

THE EFFECTS OF AN INDIVIDUALIZED
INSTRUCTIONAL APPROACH ON THE
ACADEMIC ACHIEVEMENT IN
MATHEMATICS OF INNER-CITY CHILDREN

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This is to certify that the

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APPROACH ON THE ACADEMIC ACHIEVEMENT IN MATHEMATICS
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ABSTRACT

THE EFFECTS OF AN INDIVIDUALIZED INSTRUCTIONAL APPROACH ON THE ACADEMIC ACHIEVEMENT IN MATHEMATICS OF INNER-CITY CHILDREN

By

Vernon Broussard

The Purpose

The purpose of this study was to determine the effect of an individualized instructional approach on the academic achievement in mathematics of inner-city school children. More specifically, the study attempted to determine what effect does an individualized, diagnostic, prescriptive, instructional approach have on achievement gains in mathematics of inner-city children who are economically and educationally deprived. The study compared students who were given individually prescribed work through independent study, small group discussions, large group activities and teacher-lead discussions with students who received instruction in the traditional textbook, class group method of instruction in mathematics.

The content in mathematics remain the same for the experimental and control group of students, only the method

of instruction was changed. The goal of this study was to establish that worthwhile differences occur as a result of the process of individualized instruction.

The Hypothesis

The general hypothesis tested was that there will be greater achievement gains in test performance by inner-city children who receive instruction in mathematics through the individualized diagnostic, prescriptive, instructional approach than inner-city children receiving instruction in mathematics through a traditional approach as measured by the Comprehensive Test of Basic Skills, Form R, Level I.

The above general hypothesis was particularized in the following statistical sub-hypotheses:

1. There is no difference in achievement gains, in mathematics, arithmetical computational skills between boys and girls in this study.
2. There is no difference in achievement gains, in mathematics, arithmetical computational skills between racial and ethnic groups (Blacks, Mexican-Americans, Whites, and other non-whites, i.e., Orientals, Filipinos, and American Indians) in the study.

3. There is no difference in achievement gains, arithmetical computational skills between fourth-graders in the individualized mathematics program and fourth-graders in the traditional program.
4. There is no difference in achievement gains, arithmetical concepts between fourth-graders in the individualized mathematics program and fourth-graders in the traditional program.
5. There is no difference in achievement gains, arithmetic applications between fourth-graders in the individualized mathematics program and fourth-graders in the traditional program.
6. There is no difference in achievement gains, total mathematics, i.e., arithmetic computation, arithmetic concepts, and arithmetic applications, between fourth-graders in the individualized mathematics program and fourth-graders in the traditional program.

Procedures

The sample selected for this study consisted of 495 inner-city elementary school children, in the fourth grade, who were enrolled in public schools within the Stockton Unified School District, Stockton, California. About forty percent of students were Mexican-American; forty

percent Black; eleven percent were White; and about eight percent other non-white (Orientals, Filipinos, and American Indians).

The design of the study was the "non-randomized control-group pre-test, post-test design." This design was used since the researcher was unable to achieve the rigorously control design that requires the subjects to be assigned to comparison groups at random and therefore, equivalent pre-assemble groups for the experimental and control subjects were used.

The univariate analysis of covariance was applied to the above statistical sub-hypotheses.

Findings

In the analysis of covariance it was found that when the Comprehensive Test of Basic Skills was used as the dependent variable to measure arithmetic achievement the findings indicated that:

- (1) sex differences did not significantly affect the academic achievement in mathematics, computational skills of the subjects in the study,
- (2) racial and ethnic differences did not significantly affect the academic achievement in mathematics, computational skills of the subjects in the study.

- (3) the experimental subjects (fourth-graders) in the individualized mathematics program in the area of computational skills achieved significantly higher achievement gains than control subjects (fourth-graders) in the traditional program,
- (4) the experimental subjects (fourth-graders) in the individualized mathematics program, in the area of arithmetic concepts, achieved significantly higher achievement gains than control subjects (fourth-graders) in the traditional program,
- (5) there was no difference in the relative achievement gains of pupils in the two treatment groups in the area of arithmetic applications and,
- (6) the experimental subjects (fourth-graders) in the individualized mathematics program, total battery, i.e., arithmetic computation, arithmetic concepts and arithmetic application, achieved significantly higher achievement gains than control subjects (fourth-graders) in the traditional program.

The conclusion is that the individualization of instruction in mathematics accounts for increased gains in achievement scores on the Comprehensive Test of Basic Skills, Arithmetic Computation, Arithmetic Concepts and Total Battery, i.e., arithmetic computation, arithmetic

concepts, and arithmetic application. There was no difference in the achievement gains of pupils in the two treatment groups in arithmetic applications.

Subjective analyses were applied to the data and observations of the program. It was found that the participating teachers, specialists, instructional aides as well as the pupils and parents were generally very positive in their statements of attitudes toward the program. On the basis of these observations it is suggested that the individualization of instruction accounted for the desirable changes in behavior, attitude, and learning strategies of the learners.

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CHAPTER I

FORMULATION OF THE PROBLEM

Statement of the Problem

The problem of this study was to determine the effect of an individualized instructional approach on the academic achievement in mathematics of inner-city school children. More specifically, the study attempts to determine what effect an individualized, diagnostic, prescriptive instructional approach has on the academic achievement in mathematics of inner-city children who are economically and educationally deprived.

Statement of Hypothesis

The hypothesis tested was that there will be greater achievement gains in test performance by fourth-grade inner-city children who receive instruction in mathematics through the individualized diagnostic, prescriptive, instructional approach than inner-city children receiving instruction in mathematics through a traditional instructional approach as measured by the Comprehensive Test of Basic Skills, Form R, Level I, Arithmetic Computation, Concepts, Applications and Total Mathematics.

