingency management. Unpublished paper, Albuquerque, New Mexico: Westinghouse Research Laboratories, Behavior Technology Department, 1965.

Homme, L. E. Contingency management, In, *Newsletter,* for the section on Clinical Child Psychology, Division of Clinical Psychology, American Psychological Association, 1966, 4, 1-4.

Homme, L. E. Contingency management. Unpublished manuscript. Albuquerque, New Mexico: Westinghouse Research Laboratories, Behavior Technology Department, 1967.

Homme, L. E., deBaca, P., Devine, J. V., Steinhorst, R., and Rickert, E. J. Use of the Premack Principle in controlling the behavior of nursery school children. *Journal Experimental Analytic Behavior*, 1963, 4, 544.

Krasner, L., and Ullman, L. P. *Research in behavior modification*. New York: Holt, Rinehart, and Winston, 1965.

Mager, R. F. *Preparing instructional objectives*. Palo Alto, California: Fearon, 1962.

Meehl, P. E. On the circularity of the law of effect. *Psychological Bulletin*, 1950, 47, 52-75.

Nelson, D. E. Ratings of concepts from the college environment by academically successful and unsuccessful undergraduates. Unpublished Masters Degree Thesis, Brigham Young University, 1966.

Osgood, C. E. and Suci, G. J. Factor analysis of meaning. *Journal of Experimental Psychology*, 1965, 50, 325-338.

Osgood, C. E., Suci, G. J., and Tannenbaum, P. H. *The measurement of meaning*. Urbana, Illinois: University of Illinois Press, 1957.

Premack, D. Toward empirical behavior laws I. Positive reinforcement. *Psychological Review*, 1959, 66, 219-233.

Premack, D. Rate differential reinforcement in monkey manipulation. *Journal of Experimental Analysis of Behavior*, 1963, 6, 81-89.

Premack, D. Reinforcement theory. Paper read at the Nebraska Motivation Symposium, Lincoln, 1965.

Sexton, P. C. *Education and income*. New York: Viking Press, 1961.

Silberman, C. E. The city and the negro. In A. H. Passow, M. Goldberg, and A. J. Tannenbaum (Eds.), *Education of the disadvantaged*. New York: Holt, Rinehart, and Winston, 1967, pp. 3-18.

Skinner, B. F. *Science and human behavior*. New York: MacMillan, 1953.

Ullman, L. P. and Krasner, L. (Eds.), *Case studies in behavior modification*, New York: Holt, Rinehart, and Winston, 1965.

Ulrich, R., Stachnik, T., and Mabry, T., (Eds.) *Control of human behavior*. Palo Alto, California: Scott, Foresman and Company, 1966.

APPENDIX A

SAMPLE CLU'S

Denholm and Blank, *Mathematics Structure and Skills*

Dolciani, *School Mathematics: Book I*

Guidance Research Program

American Institutes for Research

Cabrillo Learning Unit

D&B

CHAPTER I AN INTRODUCTION TO MODERN MATH

STEP I. Symbols

Objective 1. List one use of symbols.

Objective 2. Write numerals and word names for numbers.

Do The Following Activities

A. Read section 1-1, Symbols, pages 2-3.

B. Do problems #1-5, pages 2-3.

C. Check answers in answer book.

STEP II. Sets

Objective 1. List two ways of describing a set.

Do The Following Activities

A. Read section 1-2, Sets, pages 3-4.

B. Do problems #1 and #2, pages 3-4.

C. Check answers in answer book.

This material was prepared under Grant #OEG-9-9-140004--0024(057), Research Project #9-I-004, with the Office of Education, U.S. Department of Health, Education, and Welfare. January, 1970.

Guidance Research Program

D&B

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CHAPTER I AN INTRODUCTION TO MODERN MATH

STEP III. Whole Numbers

Objective 1. Given a list of fractions, decimals and whole numbers, list the whole numbers.

Objective 2. Write the set of whole numbers using set notation.

Objective 3. Determine the number that belongs to a set of objects.

Do The Following Activities

A. Read section 1-3, whole numbers, pages 4-5.

B. Do problems #1, 2 and 3, pages 4-5.

C. Check answers in answer book.

STEP IV. Order of Whole Numbers

Objective 1. Determine the missing numerals in different number series.

Objective 2. Given a set of whole numbers, list them in order with the smallest first.

Objective 3. Given any two whole numbers, make true sentences using "is equal to," "is less then," or "is greater than."

Do The Following Activities

A. Read section 1-4, order of whole numbers, pages 5-7.

B. Do problems #1-7, pages 5-7.

C. Check answers in answer book.

This material was prepared under Grant #OEG-9-9-140004--0024(057), Research Project #9-I-004, with the Office of Education, U.S. Department of Health, Education, and Welfare. January, 1970.

CHAPTER I AN INTRODUCTION TO MODERN MATH

STEP V. Consecutive Whole Numbers

Objective 1. Given a set of whole numbers, determine if the numbers are consecutive.

Objective 2. Starting with any whole number, write a series of consecutive numbers.

Objective 3. Name consecutive whole numbers between any two given whole numbers.

Do The Following Activities

A. Read section 1-5, consecutive whole numbers, pages 7-9.

B. Do problems #1-6, pages 7-9.

C. Check answers in answer book.

STEP VI. The Number Line

Objective 1. Draw a number line.

Objective 2. Make a number line picture to show "moves to the right" and "moves to the left."

Do The Following Activities

A. Read section 1-6, The Number Line, pages 10-12.

B. Do problems #1-6, pages 10-12.

C. Check answers in answer book.

This material was prepared under Grant #OEG-9-8-140004--0024(057), Research Project #9-I-004, with the Office of Education, U.S. Department of Health, Education, and Welfare. January, 1970.

CHAPTER I AN INTRODUCTION TO MODERN MATH

STEP VII. Graphing Whole Numbers on the Number Line

Objective 1. Graph sets of whole numbers on the number line.

Objective 2. Match graphs with word descriptions of sets of whole numbers.

Objective 3. Given a chart of heights in inches, answer related questions about the heights.

Do The Following Activities

A. Read section 1-7, Graphing Whole Numbers on the Number Line, pages 12-15.

B. Do problems #1-4, pages 12-14.

C. Do problems #1-8, page 15.

D. Check answers in answer book.

STEP VIII. Word Phrases and Number Phrases

Objective 1. Match word phrases with number phrases.

Objective 2. Translate word phrases into number phrases.

Objective 3. Translate number phrases into word phrases.

Do The Following Activities

A. Read section 1-8, Word Phrases and Number Phrases, pages 15-16.

B. Do problems #1, 2 and 3, pages 15-16.

C. Check answers in answer book.

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CHAPTER I AN INTRODUCTION TO MODERN MATH

STEP IX. Word Sentences and Number Sentences

Objective 1. Write number sentences for word sentences.

Objective 2. Write word sentences for number sentences.