Significance of the Study

The concern for improving and upgrading the quality of education for inner-city children through differentiating instruction raises serious questions about the relative advantages and disadvantages of individualizing the instructional program in mathematics. Individualized instruction has been a long-sought but elusive goal of educators. Modern technology and innovative instructional strategies puts it within the grasp of the typical inner-city school district by utilizing currently available instructional materials and at a cost factor well within school budgets.

A great deal of study and research, both pro and con, concerning the merits of traditional group instructional techniques and the present administrative techniques for deployment of students have been reported in the American Educational Research Association's Handbook of Research on Teaching, (Gage 1963), and reported at professional conferences by university scholars, compensatory education directors, (state, local and national), school administrators and classroom teachers.

A general conclusion of the available research indicated that traditional group instruction and a narrowing of the ability range in the classroom on the basis of some measure of general academic aptitude in the absence of carefully planned adaptations of content and instructional strategies, produced little positive change in the academic achievement of inner-city school children.

Research studies by Scanlon and Bolvin (1967), Co-Directors of Instructional Systems, Research for Better Schools, University of Pittsburgh, suggested that the individualization of instruction on the basis of specific, cognitive, affective, and psychomotor abilities, and providing instructional emphasis in areas of special competence may be more effective than traditional group instructional methods.

The literature indicated that the present group instructional methods along with the fixed tracking program militates against both the gifted and low-achieving inner-city school children. In the belief that real differences in academic growth result from what is taught and learned in the classroom, this study hypothesized that it is through the individualization of the instruction, appropriate selection of content and methods of teaching that emphasis should be placed.

Available research suggested that through the individualization of instruction teachers can more easily carry out specific plans appropriate for the individual child without having to provide for other children for whom the particular mathematics content may be inappropriate. The literature indicated that inner-city children at any stage of learning can be free to participate more fully without the fear of derision either for being too "dumb" or too "smart." Also indicated was that the present traditional

group instructional methods and the administrative techniques used to deploy students affect:

- 1 teacher expectations
- 2 students' personal image as learners
- 3 curricula exposure to a significant degree, and
- 4 constrains the student's individual progress within that of the group.

Additionally, the urgent need to improve the academic instruction in mathematics for inner-city school children is underscored by the increasing availability of funds from local, state, and especially federal sources allocated for the enhancement of such instruction for inner-city children.

Many responsible individuals and groups are presently initiating and implementing proposals for changing the curricula and organization of inner-city schools. Evaluating these proposals places a heavy burden and responsibility on the decision makers at the local, state and national levels.

Delimitations of the Study

In the development of most educational programs, several general items are usually considered. Among these are: instructional strategies, personnel, curriculum, materials and facilities. Because this study is concerned with the effects of an individualized instructional approach on the academic achievement in mathematics of fourth-grade

inner-city school children, it delimits its consideration to the items of instructional strategies, mathematics curriculum and materials.

The study specifically probes the effect of an individualized instructional approach (as defined in the study) on the academic achievement in mathematics of fourth-grade inner-city school children in five elementary schools in the Stockton Unified School District as measured by the Comprehensive Test of Basic Skills, Form R, Level I, Arithmetic Computation, Concepts, Applications and Total Mathematics.

This study limits its considerations to an instructional approach that may directly influence the achievement gains in mathematics of inner-city school children in the specific areas of arithmetic computations, concepts, applications and total mathematics i.e. computations, concepts and applications. The major thrust of the study was in the area of computational skills. The study is not concerned with the effects of an individualized instructional approach in other subject areas, such as, science, language arts, social studies, music and the like.

An additional limitation of this study is that the researcher in no way intends to infer beyond the immediate population in the study. The results will have limited application elsewhere; except to the extent that other populations are comparable to the population of interest

to this study. This limitation is in no way intended to minimize the results as they relate to the population being studied or the need for this type of information that may be obtained from other academic areas and similar studies of a larger population of inner-city children located in other geographical areas in the country. Finally, other limitations are:

- 1 the length of time of the study, approximately one school year, and
- 2 the varying degrees of pre-service and in-service preparation of the teachers responsible for the implementation of the individualized instructional approach.

Definition of Important Terms

- 1 The individualized instructional approach in this study is defined as the assignment of appropriate learning tasks to children according to their needs as determined by a comprehensive, diagnostic assessment of each child's strengths and special educational needs in arithmetic.
The assignment of learning tasks which participating children are able to accomplish and the assignment of appropriate ways of accomplishing these learning tasks are a part of the definition.

The individualized instructional approach described in this study applies to the assignment and the methods of achieving these assignments, rather than learning in isolation. Children in this study may learn through independent study, small group discussions, large group activities, or teacher-led activities, whichever is most appropriate.

An important component in the individualized instructional approach described in this study is breaking down the mathematics instructional program in computational skills into sets of behavioral objectives that can be assigned as learning tasks to individual children. The objectives are not vague or general such as the subtraction of whole numbers, but rather specific and behavioral as, "given ten exercises, subtraction of whole numbers with hidden zeros, the child is expected to work correctly nine of the ten."

These objectives are then coded into an orderly scope and sequence and related to the tests and to the instructional materials used. An attempt is made to avoid the trivial or insignificant at the same time to avoid the impossible.

- 2 Inner-city school children for the purpose of this study are those children who attend public schools with an average daily attendance of 30,000 and above, reside within a city whose population is 100,000 or more and who are potentially capable of successfully completing a regular academic program, but who, because of language, cultural, economic, racial isolation, and environmental handicaps, are unlikely to achieve at grade level.
- 3 Arithmetic computation as used in this study is defined as those arithmetical operations involving the addition, subtraction, multiplication and division of whole numbers and fractional numbers as measured by the Comprehensive Tests of Basic Skills, Form R, Level I, Arithmetic Computations.
- 4 Arithmetic concepts as used in this study is defined as those arithmetical tasks which measure the ability of the student to recognize and/or apply the appropriate concept and technique (method, operation, structure, formula, principal); the ability to convert concepts expressed in one numerical, verbal, or graphic form to another form; and the ability to comprehend numerical concepts and understand their interrelationships as measured by the Comprehensive Tests of Basic Skills, Form R, Level I, Arithmetic Concepts.

- 5 Arithmetic applications as used in this study is defined as those arithmetical tasks which measure the ability of the student to comprehend the written problem, select the appropriate method for solving, organize all the facts in total problems of a more complex nature and solve for the correct answer as measured by the Comprehensive Test of Basic Skills, Form R, Level I, Arithmetic Applications.
- 6 Behavioral Objectives as used in this study are specific statements of intent communicated to the student describing the terminal behavior to be demonstrated and the standard or test by which that terminal behavior is to be evaluated.
- 7 Traditional program as defined in this study is an instructional approach in which the major teaching strategies are, lectures and class discussions. Additionally, in the traditional program the learning tasks are structured and paced for the group.
- 8 Academic achievement is defined in this study as statistically significant achievement gains by the experimental group over the control group as measured by the Comprehensive Tests of Basic Skills, Form R, Level I, Arithmetic Computations, Concepts and Applications.

- 9 Teachers as defined in this study are the members of the professional staff, providing instruction for the experimental and control groups, who had met the minimum requirements for California teaching credentials.

CHAPTER II

REVIEW OF RELATED LITERATURE

INTRODUCTION

Recorded in the literature is a vast number of studies devoted to the merits and the effects of individualizing the instructional program. In the exploration of research findings, this researcher found the quantity great (dating back forty-five years or more), the quality irregular, and much of the results were generally inconclusive for reasons which the researcher hopes to make apparent.

Many varieties of individualizing instruction have been devised to make the teaching of groups more personalized and effective. Because of the many varieties recorded in the literature of instructional approaches that are labeled "individualized instruction" the researcher has delimited the review to those research studies that closely approximate the definition of an individualized instructional approach as defined in this experimental study.

For the purpose of this study, the review of related literature will focus on two major areas. The first will cover major schemes for individualizing instruction,

which includes studies dealing with the varieties of ability grouping, team organization, non-graded organization, planned heterogeneous grouping, and teachability grouping; all of which are closely related to the specific scope of this study.

These major schemes are intended to take into account differences among students in a group. Innovators of these schemes either have tried changing the composition or the size of the group or have tried new methods for differentiating the instruction to given group members; not both simultaneously.

The second area, individualized instruction, will focus comprehensively on those studies that deal specifically with adapting instruction to individual needs within the classroom. These studies closely parallel the definition of the individualized instructional approach defined in this study.

Major Schemes for Individualizing Instruction Ability Grouping

Homogeneous grouping is defined in the Dictionary of Education, Good (1959), as "the classification of pupils for the purpose of forming instructional groups having a relatively high degree of similarity in regard to certain factors that effect learning (p. 255)." One can ascertain in the literature that many different schemes fitting this definition and a wide variety of programs and practices

that have emerged, all of which involve some form of classification or selection of students, each aiming to increase either individualized teaching or learning effectiveness.

The many provisions for individual differences found in the 1932 National Survey of Secondary Education which involved a study of 432 schools Billet (1933), homogeneous grouping and special classes were found to be the most popular and were judged by the school respondents as the most successful. Homogeneous grouping in that survey included all efforts to:

improve the teaching and learning environment through refined classification of pupils, while classes encompassed various attempts to provide for extreme deviance in abilities and/or needs by means of such provisions as special coaching for slow or gifted pupils or by opportunity, remedial and adjustment classes (p. 11).

Harap (1936) reported a few years later that ability grouping was the "most common method of adjusting learning to individual differences (p. 163)."

For over a century, group teaching of grade-level classes has dominated instruction in elementary schools. Both grade placement and group teaching tend to ignore differences among students. Group teaching has been mainly whole-class teaching in which the methods and pacing of instruction, as well as the lessons taught, are largely the same for all members of the class.

The most comprehensive review of grouping practices and research can be found in the volume edited by Yates (1966). This study was sponsored by UNESCO Institute for Education in Hanbury and deals with grouping in various countries including England, Italy, Sweden, the United States and West Germany. Yates presents a list of seventeen varieties of grouping in elementary and secondary schools. A partial list of major sorts of grouping includes grade-level grouping; tracking students into different curricular sequences; ability or achievement-level grouping within a grade; assigning students to special classes; multi-age or multi-grade grouping; differential grouping; subject to subject; flexible grouping according to students capabilities with different learning activities; and numerous methods of interclass grouping. Most grouping practices are intended to produce classes that are relatively homogeneous in abilities, achievement, age, personal-social characteristics, etc.

A United States Office of Education study, Dean (1960), of practices and policies of elementary school administration and organization in forty-five states, noted that ". . .the methods of grouping and assigning pupils for instructional purposes represent another area of timely interest and one on which there is a great deal of public and professional discussion (p. 67)." The study indicated that, of the 4,307 participating urban places with

population of 2,500 or more, only 16.9 percent had a basic policy of homogeneous grouping in grades one through six; 34.4 percent grouped homogeneously in grades seven and eight. The schools using a policy of heterogeneous grouping and those using homogeneous grouping were in agreement that there would be an increase in homogeneous grouping in the future.