Do The Following Activities

A. Read section 1-9, Word Sentences and Number Sentences, pages 16-18.

B. Do problems #1-6, pages 16-18.

C. Check answers in answer book.

STEP X. True and Fake Sentences

Objective 1. Determine if a sentence is true or false.

Objective 2. Write true sentences using > or <.

Do The Following Activities

A. Read Section 1-10, True and Fake Sentences, pages 19-20.

B. Do problems #1-4, pages 19-20.

C. Check answers in answer book.

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STEP XI. Addition in Frame Arithmetic.

Objective 1. Fill in frames to make true sentences.

Do The Following Activities

A. Read section 1-11. Addition in Frame Arithmetic, pages 20-21.

B. Do problems #1-4, pages 20-21.

C. Check answers in answer book.

STEP XII. Subtraction in Frame Arithmetic.

Objective 1. Fill in frames to make true sentences.

Do The Following Activities

A. Read section 1-12, Substraction in Frame Arithmetic, pages 21-22.

B. Do problems #1, 2 and 3, pages 21-22.

C. Check answers in answer book.

STEP XIII. Multiplication in Frame Arithmetic.

Objective 1. Fill in frames to make true sentences.

Do The Following Activities

A. Read section 1-13, Multiplication in Frame Arithmetic, pages 22-23.

B. Do problems #1-4, pages 22-23.

C. Check answers in answer book.

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STEP XIV. Division in Frame Arithmetic.

Objective 1. Fill in frames to make true sentences.

Do The Following Activities

A. Read section 1-14, Division in Frame Arithmetic, pages 23-24.

B. Do problems #1, 2 and 3, pages 23-24.

C. Check answers in answer book.

STEP XV. Sentences with < or >.

Objective 1. Complete two phrases with < or > to make a true sentence.

Objective 2. Given a chart with distances between cities, answer related questions about the chart.

Do The Following Activities

A. Read section 1-15, Sentences with < or >, pages 24-25.

B. Do problems #1, 2 and 3, page 24.

C. Do problems #1 and 2, page 25.

D. Check answers in answer book.

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STEP XVI. Length

Objective 1. Write the meaning of "unit length."

Objective 2. Given the unit of length, determine the measure of various items.

Objective 3. Determine the length of line segments for various units of length.

Do The Following Activities

A. Read section 1-16, Length, pages 26-28.

B. Do problems #1-5, pages 26-28.

C. Check answers in answer book.

STEP XVII. Area

Objective 1. Write the meaning of "unit square."

Objective 2. Determine the area of rectangular regions.

Objective 3. Estimate the area of irregular regions.

Do The Following Activities

A. Read section 1-17, Area, pages 29-31.

B. Do problems #1, 2 and 3, pages 29-31.

C. Check answers in answer book.

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CHAPTER I AN INTRODUCTION TO MODERN MATH

STEP XVIII. Volume

Objective 1. Write the meaning of "unit cube."

Objective 2. Find the volume of solids made up of cubes.

Do The Following Activities

A. Read section 1-18, Volume, pages 31-32.

B. Do problems #1-4, pages 31-32.

C. Check answers in answer book.

Note: Review all your previous papers. When you are certain you know the material, ask your teacher for the test on CHAPTER I.

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CHAPTER I--NUMBERS AND NUMERATION SYSTEMS

STEP 1.

Objective 1. DISCRIMINATE BETWEEN NUMBER AND NUMERAL.

Do The Following Activities

A. Read pages 1 and 2 and study the illustrations on these pages.

B. Do Exercises #1, #2, and #3 on pages 2 and 3.

C. Use the Answer Key to check your work.

STEP 2.

Objective 2. GIVEN A WHOLE NUMBER OF NINE DIGITS OR LESS, READ AND WRITE THE CORRECT PLACE VALUE OF EACH OF THE DIGITS.

Do The Following Activities

A. Read and study page 5.

B. On page 6, do Exercises #1, #2, (a), (b) and (c), #3 and #5.

C. Check your work.

D. Try problems #7 and #8 on page 7 if you would like a challenge.

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CHAPTER I--NUMBERS AND NUMERATION SYSTEMS

STEP 3.

Objective 3. EXPRESS THE PRODUCT OF SEVERAL LIKE FACTORS IN EXPONENT FORM AND VICE VERSA.

Do The Following Activities

A. Read carefully the top half of page 8. Make certain that you know the meanings of: power, base, exponent.

B. What is the meaning of 10^1?

C. Do Exercises #1 and #3 on page 8 and #4, #6 and #8 on page 9.

D. Check your answers.

STEP 4.

Objective 4. ROUND NUMBERS TO THE NEAREST TEN, HUNDRED, THOUSAND TEN THOUSAND, HUNDRED THOUSAND OR MILLION.

Do The Following Activities

A. Read page 13.

B. Is $987 approximately equal to $1000?

C. Do Exercise #1 on page 13 and Exercises #2, #5 and #7 on page 14.

D. Check your answers.

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CHAPTER 1--NUMBERS AND NUMERATION SYSTEMS

STEP 5.

Objective 5. USE THE SYMBOLS <, >, AND =, TO CORRECTLY COMPLETE NUMBER SENTENCES.

Do The Following Activities

A. Study the section on "Inequalities" on page 15.

B. Think about the "Discussion Exercise."

C. Do Exercises #1 on page 15 and #4 on page 16.

D. Check your answers.

STEP 6.

Objective 6. BE ABLE TO WRITE BASE EIGHT NUMERALS FOR GIVEN BASE TEN NUMERALS AND VICE VERSA.

Do the Following Activities

A. Read page 18.

B. Read the top half of page 21 very carefully.

C. Think about the "Discussion Exercise."

D. Do Exercises #1 and #2 on page 21 and #4 and #5 on page 22.

E. Check your answers.

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CHAPTER I--NUMBERS AND NUMERATION SYSTEMS

STEP 7.

Objective 7. BE ABLE TO ADD ANY TWO THREE-DIGIT NUMBERS IN BASE EIGHT NUMERATION.

Do The Following Activities

A. Read the top half of page 25. Study the illustrations.

B. Do Exercises #1 and #2 on page 25

C. Check your answers.

STEP 8.

Objective 8. BE ABLE TO MULTIPLY TWO NUMBERS IN BASE EIGHT NUMERATION.

Do The Following Activities

A. Review the top half of page 25.

B. Do Exercises #2 on page 25 and #4 on page 26.

C. Check your answers.

D. If you would like some more interesting problems, try the starred problems on page 26.

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CHAPTER I--NUMBERS AND NUMERATION SYSTEMS

STEP 9.

Objective 9. WRITE HINDU-ARABIC NUMERALS AS EGYPTIAN NUMERALS AND VICE VERSA.

Do The Following Activities

A. Read the paragraph at the top of page 27.

B. Study the chart at the left side of page 27.

C. Do Exercises #1, #2, #3 and #4 on pages 27 and 28.

D. Check your answers.

STEP 10.

Objective 10. WRITE HINDU-ARABIC NUMERALS AS BABYLONIAN NUMERALS AND VICE VERSA.