A recent study of ability grouping by Goldberg, Passow, and Justman (1966) states that although the practice of grouping students, in its present meaning, reached its peak in the 1920's and 1930's, the origin of grouping goes back into the 19th century. W. T. Harris' plan, initiated in St. Louis in 1867, is often cited as one of the first systematic attempts at homogeneous grouping. Selected groups of bright students, chosen on the basis of achievement as determined by the teachers, were promoted rapidly through the elementary grades.

One of the earliest critical analyses of research on ability grouping was made by Rock in 1929. Considering only those studies which he viewed as "scientific" Rock (1929) concluded that:

The experimental studies of grouping which have been considered fail to show consistent, statistically or educationally significant differences between the achievement of pupils in homogeneous groups. This failure to realize one of the important advantages claimed for ability grouping is not, however, evidence that homogeneous grouping cannot result in increased academic achievement. Neither do the experiments show that claims made

for grouping cannot be attained under proper organization. There was practically unanimous agreement found among the teachers involved in the studies that the teaching situation was improved by homogeneous grouping (p. 125).

Billett (1932) reviewed 140 articles, including 108 experimental or practical studies, which appeared in the literature between 1917 and 1928. Among the trends in the study of homogeneous grouping Billett found; "so called homogeneous grouping in practice produces not homogeneity, but reduced heterogeneity (p. 6)."

Billett's general conclusions and recommendations from his review plus seven experiments which he himself conducted were:

(a) One cannot predict the measurable results which will be obtained by individual teachers when given homogeneous groups for the first time and (b) Proposals to segregate only the slow pupils in academic subjects on the basis of academic intelligence does not eliminate all of the usual objections that such a policy places a stigma upon the dull, and narrows their opportunities for development (pp. 119-120).

The conclusions that Turney (1931) drew from his analysis of the research studies on grouping were:

(a) Most of the studies purporting to evaluate ability grouping have proved nothing regarding ability grouping but have only added evidence bearing upon the nature and extent of individual differences, (b) Most experimental attacks upon the value of ability grouping have failed to evaluate the chief claims for it, i.e., the possibility of adapting content, method, or time and (c) The true evaluation of ability grouping must be deferred until adequate experimental attacks have succeeded in measuring its alleged advantages (pp. 126-127).

Twenty studies were summarized by Miller and Otto (1930). Although they were critical of some of the methodology used in the studies and the experimental designs, their conclusions were:

(a) While the evidence is contradictory, at least two of the studies suggest that ability grouping is quite ineffective unless accompanied by proper changes in method. Unless adaptation of methods and materials is a necessary correlation to ability grouping, one of the purposes of the project is defeated and (b) So far as achievement is concerned, there is not clear-cut evidence that homogeneous grouping is either advantageous or disadvantageous. The studies seem to indicate that homogeneous classification may be effective if accompanied by proper adaptation in methods and materials (p. 120).

The National Society for the Study of Education's thirty-fifth yearbook (1936) includes a comprehensive discussion on the practical, theoretical, and experimental considerations in grouping of pupils as of that time. The chapter by Cornell supports the twenty studies cited above by Miller and Otto. In the aforementioned chapter Cornell reviewed published studies and included an examination of findings related to (a) academic achievement and speed of learning; (b) quality of learning; (c) intellectual traits and habits of work; (d) social, emotional and personality adjustment; and (e) health and creative interest. Cornell's conclusion (1936).

The results of ability grouping seem to depend less upon the fact of grouping itself than upon the philosophy behind the grouping, the accuracy with which grouping is made for purposes intended, the differentiations in content, method, and speed and the technique of the teacher as well as upon

more general environmental influences. Experimental studies have in general been too piecemeal to afford a true evaluation of the results, but when attitudes, methods and curricula are well-adapted to further adjustment of the school to the child, results, both objective and subjective, may be favorable to grouping (p. 302).

In connection with the above cited work, Goodlad (Harris, 1960) observed that studies since the 1930's "have not added to precision of the conclusion or clarification of the problems analyzed by Cornell (p. 224)." In the thirty-fifth yearbook of the National Society for the Study of Education, Goodlad (1960) reported the following conclusions from the research:

(a) An analysis of many studies suggests that curricula differentiation from the range of study variability represented in a given group is a more significant contributor to academic progress than is the basis for establishing the classroom groups and (b) Teachers tend to react more favorably to teaching groups in which the heterogeneity has been somewhat reduced, than to teaching groups selected at random (p. 224).

A thorough analysis of research from both British and American sources caused Daniels (1962) to reach the following conclusion concerning the effects of 'streaming,' the English label for ability grouping:

(a) Streaming lowers rather than raises the average level of attainment of pupils in junior schools, (b) streaming slightly reduces the level of attainment of "bright" junior school children, (c) streaming markedly retards the educational progress of the "slower" junior children, (d) streaming artificially increases the range of educational attainment of junior school children, and (e) widens the gap between the "bright" and the "backward." (This though independently demonstrated, necessarily follows from the first three conclusions (p. 80).

Daniels suggested that what is operating may be a self-proving hypothesis regarding the nature of grouping, the differences at the end of the fourth year of junior school (approximately age 11), between the more and the less able students may simply reflect the consequences of four years of streaming during which, A classes get A minded teachers and therefore A results, while C classes get C minded teachers, C educational aspirations and inevitably C results. Daniels' own studies of 'unstreaming' underscore clearly the notion that a system which does not employ streaming can only be successful if teachers believe in the potentialities of all their pupils and are willing to adapt and differentiate instruction accordingly.

Douglas' (1964) experiments tended to support Daniels' conclusions. Douglas' study examined streaming from other aspects as well, including the effects of socio-economic biases on opportunity and teacher commitment. In general, the streaming process (ability grouping) seemed to reinforce the social selection process. Douglas concluded that:

Children who come from well kept homes and who are themselves cleaned, well-clothed and shod stand a greater chance of being put in the upper streams than their measured ability would seem to justify. Once there, they are likely to stay and to improve performance in succeeding years. This is in striking contrast to the deterioration noticed in those children of similar initial measured ability who are placed in lower streams. In this way the validity of the initial selection appears to be confirmed by the subsequent performance of the children and an element of rigidity is introduced early into the primary school system (p. 118).

The reviews and summaries of research on grouping during the past four decades, as indicated earlier in this chapter, have been relatively few. The researcher found in recent studies not included in the reviews above, studies that have involved a larger number of children over a longer period of time. These studies involved the setting of objective criteria for determining section variability in order to provide comparability, i.e., classifying homogeneity on the basis of initial achievement level and standard deviation and using the class section rather than the individual pupil as the unit of analysis.

Millman and Johnson (1964) analyze more than 8,000 gain scores for pupils in 327 class sections in twenty-eight schools. The analysis failed to show that the amount of gain depended to any significant extent on the class variability. They concluded from their study of the relation of section variance in grades seven and eight to achievement gains in mathematics and english that "whatever the potentialities may be for increasing achievement through narrowing the ability range of classes such improvement is apparently not taking place (p. 51).

Millman and Johnson's conclusion again support the idea that, unless curriculum modifications are made within the class sections, school personnel who go to considerable trouble deciding upon proper section composition and risk various problems in order to maintain a grouping scheme

may be deludeing themselves if improved performance on achievement is expected.

As the number of grouping studies grows, the inconclusiveness of the research findings become more apparent with each researcher couching his summary in tentative or unequivocal fashion. While it is true, as Ekstrom (1959) has observed, that ". . .the studies differ widely in quality, purpose, and significance (p. 17,)" there are also many other differences which make a synthesis of the research difficult in this area. The conflict in findings caused by Cornell (1936) to observe that "a review of the objective results of ability grouping leaves one convinced that we have not yet attained any unequivocal experimental results that are capable of wide generalization (p. 29)." Two years earlier Wyndham (1934) had noted that "the first general impression one gains from these studies is that, granted their unequal experimental significance they raise more issues than they settle (p. 107)."

The essential weakness in many of the studies reviewed by this researcher is that they simply have been poorly designed as experiments. As Svensson (1952) put it, "they have drawn on existing educational situations and their findings have in consequence not been sufficiently clear cut to permit the making of generalization (p. 51).

Many of the issues concerning grouping remain unresolved, and most questions are still unanswered despite

seventy or eighty years of practice and at least forty years of study. The researcher opinionates that insufficient and conflicting findings are being used to support partisan views concerning the consequences of grouping rather than to resolve the persistent issues. Wrightstone (1957) observed, ". . .the search for better class organization for instruction is complex and elusive (p. 30)." Newer grouping plans and proposals continue to emerge, team organization, nongraded organization, teachability grouping and individually prescribed instruction. These plans generally represent departures from the more traditional procedures aiming at greater flexibility and individualized instruction. A summary of the major studies of these plans constitutes the following parts of this review.

Team Organization

A great variety of organization patterns are included under the umbrella label of "team teaching." Heathers (1966) states, "team teaching, also called cooperative teaching, occurs when two or more teachers share in planning and conducting instruction that is offered to the same group of students whether at elementary, secondary or college levels (p. 110)." The term "team teaching" is misleading since it usually happens that only one teacher conducts the instruction offered a group at any given time. Woodring (1964) suggests that a better

descriptive label would be "team organization and planning." However in many teams' planning of instruction in a given area is done mainly by the one or two team members who specialize in teaching in that area. Grennis (1964) offers an exploration of team planning of a curriculum unit that illucidates both the potential of team work and the demands it places on team members. Wallace (1965) in a study of fifty team teaching organizational plans, explored the issue of whether large group instruction can take account of individual differences among students. His answer was positive, but he recommended following large-group sessions with small group activities that involved all members of the instructional team.

The theme of flexibility applies to virtually all aspects of team organization and functioning. In addition to the continual variation of group composition and size flexibility also occurs in scheduling of time, space, and personnel. The plan for the secondary school described by Trump and Baynham (1961) places emphasis on flexibility. Bush and Allen (1964) offer a method for flexible scheduling in the high school that uses an electronic computer.

Research on cooperative teaching is generally of poor quality. Most of the studies have been descriptive rather than evaluative. In a review of the research conducted up to 1963, Heathers (1964) found no well controlled

studies that measured outcomes of team teaching. The results reported could not be interpreted because of a lack of data on the implementation of the plans being compared. Also the reports did not provide the basis for determining separately the effects of different features of the team organization such as flexible scheduling, flexible grouping, staff specializations, the use of teacher aides, or team planning. The reports available then did not indicate any substantial effects of the plans on student achievement.