Do The Following Activities

A. Study the middle chart on page 27.

B. Do Exercises #5 and #6 on page 28.

C. Check your answers.

D. If you prefer more difficult problems try #7 on page 28.

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CHAPTER I--NUMBERS AND NUMERATION SYSTEMS

STEP 11.

Objective 11. WRITE HINDU-ARABIC NUMERALS AS ROMAN NUMERALS AND VICE VERSA.

Do The Following Activities

A. Read the top part of page 29 and study the Roman Numeral chart on page 29.

B. How is XI different from IX?

C. Do Exercises #8, #9, #10 and #11 on page 29.

D. Check your answers.

Note: Review all papers from this chapter before asking your teacher for the CHAPTER 1 test.

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APPENDIX B

SAMPLE CHECK OFF PROBLEM FORM

Name: _____ Section: _____ Date: _____

Book: *Denholm and Blank* Chapter: *4* Objective: *6*

Problem *2d* on page *97*.

Answer Below

APPENDIX C

SAMPLE UNIT TESTS

Denholm and Blank, *Mathematics Structure and Skills*

Dolciani, *School Mathematics: Book I.*

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INDEPENDENT TEST FOR CHAPTER 1

PART 2. SECTIONS 1-8 through 1-15.

1. #2 a, e, l, page 16.
2. #1.b, page 17.
3. #2h, page 17.
4. #4c, page 18.
5. #4g, page 18.
6. #1d, i, k, page 19.
7. #2a, k, l, page 19.
8. #4a, g, h, page 20.
9. #1j, n, o, page 20.
10. #3h, p, x, page 21.
11. #1, g, m, o, page 21.
12. #3a, f, i, page 22 top.
13. #2a, j, p, page 22 bottom.
14. #4a, j, p, page 23.
15. #2a, f, j, page 23.
16. #2a, e, h, page 24.

PART 3. SECTIONS 1-16 through 1-18.

1. #3 all, page 27.
2. #2 all, page 30.
3. #2a, c, d, page 32.
4. #4a, e, f, page 32.

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INDEPENDENT TEST FOR CHAPTER 1

PART 1. SECTIONS 1-1 through 1-7.

1. #1, all page 2.
2. #2b, page 4, top of page.
3. #2c, page 4, bottom of page.
4. #2d, page 6.
5. #3b, page 6.
6. #7j, page 7.
7. #4f, page 9.
8. #5f, page 9.
9. #2b, page 10.
10. #3k, page 10-11.
11. #4d, page 11.
12. #1, all, page 13.
13. #2b, page 13.
14. #3c, page 14.

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INDEPENDENT TEST FOR CHAPTER I

1. Which is the larger numeral, 3 or 8?
2. Is 10^3 a numeral for 1000?
3. In the numeral 234,686, the 4 is in the _____ place.
4. Which of these statements is true? Circle them.
   (a) $10^2 = 20$ (b) $50^0 = 1$ (c) $10^2 = 100$
5. Using 10, with an exponent write 1,000,000.
6. Write a Hindu-Arabic numeral for:
   $3 \cdot 10^4 + 2 \times 10^3 + 0 \times 10^2 + 3 \times 10 + 6$.
7. Round 7468 to the nearest hundred
8. Write the base eight numeral to show the number of eggs in a dozen.
9. 67_8 is equal to what base ten numeral?
10. The product of $10^4 \cdot 10^3$ written as a power of ten is: _____.

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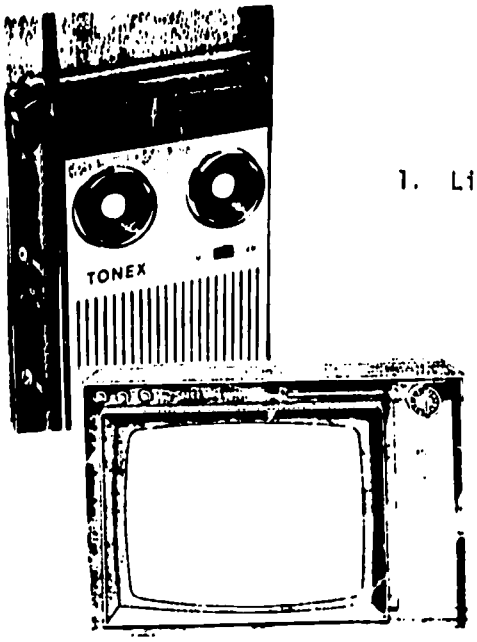
APPENDIX D--REINFORCEMENT MENU

American Institutes for Research
Guidance Research Program
December 15, 1969

Preferred Activities Survey

We are visiting your classroom today to find out what things you like to do. First, imagine that there were some time during each school day when you could choose what you wanted to do. If someone were willing to provide the materials and equipment, what activities would you choose to do if some time were given to you during each school day. Maybe you'd like to work on one of your school subjects that you especially enjoy. Perhaps you'd enjoy reading some books or magazines that interest you. On the next few pages are pictures of activities you might enjoy. Suppose a place and the materials you need were provided at school. What things would you like to do if you were given some time? In the box at the right hand of the page place a check mark by each thing you'd really like to do. If there are activities you would like but they are not listed, add them in the blanks on the last page of this booklet.

After you have decided which activities you'd like to do, go back and circle the boxes by the <u>three</u> activities you want to do most. Pick any three from the list we included and/or from those activities you added to the list. Choose the <u>three</u> activities you would enjoy most if you had some free time here at school by putting a circle around the box by each of the three activities.



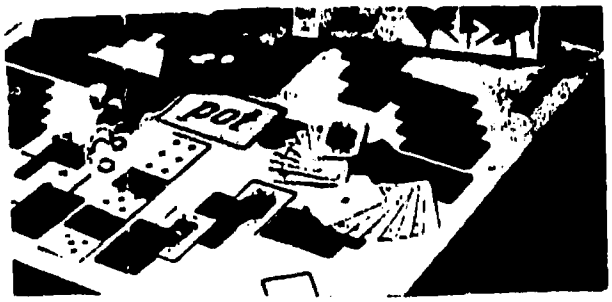
1. Listening to the radio.