Bair and Woodward (1964) report favorable outcomes of the Lexington Plan with respect to student achievement and attitudes of participants. Their analysis on financing team teaching led to the conclusion that the Lexington Plan need not be more expensive than conventional plans. Lambert (1964) in his study comparing team teaching with the self-contained classroom found significant differences between the two plans in classroom and interaction patterns and in student achievement, but not in student adjustment. Interpreting their findings is made uncertain by the fact that they did not offer data on the conduct of instruction in the two plans. Also, they did not offer data on the comparability of the staff serving the two plans. Lopossa (1970) in a study of sixty teams and twenty individual teachers, explored the issue of what effect group problem solving versus individual

problems solving have on decision-making behavior of teachers. This experiment has great significance since one suggested advantage of team teaching is that a group of teachers will have greater insights than an individual teacher into the needs and problems of students, and hence will improve the academic program. Lopossa's findings failed to support the hypothesis that groups are rational in the way they rank order alternatives after having considered consequences. Very little evidence was found that teams of teachers and individual teachers differed in their approaches to problem solving. The findings do not warrant the assumption that teams will necessarily make better decisions than will individual classroom teachers. This may point to the need for special team training to overcome liabilities of group problem solving, to realize the potential and limitations of the group and to improve efficiency.

Nongraded Organization

Nongrading, as the concept is presented by Goodlad and Anderson (1963), refers to any approach that breaks away from conventional grade-level instruction that enables students to advance in the curriculum at rates corresponding to their individual capabilities. While nongrading or continuous progress can be accomplished by differentiating instruction within any organizational

pattern, many school systems with nongraded programs make use of multi-age grouping to bring together students who are at about the same level of advancement in one or more subjects. In elementary schools nongraded programs are most numerous in the primary years though some school systems have introduced nongrading on a K-6 basis. Usually nongrading in the elementary schools applies only to the skilled learning in reading and mathematics. Some high schools have adopted the nongrading program, most frequently following the model developed by Brown (1963). In this plan nongraded advancement applies to mathematics, science, english and history.

Unfortunately, research studies on nongrading usually have been silent on how, or to what extent, teachers actually adapted their instruction to promote nongraded advancement. The research reports ordinarily offer a description of the structural features of the new program without giving data on how instruction was adapted to suit the purpose of the program. The seriousness of this matter is indicated by the fact that Goodlad and Anderson (1962) in a study of nongraded programs at the elementary level found many where the local school leadership had set up homogeneous groups that appeared not to practice nongrading.

Despite the fact that nongraded programs have been in operation in hundreds of elementary schools for a number

of years there is an extraordinary paucity of research studies of nongrading. As Goodlad and Anderson (1963) indicate, most of the studies that have been conducted are subject to one or more of these weaknesses; a failure to report instructional practices within the graded structure, confusing inter-class grouping with vertical progression, and using improper basis for comparing progress with graded and nongraded instruction. Hillson (1964) reports a controlled experimental study on nongraded teaching in forty primary school classes. The most common finding in this study was that nongraded programs at the elementary level result in gains in the skilled subjects that are made the foci of the program. Hopkins (1965) in a study of ten elementary schools indicated no reliable effects of nongrading on reading achievement and Carbone (1961) reports that a graded program was superior to a nongraded program in terms of both achievement and mental health of students. Anderson and Goodlad (1962) criticized the Carbone study because the study indicates that there were no significant differences in instructional practices between the graded and the nongraded program.

Brown (1963) asserts from his experimental study that the program at Melbourne High School, Melbourne, Florida, led to a decrease in the frequency of dropouts. However, he does not present the data needed to support this assertion. Brown also claims that the proportion of

Melbourne's graduates attending college increased to 70% from a base of 40% prior to the nongraded program.

Despite the emphasis its proponents have placed on using nongrading as a way of removing the stigma associated with being a slow learner, the researcher was unable to find studies that offer clear objective data on this matter. Also, no research reports were located that dealt with the role of nongrading in eliminating remedial problems through insuring that a slow learner master each level of work before proceeding to the next level.

Interclass Grouping Patterns

The basis for setting up instructional groups most often have involved the issue of heterogeneous versus homogeneous grouping at grade level or that of graded versus nongraded grouping. Other bases that have been used in setting up classes are planned heterogeneous grouping and teachability grouping which are discussed below.

Planned Heterogeneous Grouping. School systems often have set up within grade homogeneous groups on some basis other than random assignment. Sometimes they have balanced groups in terms of IQ distribution. At other times they have tried to distribute leaders and trouble makers equitably among the groups at a grade level. The researcher was unable to find studies that test outcomes of such grouping practices.

Heterogeneous multi-age grouping has been tried notably in elementary schools in Torrance, California. In reporting on the program there, Hamilton and Rehwoldt (1957) contend that grouping should be on the basis of students differences rather than similarities on the assumption that "by their differences, they learn." They describe a control study in which the experimental subjects were in groups composed of students from grades one through three or four through five. They found that the academic achievement of students in wide-range classes were superior to that of students in single-grade classes. Also, the authors report favorable effects of multi-grade grouping on students social adjustment and their personality development. Similar results are reported by Hull (1958). Hull interprets the results as being due to students being stimulated by the wide range of differences; the older students teaching younger ones, and to teachers acceptance of the challenge to adapt their instruction to the widely different needs and the readiness of children in the group.

Teachability Grouping. Thelen (1963) has developed a method of setting up a so-called teachable class on the basis of the assignment to a given teacher of a group of students similar to those in former classes whom the teacher felt got a lot out of the class. From a control study of teachability grouping, Thelen concluded that the practice resulted in more manageable classes, better attainment of

the teachers purposes and a more satisfied teacher. Thelen did not conclude from his study either that students learn more in these groups or that they gain greater satisfaction from being members of such groups. The choice of teachers appears to remain a critical consideration.