2. Watching TV

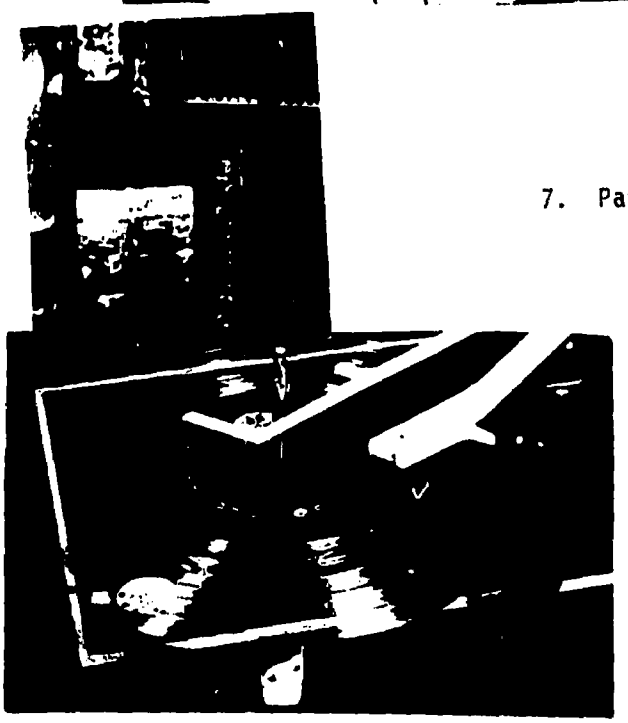
3. Having a soft drink

4. Drawing or writing

5. Watching slides or movies of interesting places and people

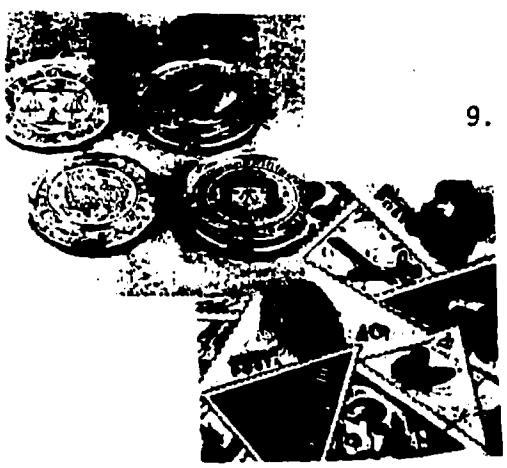


6. Playing games ☐



7. Painting and art work ☐

8. Listening to records ☐



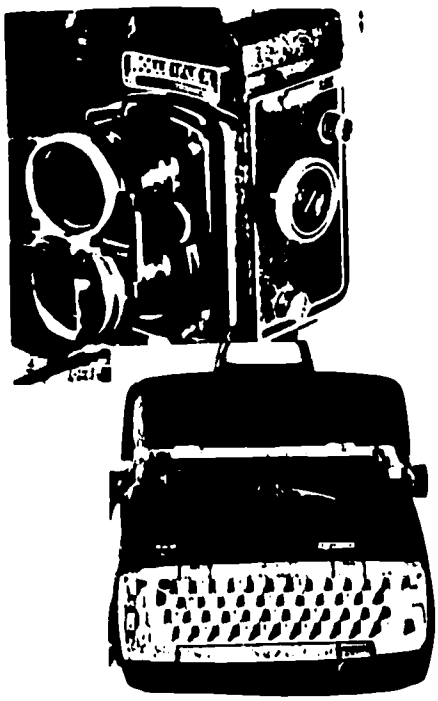
9. Collecting things or working on a hobby ☐

10. Making models ☐

11. Listening to tapes ☐

12. Reading books or magazines ☐

13. Playing a musical instrument ☐



14. Taking pictures or making movies ☐

15. Typing or writing ☐

Other Activities I Would Enjoy

1.

2.

3.

4.

5.

6.

7.

8.

9.

10.

11.

12.

13.

14.

15.

Q3

Form Q • Level

CTBS

COMPREHENSIVE TESTS OF BASIC SKILLS

ARITHMETIC

CTB

PUBLISHED BY **CALIFORNIA TEST BUREAU** A DIVISION OF McGRAW-HILL BOOK COMPANY

TO THE STUDENT:

This booklet contains tests that will show how well you can use basic skills that are important to you in many things you do every day. The paragraphs below give you some points to remember while you take these tests.

- Make sure you understand all the directions before you begin to do each test. You may ask questions about any directions you do not understand. Do not begin any test until you are told to do so.
- Work as fast as you can. There may be items you cannot do because they test things you have not yet been taught. If an item is too difficult, do not spend too much time on it. Make the most careful choice you can, and go on to the next item.
- If you come to the word "Stop" at the bottom of a page before time is called, do not turn the page. Go back over your work in the test you just completed.
- Mark all of your answers on your answer sheet. Answer marks should be neat and clear. Be sure you mark only one answer for each item. If you make a mistake or want to change an answer, erase your first answer completely.

Published by California Test Bureau, a Division of McGraw-Hill Book Company, Del Monte Research Park, Monterey, California 93940
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TEST 6 • ARITHMETIC Computation

This test will show how well you can add, subtract, multiply, and divide.

DIRECTIONS: On the next four pages, the word above each column will tell you to add, subtract, multiply, or divide. Use scratch paper to do your work. Mark on your answer sheet the space that goes with the letter of the answer you think is correct.

SAMPLE ITEMS: Do the Sample Item in the first column below and see how the correct answer is marked on your answer sheet.

Now do the Sample Item in the next column and mark the answer on your answer sheet.

Addition		Subtraction	
	A 4		A 1
8	B 6	3	B 6
+ 1	C 8	− 2	C 23
	D 12		D 32

TEST 6

► Do these items the same way you did the Sample Items. Reduce fractions to lowest terms.

Addition

1

$3.00 + $0.12 + $1.80 =

A $ 3.92
B $ 4.92
C $ 6.00
D $16.80

2

4,725
257
1,635
+ 445

F 7,062
G 7,071
H 7,942
J 8,072

3

46.7000
6.2300
.0574
+ 7.0000

A 49.9874
B 52.9774
C 59.9774
D 59.9874

4

.03 + .134 + .7305 =

F .7442
G .8945
H 7.945
J 8.942

Subtraction

5

3,570
− 2,680

A 810
B 890
C 990
D 1,090

6

16.25
− 3.95

F 3.20
G 12.20
H 12.30
J 13.30

7

57.240 − 15.13 =

A 41.310
B 42.110
C 55.627
D 55.727

8

76.04 − 6.0225 =

F 52.621
G 67.379
H 70.0175
J 70.0225

Multiplication

9

956
× 40

A 3,824
B 36,240
C 38,140
D 38,240

10

576
× 42

F 24,192
G 24,198
H 24,202
J 26,010

11

14.65
× 20

A 28.30
B 29.30
C 292.00
D 293.00

12

4,043
× 705

F 303,225
G 2,850,315
H 2,935,205
J 3,130,315

► Reduce fractions to lowest terms.

Division

13 $6 \overline{)} 60$

A 10
B 12
C 15
D 16

14 $7 \overline{)} 427$

F 10
G 57
H 61
J 67

15 $4 \overline{)} 426$

A 96 *R* 2
B 106 *R* 2
C 111 *R* 2
D 160 *R* 2

16 $\frac{2}{3} \div \frac{2}{3} =$

F $\frac{1}{3}$
G $\frac{4}{9}$
H $\frac{2}{3}$
J 1

Addition

17 $6\frac{1}{2} + 3.5 =$

A 5.2
B 9.4
C 10.0
D 10.5

18 $\frac{1}{3} + \frac{1}{3} =$

F $\frac{1}{6}$
G $\frac{1}{3}$
H $\frac{1}{2}$
J $\frac{2}{3}$

19 $\frac{1}{4} + \frac{1}{8} =$

A $\frac{1}{12}$
B $\frac{1}{6}$
C $\frac{1}{4}$
D $\frac{3}{8}$

20 $\frac{3}{4} + 4\frac{1}{2} =$

F $4\frac{2}{3}$
G $5\frac{1}{4}$
H $5\frac{3}{8}$
J $6\frac{1}{2}$

Subtraction

21 $\frac{2}{5} - \frac{1}{4} =$

A $\frac{1}{10}$
B $\frac{1}{20}$
C $\frac{1}{4}$
D $\frac{7}{20}$

22 $42\frac{1}{2} - 12.25 =$

F 29.25
G 29.75
H 30.15
J 30.25

23 $\frac{1}{4} - \frac{1}{8} =$

A $\frac{1}{8}$
B $\frac{3}{8}$
C $\frac{1}{2}$
D $\frac{3}{4}$

24 $14\frac{1}{10} - 7\frac{1}{100} =$

F $6\frac{9}{100}$
G $6\frac{9}{10}$
H $7\frac{9}{100}$
J $7\frac{9}{10}$

► Reduce fractions to lowest terms.

Multiplication

25

$$\begin{array}{r} 76.60 \\ \times \quad 51 \\ \hline \end{array}$$

A 459.60
B 3,806.00
C 3,903.60
D 3,906.60

26

$$\begin{array}{r} 382.5 \\ \times \quad 6 \\ \hline \end{array}$$

F 1,892.0
G 2,185.0
H 2.295.0
J 22,950.0

27

$4 \times \frac{1}{5} =$

A $\frac{4}{5}$
B $1\frac{1}{5}$
C $4\frac{1}{5}$
D 20

28

$\frac{1}{3} \times \frac{3}{5} =$

F $\frac{1}{5}$
G $\frac{3}{5}$
H $\frac{5}{9}$
J $\frac{4}{5}$

Division

29

$3\overline{)\,8.04}$

A 2.24
B 2.66
C 2.68
D 26.80

30

$5\overline{)\,93.75}$

F 17.85
G 18.75
H 19.15
J 21.05

31

$54\overline{)\,33.48}$

A .59
B .62
C 1.62
D 6.02

32

$\frac{7}{8} \div \frac{1}{8} =$

F $\frac{7}{64}$
G $\frac{7}{8}$
H 1
J 7

Addition

33

$5^2 + 899 =$

A 904
B 909
C 924
D 951

34

$$\begin{array}{r} 14\frac{1}{8} \\ +\ 3\frac{1}{3} \\ \hline \end{array}$$

F $17\frac{3}{8}$
G $17\frac{11}{24}$
H $18\frac{1}{24}$
J $18\frac{1}{3}$

35

$$\begin{array}{r} 2\frac{1}{4} \\ +\ 3\frac{5}{6} \\ \hline \end{array}$$

A $6\frac{1}{12}$
B $6\frac{1}{4}$
C $6\frac{5}{12}$
D $7\frac{1}{24}$

36

$$\begin{array}{r} 52\frac{3}{8} \\ 15\frac{1}{6} \\ +\ 34\frac{3}{4} \\ \hline \end{array}$$

F $101\frac{1}{24}$
G $101\frac{1}{14}$
H $102\frac{1}{48}$
J $102\frac{7}{24}$

► Reduce fractions to lowest terms.

Subtraction

37

$999 - 4^2 =$

A 983
B 991
C 993
D 997

38

$$\begin{array}{r} 11\frac{1}{4} \\ -\ 8\frac{3}{5} \\ \hline \end{array}$$

F $2\frac{7}{20}$
G $2\frac{13}{20}$
H $3\frac{7}{20}$
J $3\frac{2}{3}$

39

$$\begin{array}{r} 8 \\ -\ 3\frac{1}{3} \\ \hline \end{array}$$

A $4\frac{1}{3}$
B $4\frac{2}{3}$
C $5\frac{1}{3}$
D $11\frac{1}{3}$

40

$$\begin{array}{r} 2\frac{5}{8} \\ -\ 1\frac{1}{6} \\ \hline \end{array}$$

F $\frac{15}{24}$
G $\frac{23}{24}$
H $1\frac{11}{24}$
J $1\frac{19}{24}$

Multiplication

41

$\frac{1}{5} \times \frac{5}{8} =$

A $\frac{1}{8}$
B $\frac{1}{2}$
C $\frac{25}{32}$
D $1\frac{1}{3}$

42

$\frac{1}{3} \times \frac{1}{3} =$

F $\frac{1}{9}$
G $\frac{1}{3}$
H 1
J 3

43

$$\begin{array}{r} 3x + 4y + 7z \\ \times \qquad\qquad 4 \\ \hline \end{array}$$

A $19x + y + 15z$
B $17x + 2y + 8z$
C $18x + 8y + 4z$
D $12x + 16y + 28z$

44

$7\frac{1}{3} \times \frac{5}{6} =$

F $5\frac{1}{2}$
G $6\frac{1}{9}$
H $9\frac{1}{6}$
J $12\frac{2}{9}$

Division

45

$1 \div \frac{1}{4} =$

A $\frac{3}{4}$
B $1\frac{1}{4}$
C 2
D 4

46

$\frac{1}{5} \div 2 =$

F $\frac{1}{10}$
G $\frac{2}{5}$
H $2\frac{1}{5}$
J $2\frac{1}{2}$

47

$4\frac{3}{4} \div \frac{7}{8} =$

A $5\frac{3}{7}$
B $7\frac{3}{4}$
C $21\frac{5}{7}$
D 38

48

$\left(\frac{1}{2} \text{ of } 12\right) \div \left(\frac{1}{4} \text{ of } 8\right) =$

F $\frac{1}{3}$
G $\frac{3}{4}$
H 3
J 12

TEST 7 • ARITHMETIC Concepts
TEST 8 • ARITHMETIC Applications

These tests will show how well you can do arithmetic problems.

DIRECTIONS: Read each item in the next two tests and choose the answer you think is correct. Mark on your answer sheet the space that goes with the letter of the answer you think is correct. Use scratch paper to do your work.

SAMPLE ITEMS: Do the first Sample Item below and see how the correct answer is marked on your answer sheet.

What should be next in this series:

8, 10, 12, ____ ?

A 11
B 13
C 14
D 16

Now do the next Sample Item and mark the answer on your answer sheet.

Which fraction means the *same* as one-half?

F $\frac{1}{8}$ G $\frac{1}{4}$ H $\frac{1}{3}$ J $\frac{1}{2}$

► Do these items the same way you did the Sample Items.

1 How much money is two dollars, six cents, and $10.30 ?

A **$12.36**
B **$12.63**
C **$18.03**
D **$30.63**

2 The expanded numeral form of the number 842 is

F **8 + 4 + 2**
G **8 + 4 + 2 × 100**
H **(8 + 100) × (4 + 10) × (2 + 1)**
J **(8 × 100) + (4 × 10) + (2 × 1)**

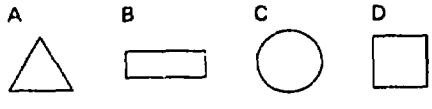
3 Solve for n in $\frac{n}{5} = 4$.