Intraclass Grouping

Teachers often subdivide their classes to facilitate instruction. Subgrouping is more apt to occur in heterogeneous classes than in ability-grouped classes since teachers employ it to accomplish within-class ability or achievement-level grouping. Such sub-grouping is more common in elementary schools and is used most frequently with instruction in the skilled areas of reading, spelling and arithmetic. In a survey conducted by the National Education Association (1962) a sample of elementary school principals reported intra-class grouping for reading in about four-fifths of large school districts and similar arrangements for arithmetic in about two-thirds of such districts. Subgrouping also occurs often in the conduct of project activities in science or social studies.

Spence (1958) studied intraclass ability grouping in arithmetic in grades four to six, involving 300 students. Content in instructional methods were adapted to suit the three group levels in each of grades four to six, subgroup teaching produced significantly higher achievement scores

than whole-class teaching. Jones (1948) in an experimental study involving five elementary schools, found that subgroups using individualized nongraded materials achieved significantly more in reading, spelling and arithmetic than the control group that learned the usual grade-level materials with whole-class teaching. Dewar (1963) found subgrouping for arithmetic instruction in the sixth grade to produce reliable gains in achievement of the high and low subgroups but not by the middle subgroup.

Durrell (1959) tested a pupil-team learning plan in which the elementary teacher divided the class in groups of two to five students who studied arithmetic and spelling team-fashion. They worked with programmed materials and were required to pass the mastery test for a learning task before proceeding to the next task. Each student learned on a nongraded basis, advancing as rapidly as he could learn. In the study pupil-team learning produced significant gains in students' achievement as compared with a control group, and the plan was well liked by pupils, parents, and teachers. Zimmerman (1965) employed another sort of pupil-team work for the study of english in grade 9. The most able students in the class ran mastery booths where they helped less-able students to learn both skills and problem solving.

Thelen (1949) proposed that principles of group dynamics should be employed in setting up a social organization for learning in the class. He recommended using a

principle of at least group size where the subgroup would contain the smallest number of students who had among them the capabilities required to accomplish the learning tasks.

The researcher found a mere handful of studies on intra-class provisions for meeting differences among learners as compared with the large volume of research found on inter-class grouping. The researcher opinionates that reliance has usually been placed on structural approaches to meeting individual differences rather than on methods of adapting instructional approaches to meet such differences. In support of this interpretation is the fact that most research reports on interclass grouping have not presented data on how the instruction differed from one type of group to another. It is noteworthy that the most frequently used way of classroom teaching, the interaction analysis method designed by Flanders (1960) was devised to measure teacher-student interaction in group studies without making provisions for measuring how the teacher adapted instruction to individual differences.

Individualized Instruction

A review of the current literature indicates that the concept of individualization has acquired such potency that it is reducing to subordinate status those grouping arrangements promoted under the banners of nongrading and team-teaching previously described in this chapter. According

to Heathers (1969), a major factor in the increasing attention being given to individualization is the development of technological devices and learning programs suitable for independent study. Also indicated in the research as reported in this chapter, there is a growing disenchantment with grouping as a theme in organization for instruction.

Interest in individual differences in mental traits can be traced back to Plato and Aristotle, however, scientific study in this area was initiated by Sir Francis Galton and his followers who attempted to identify and measure variability in human nature. The first studies on the laws of variation, Ellis (1947), was made by biologists who were interested in the natural causes of variability. Galton was among the earliest workers to use statistical methods in the study of individual types.

A comprehensive treatise on individual differences was published by Stern (1921), summarizing the principal psychological and statistical studies that had been published up to that time. Stern described various methods for observing and testing individual differences, and statistical methods for analyzing the data.

Studies of individual differences in psychological traits have been reported by Ellis (1928), who concluded that the laws concerning variability were complex and could not be summarized in a few simple statements. Wechsler (1935), investigated the range of human capacities. After

eliminating the pathological extremes, he found a ratio of measurements of highest to lowest amounts of a trait not to exceed 3.0:1.0. He concluded that while individual differences are real and important they are not nearly so great as has been commonly supposed. Statistical analysis of human traits showed that there are both special and general abilities in which individuals vary one from another. The data proved that the individual deviates less from the average in total mental ability than he does in specialized abilities.

Thorndike (1927) reached the conclusion after surveying studies in the psychology of trait differences that the higher and more complex the process the more it varies from individual to individual. Ellis (1947) in a study involving 1,200 subjects, concluded that the more complex, higher and more recently developed functions tend to be relatively less rather than more variable, contrary to the findings of Thorndike.

The scientific movement in child study in education which began about the turn of the century focused attention on individual differences among children. As a result, great progress has been made in understanding individual differences in pupils and in individualizing instruction.

Any typical school population with a narrow range in mental ability shows marked variation in school achievement, motor skills, interests, personality traits and the

like. Studies of American children, Hildreth (1940), have consistently revealed a wide range of learning ability in both age and grade groups. Studies of children in other countries, Thompson (1921), revealed similar findings. In order to provide for this wide range of learning abilities, scientific determination of trait variability among the pupils is required. This is accomplished, Hildreth (1940), through objective measurements of mental ability and scholastic aptitude; diagnostic study of special verbal and numerical abilities or limitations; the rating and appraisal of personality, temperament, social and emotional traits, evaluation of interests; measurement of physical development and health status; and measurement of achievement.