A $n = 2.2$
B $n = 15$
C $n = 20$
D $n = 35$

4 Which of the following is closest to an hour?

F **20 min. 35 sec.**
G **25 min. 35 sec.**
H **35 min. 50 sec.**
J **90 min. 30 sec.**

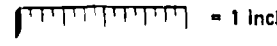
5 The perimeter formula, $P = 4s$, is correct for which of the following?



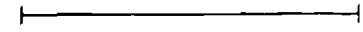
6 One half of the class is girls. Which one of the following statements about the class must be true?

F **There are more girls than boys in the class.**
G **There is an even number of students in the class.**
H **There is a one to two ratio of girls to boys.**
J **There is a two to one ratio of girls to boys.**

7 One inch is about 2.5 centimeters (cm.).



Estimate the length of the line below in centimeters.



A **1 cm.**
B **5 cm.**
C **10 cm.**
D **25 cm.**

8 Simplify the expression:

$$5 + (4 \times 3)$$

F **12**
G **17**
H **23**
J **27**

9 Mary was 15 three years ago. In ten years she will be the same age as Sally is now. How old is Sally now?

A **12**
B **18**
C **22**
D **28**

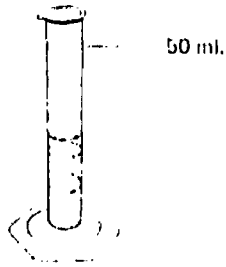
10 Which of these decimal fractions lies on the number line between .30 and .40 ?

F **.03**
G **.14**
H **.31**
J **.41**

11 If a meter is 3.37 inches longer than a yard, then a 100 meter dash is

A **always greater than a 100 yard dash**
B **always less than a 100 yard dash**
C **the same as a 100 yard dash**
D **sometimes less and sometimes greater than a 100 yard dash**

12 Estimate the amount of liquid in this 50 milliliter (ml.) graduate.



F 10 ml.
G 15 ml.
H 20 ml.
J 25 ml.

13 What is the correct answer for the subtraction problem below?

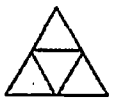
3 yards 7 feet 5 inches
− 1 yard 6 inches

A 2 yd. 1 in.
B 2 yd. 6 ft. 11 in.
C 3 yd. 11 in.
D 3 yd. 2 ft. 8 in.

14 If A is less than C and B is less than A, then

F C is greater than B
G B is greater than C
H B and C are equal
J A plus C equals B

15 What per cent of this geometric figure is not shaded?



A 1%
B 25%
C 30%
D 75%

16 Which of the following is equal to six?

F $2 \times 3 \times 0$
G $6\ (0)$
H $36 \div 6$
J $\sqrt{6}$

17 Which of the following, when divided by 9, has no remainder?

A 66
B 305
C 315
D 512

18 If $a = 7$, $b = 3$, $c = 11$, $d = 9$, then what is the value of $(a - b) \times (c - d)$?

F 7
G 8
H 12
J 16

19 Four multiplied by four is the same as

A 4^2
B $4 \cdot 4 \cdot 4$
C $4 : 4$
D $\sqrt{16}$

20 Which of the following is closest to a yard?

F 1 ft. 10 in.
G 2 ft. 7 in.
H 3 ft. 11 in.
J 12 ft. 1 in.

21 In 5963.427 the digit in the hundredths place is

A 2
B 5
C 6
D 7

22 Which has the greatest value?

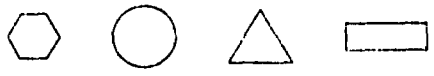
F $\frac{1}{5}$ G 32% H 28% J $\frac{1}{3}$

23 What is .371 written as a fraction?

A $\frac{371}{10}$ B $\frac{371}{100}$ C $\frac{371}{1000}$ D $\frac{3.71}{100}$

24 The perimeter formula $P = 2l + 2w$ would be used for which of the following?

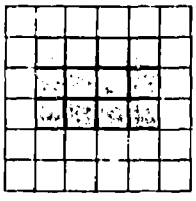
F G H J



25 In decimal form, 5% may be written as

A .05
B .5
C 5
D 50

26 What is the formula for the number (n) of the shaded blocks in this square?

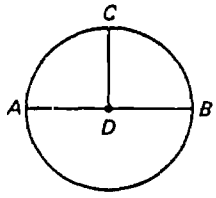


F $\frac{4}{6} \times \frac{3}{6} = n$
G $\frac{1}{6} \times \frac{5}{6} = n$
H $5 \times 3 = n$
J $4 \times 3 = n$

27 What is four hundred seventy-one thousandths written as a decimal?

A .471
B .0471
C 470.100
D 471.000

28 Which line segment shows the diameter of the circle?

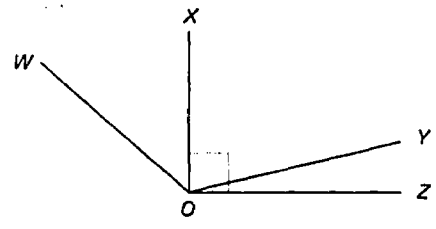


F segment *AD*
G segment *AB*
H segment *DB*
J segment *CD*

29 If A $< \frac{5}{6}$ and $\frac{5}{6} <$ B, then what do you know about A and B ?

A A = B
B A > B
C A < B
D A + B = $\frac{5}{6}$

30 In the figure below, which angle is a right angle?



F ∠ *XOY*
G ∠ *XOZ*
H ∠ *YOZ*
J ∠ *WOY*

► Do these items the same way you did the Sample Items.

31 Pedro ate $\frac{5}{8}$ of a pie and Bob ate $\frac{1}{8}$ of a pie. How much of the pie did they eat?

A $\frac{2}{8}$ B $\frac{3}{8}$ C $\frac{6}{8}$ D $\frac{7}{8}$

32 Mark gave the waiter $4.00 and received $1.60 in change. How much did the dinner cost?

F **$1.40**
G **$2.40**
H **$3.80**
J **$5.60**

33 John saved $7 and Dave saved $28. What is the ratio of John's money to Dave's?

A $\frac{1}{35}$ B $\frac{7}{35}$ C $\frac{1}{7}$ D $\frac{1}{4}$

34 There were 10 boys and 5 girls in Bill's class. The ratio of boys to girls is

F **2 to 1**
G **3 to 1**
H **3 to 2**
J **4 to 1**

35 Marilyn had 8 ounces of butter and 2 pounds of meat. How many pounds did the food weigh?

A **$1\frac{1}{2}$ lb.**
B **$2\frac{1}{8}$ lb.**
C **$2\frac{1}{2}$ lb.**
D **10 lb.**

36 Of the 24 children in class, 6 were reading. What fraction of the class were reading?

F $\frac{1}{4}$ G $\frac{1}{3}$ H $\frac{2}{3}$ J $\frac{3}{4}$

37 Phil sold 25 papers at 10¢ each. Then he worked for 2 hours at 25¢ an hour. To find how much money he had all together, you can

A **multiply and then add**
B **divide and then add**
C **multiply and then subtract**
D **divide and then subtract**

38 A board 3 *feet* long and a board 2 *yards* long are placed end to end. How far, in feet, do they reach?

F **5 ft.**
G **6 ft.**
H **9 ft.**
J **11 ft.**

39 Jean had 1 *gallon* of water and 2 *pints* of milk. How many pints of liquid did she have all together?

A **5 pt.**
B **6 pt.**
C **10 pt.**
D **18 pt.**

40 On a map 1 inch = 50 miles. How far is $3\frac{1}{2}$ inches on the map?

F **125 mi.**
G **150 mi.**
H **175 mi.**
J **350 mi.**

41 Mr. Briggs bought a TV set. He may pay $20 a month for 1 year or $195 cash. How much can he save by paying cash?

A $ 5
B $ 45
C $200
D $240

42 A rug is 5 feet wide and 6 feet long. What is its area?

F 2 sq. ft.
G 11 sq. ft.
H 15 sq. ft.
J 30 sq. ft.

43 Mr. Hall must wash 217 windows. He washed 7 windows each day for 8 days. To find how many were left to wash, you can

A add and then divide
B multiply and then add
C multiply and then subtract
D subtract and then multiply

44 Mae had $\frac{1}{2}$ of a cake and Jane had $\frac{1}{6}$ of a cake. How much more cake did Mae have than Jane?

F $\frac{1}{4}$ G $\frac{1}{3}$ H $\frac{4}{9}$ J $\frac{1}{2}$

45 Three boys were 58, 61, and 66 inches tall. To find their average height, you can

A add the heights
B add the heights and divide by 2
C add the heights and multiply by 3
D add the heights and divide by 3

46 A sales tax is 4%. What is the tax on $10 ?

F $0.04
G $0.40
H $0.44
J $4.00

47 To find the average score on an arithmetic test for a class of 20 students, we need to know

A the score of each student on the test
B the number of questions in the test
C only the scores of the failing students
D the number of questions each student attempted

48 Bob had $\frac{3}{8}$ of the melon and Juan had $\frac{3}{8}$ of the melon. How much of the melon did they have all together?

F $\frac{1}{4}$ G $\frac{6}{16}$ H $\frac{2}{3}$ J $\frac{3}{4}$

49 A cake was cut into 8 equal pieces. Jim and Ed each got 1 piece. What per cent of the cake did they have together?

A $12\frac{1}{2}\%$ B 25% C $33\frac{1}{3}\%$ D 50%

50 In order to change inches into feet, you can

F add 12
G subtract 12
H multiply by 12
J divide by 12

APPENDIX F--ATTITUDE QUESTIONNAIRE

American Institutes for Research
Guidance Research Program
6 February 1970

ATTITUDE QUESTIONNAIRE - PART I

The items in Part I try to measure your understanding of certain words or phrases of words. Each numbered item presents both a word or phrase such as "pie" and a scale with seven spaces.

If you feel that the word or phrase is very closely related to one end of the scale, you might place your check mark in one of the two spaces checked below.

Pie:

Up / X / / / / / / X / Down

If you feel that the word is quite closely related to one side of the scale you might place your check mark in one of the two spaces checked below.

House:

Straight / / X / / / / X / / Crooked

If the word seems only slightly related to one side as opposed to the other, you might put a mark in one of the two spaces checked below.

Cloud:

Easy / / / X / / X / / / Difficult

If the word just isn't related at all in your mind with either side of the scale, or is related equally with both sides of the scale, you might check the middle space that is checked below.

Tree:

Idealistic / / / / X / / / / Realistic

Sometimes you may feel as though you have had the same item before. This is not true since all items are different. Do not look back and forth throughout the booklet. Also, do not try to remember how you mark items. Make each item a separate and independent rating. Work at fairly high speed, without worrying about individual items for a long time. It is your first impression that is best.

(MARK ONLY ONE SPACE ON THE SCALE FOR EACH ITEM.)

1. Math:

Fair / / / / / / / / Unfair

2. Teachers:

Valuable / / / / / / / / Worthless

3. Studying:

Sweet / / / / / / / / Sour

4. Tests:

Clean / / / / / / / / Dirty

5. Classes:

Good / / / / / / / / Bad

6. Grades:

Fair / / / / / / / / Unfair

7. Myself as a Student:

Valuable / / / / / / / / Worthless

8. The Ideal Student:

Sweet / / / / / / / / Sour

9. School:

Clean / / / / / / / / Dirty

10. Learning:

Good / / / / / / / / Bad

11. Teachers:

Fair / / / / Unfair

12. Studying:

Valuable / / / / / / / / Worthless

13. Tests:

Sweet / / / / / / / / Sour

14. Classes:

Clean / / / / / / / / Dirty

15. Grades:

Good / / / / / / / / Bad

16. Myself as a Student:

Fair / / / / / / / / Unfair

17. The Ideal Student:

Valuable / / / / / / / / Worthless

18. School:

Sweet / / / / / / / / Sour

19. Learning:

Clean / / / / / / / / Dirty

20. Math:

Good / / / / / / / / Bad

21. Studying

Fair / / / / / / / / Unfair

22. Tests:

Valuable / / / / / / / / Worthless

23. Classes:

Sweet / / / / / / / / Sour

24. Grades:

Clean / / / / / / / / Dirty

25. Myself as a Student:

Good / / / / / / / / Bad

26. The Ideal Student:

Fair / / / / / / / / Unfair

27. School:

Valuable / / / / / / / / Worthless

28. Learning:

Sweet / / / / / / / / Sour

29. Math:

Clean / / / / / / / / Dirty

30. Teachers:

Good / / / / / / / / Bad

31. Tests:

Fair / / / / / / / / Unfair

32. Classes:

Valuable / / / / / / / / Worthless

33. Grades:

Sweet / / / / / / / / Sour

34. Myself as a Student:

Clean /____/____/____/____/____/____/____/ Dirty

35. The Ideal Student:

Good /____/____/____/____/____/____/____/ Bad

36. School:

Fair /____/____/____/____/____/____/____/ Unfair

37. Learning:

Valuable /____/____/____/____/____/____/____/ Worthless

38. Math:

Sweet /____/____/____/____/____/____/____/ Sour

39. Teachers:

Clean /____/____/____/____/____/____/____/ Dirty

40. Studying:

Good /____/____/____/____/____/____/____/ Bad

41. Classes:

Fair /____/____/____/____/____/____/____/ Unfair

42. Grades:

Valuable /____/____/____/____/____/____/____/ Worthless

43. Myself as a Student:

Sweet /____/____/____/____/____/____/____/ Sour

44. The Ideal Student:

Clean /____/____/____/____/____/____/____/ Dirty

45. School:

Good /____/____/____/____/____/____/____/ Bad

46. Learning:

Fair /____/____/____/____/____/____/____/ Unfair

47. Math:

Valuable /____/____/____/____/____/____/____/ Worthless

48. Teachers:

Sweet /____/____/____/____/____/____/____/ Sour

49. Studying:

Clean /____/____/____/____/____/____/____/ Dirty

50. Tests:

Good /____/____/____/____/____/____/____/ Bad

ATTITUDE QUESTIONNAIRE -- PART II

On the two pages that follow are several statements about the math class you now are in. Read each statement and place a check directly across from it in one of the columns at the right of the page. The way you answer will not in any way affect your grade or standing in this class. Think only of this one class when you read each statement and when you choose a column in which to place your check mark. If you agree very much with a statement, place a check mark in the first column, marked "strongly agree." If you think the statement is mostly true when you think of this class, mark your check mark in column two, titled "agree." If you disagree about as much as you agree with a statement, check column three. Put a check mark in column four if you don't agree with a statement, and column five should be checked if you find a statement you really disagree with a lot. Being honest in your answers will help you most.

Statements	Column 1 Strongly Agree	Column 2 Agree	Column 3 Neither Agree or Disagree	Column 4 Disagree	Column 5 Strongly Disagree
1. I do not want to miss this class.					
2. My teacher helps make this class interesting.					
3. Studying for this class is usually enjoyable.					
4. The things I learn in this class help me in other situations.					
5. The rules in this class are unfair.					
6. Coming to this class is a waste of time.					
7. I want very much to succeed in this class.					
8. I don't see any value to the things we do in this class.					
9. I put off studying for this class.					
10. I come to class unprepared.					
11. I daydream in this class.					
12. I feel successful in this class.					
13. Nobody would be interested in the things you learn in this class.					
14. The teacher tries to embarrass students in this class.					
15. When I don't do my work in this class, it's my own fault.					
16. Getting an education is not very important.					
17. All work in this class should be easy.					
18. I don't like this class.					
19. Doing well in school is important.					

Statements	Column 1 Strongly Agree	Column 2 Agree	Column 3 Neither Agree or Disagree	Column 4 Disagree	Column 5 Strongly Disagree
20. Getting a good grade in this class is impossible.					
21. Students are stupid if they try to do well in this class.					
22. It's not my fault if I do not do well in this class.					
23. This class isn't interesting.					
24. The teacher likes to give students in this class a "hard time."					
25. Even if I don't like a class, I try to make a good grade.					
26. It doesn't matter whether you pass or fail a class.					
27. I like the new way we get paid for our work in this class.					
28. I don't like Math as much as I used to.					
29. This class is one of the most enjoyable I've ever had in school.					
30. School will never be important in my life.					

APPENDIX G

PRESENTATION TO STUDENTS ON CONTINGENCY MANAGEMENT

Sometime ago we visited your class and asked you to indicate to us activities in which you would enjoy participating if the time and facilities were available here at school. We now can tell you how we used the information you gave us. We tried to decide which activities were selected most often and which were most preferred. This chart illustrates the main types of activities which turned out to be rather popular. The equipment, facilities, and materials necessary for you to participate in these activities have been obtained and have been installed in the large trailer parked out on the back patio which will be called the Activity Center.

During the entire second half of the school year, we'll be trying out something quite new in your classroom. A way has been set up for you to participate in the activities housed in the Activity Center. This is how it will work. Each of you will receive a card like this. (Hold up one and illustrate on the blackboard.) Most people who go to work each day have a card very much like this one. They punch in at the time they arrive for work and punch out their card at the clock when they go home. Whoever supervises their work adds up the time and work the workers put in, and the workers receive money for their work.

You as a student are very much like the worker in many ways. You come to school and work each day. Every once in a while your teacher figures out how much work you've done and how well you did it and gives you your pay. The money normally given in school is grades. What we want you to do during the rest of this school year is to have you consider yourself a regular worker with school as your occupation. Rules need to be set up for student use of the Activity Center. The general purpose is that you will be paid for class work by being allowed to go to the Activity Center to do one of the activities

you soon will choose from those available in the Center. So when you do your work in mathematics, you will be earning time in the Activity Center. We also have thought about exactly how much pay or how much time in this case you should be paid for your work. Mr. Neufeld will discuss with you now possible ways in which this can be worked out.

(Herm discusses what specific academic behaviors are worth in terms of time in the Activity Center. Students should feel like they have contributed to the decisions on this matter.)

Now that you know exactly how much time you can earn in the Activity Center by completing your work and doing well on tests, let's talk about what actually happens--about how all this actually works in practice. Each week each of you will receive a new time card with your name on it. You also will receive a copy of the activity menu. You will be asked to check two kinds of activities that you most want to do during that week. These can change from week to week or you may choose the same activities each week. We are asking you to do this in order that the Activity Center can be prepared for the activities which students will be wanting to use. Also, since most activities can be used by only one or two people at a time, we need to know how many people want to use each activity. After receiving your time card and selecting your preferred activities for that week, you carry on with your regular classroom work for this class. Whenever you've completed one of the tasks which are shown on the chart, you check with your teacher, Mr. Neufeld. For instance, when you have completed one section of a chapter and feel you are ready for the check off problem for that section, you get the check off problem, do it, and then submit it to be corrected. You will find out the next day if you completed that section successfully by watching the large chart which will be posted in the classroom. (Explain chart showing date stamped for completion of a chapter

section for each student.) Similarly, if you take a test, you'll find out the next day how well you did and how much you earned. The amount of time you earned will be written on your time card. Whenever you have earned time in the Activity Center, you may choose either to use the time you've earned right away, or if you prefer, you may save it and accumulate time up to a total equal to one class period. That means you would save up earned time until you have about one hour before you actually go to the Center and spend your time.

When you do use time that you have earned, get the approval of your teacher by telling him you wish to use earned time, punch out with your card at the time clock, and go directly to the Activity Center. You are allowed three minutes to reach the Activity Center. This is considered enough time. If you take longer than this to get to the Activity Center, the additional time will be deducted from the time you have earned. Once you reach the Activity Center, you will punch in at the time clock located there and begin whatever activity you have chosen. <u>It is your responsibility to know how much time you have earned in the Activity Center. If you spend more time there than you have earned, you must earn the extra time you have spent.</u> (Give narrative example.) When you have spent your earned time, check out of the Activity Center and return to your classroom. Remember to punch in at the time clock when you return to the class and put your time card in this box. (Indicate location of box for time cards.)

(Answer questions regarding procedures for spending Earned Time.)

Since we want to give everyone a chance to use the Activity Center, not all the students will be able to participate in this project at the same time. So, before we came today we divided the class in half. Half of you will start earning time for your work in the class right away. After three weeks of school, those who are not getting to earn time now will begin. Those of you

who start earning time now will be asked not to participate for three weeks after that point of time. Three weeks later, you will have your turn again for three weeks while the other students do not participate.

(Answer any additional questions.)