Gilliand and Clark (1939), summarized results from a number of studies and showed the significance of individual differences for education. In a 1945 publication Betz (1945) listed and discussed principles of individualized instruction. The 19th yearbook (1940) of the Department of Elementary Principals of the National Education Association deals with various aspects of the topic of meeting the needs of the individual child. It states that ". . .differences among school children relative to general intelligence, previous experiences, study habits, interest and other traits furnishes the setting for a complex educational problem (229)." Two phases of this

problem are indicated by the question; what differentiation of objectives should be made? What adaptations of organization curricula and instruction should be made as a means toward desired results? The first is a subproblem in the area of curriculum construction and cannot be answered by means of objective studies alone. The basic thesis must be derived from the accepted purpose of education. Hypotheses relative to desirable differentiations of objectives have received explicit consideration commensurate with the importance of the question, and three general positions may be identified. The practice in many schools, especially those commonly designated as conventional, implies objectives which differ mainly in degree of quality of achievement, i.e., the goals include the same items for all pupils in a grade or class group, but differences in degree of achievement are expected and are reflected by the distribution of final marks. A second position is in terms of minimum essentials, i.e., common goals for all members of the group, plus supplementary items sometimes classified into two or three successive categories for those pupils who have the ability and inclination to attempt them. The third position is suggested by the principle that in a democratic social order each individual should have educational opportunities compatible with his capacities and interests. The matter of goals is not mentioned and hence there is the implication that the differentiation of objectives

is secondary. If educational opportunity is adjusted to the child's capacity and interest appropriate differentiation of objectives will emerge.

Hildreth (1940) seems to favor a combination of the second and third positions, with the greater emphasis upon the latter during the first three or four years of the elementary school. A variety of adaptations to individual differences have been proposed and there are a number of reports of the effectiveness of particular plans. Individualization of instruction within classes has a long history. Hildreth (1940) states "it is likely that, soon after class instruction became the fashion in American schools some resourceful teachers began to employ means for giving specific attention to individual pupils, especially those whose learning was unsatisfactory (p. 23)." In 1888 Preston W. Search developed a systematic plan of instruction to provide for individual differences among students at the secondary school level. During the second decade of the 20th century Burk (1921) pioneered in breaking the "lock step" by developing individual instructional material. A few years later Washburne (1925) a member of Burk's faculty, extended Burk's work into what became known as the Winnetka Plan. About the same time Parkhurst (1925) developed the Dalton Plan. A number of other plans have been proposed, some of them being adaptations of plans previously proposed. During recent years many teachers

have tried dividing the class into smaller groups relatively homogeneous with respect to learning capacity and interest, as a compromise plan of adapting instruction to individual differences. As each group engages in a separate project or undertakes an assignment planned for it, the teacher works with the several groups in turn, concentrating more on helping the pupils who are less independent than others.

Evidence that the individualized program as developed at Winnetka and elsewhere saves time has been reported by Washburne (1925). He reported that the saving of time was 78% in San Francisco and 50% in Winnetka. In Los Angeles the child who works in the adjustment rooms proceeds on the average of 3.36 times as fast as the child in regular classrooms. Retardation in the Winnetka Schools was reduced and the cost was found to be no greater than that for conventional programs.

Another plan of instruction reported by Baker (1932) which emphasized individualized teaching is the Dalton Plan. The principle features of which are: freedom for the individual child to work on his assignment, economy through budgeting of time, and abandoning the fixed daily schedule. Differentiation of assignments for different ability levels is provided. During individual work and laboratory periods individual attention is assured as the teacher observes work and points out errors. Help is given on individual

study difficulties. Pupils read and collect data on the assignment. The classroom is a workroom, not an oral recitation room. Self-corrective practice is used. In the Dalton Plan there is correlation of assignments to provide integration in the pupils work. By means of departmental cooperation many overlappings are removed. Mayer-oakes (1936) also adapted the Dalton Plan successfully. He reported a gain of 25% in the proportion of students who passed the state-wide examinations when this instructional plan was used. Peters (1938) using groups matched for intelligence experimented with the contract plan in contrast to the recitation plan. Results from thirteen experiments show the superiority of the contract method. Thompson (1933) in evaluating results from a controlled experiment did not find any special advantage for the Dalton Plan. A modified Dalton Plan was worked out successfully by Underhill (1931). Billett (1932) describes a third individualized method of instruction known as the Morrison Plan. In this plan the sequence in units is provided for, and guide sheets are used for lesson assignment. The classroom is transformed into a laboratory. Units and assignments are differentiated for pupils of varying ability. The teacher is at hand to give personal guidance to the pupils work and study activities. The Morrison Plan has been used most generally with science teaching; 9% of the secondary schools in the country reported using this plan in 1932.

In addition to the relatively comprehensive plans of adaptation referred to as laboratory methods, the literature includes descriptions of a number of procedures and devices such as differentiated assignments, supplementary assignments, workbooks, self-teaching materials and supervised study. Hildreth (1940) summarized recommendations from teachers concerning ways of individualizing reading instruction. Bonn (1942) prepared a bulletin on the same subject; and DeLong (1938) described a plan for the primary grades. In the bulletin on adopting instruction in arithmetic to individual differences, Bruckner (1941) described adjustments in curriculum and teaching procedures and the ways in which materials can be used for individualizing instruction. There is also a limited number of earlier reports of experimental studies in which an attempt was made to determine the relative merits of two or more procedures. The Philadelphia Board of Public Education (1933) in a report released by the Division of Educational Research and Results, describes three devices for individualizing classroom work in junior and senior high school classes. These included differentiated unit assignments, grouping pupils within the classroom and individual remedial exercises. There were three types of differentiated assignments; the common assignments differentiated in rate, minimum and maximum assignments differentiated as to achievement-level expected, and common

group objectives with special assignments for each pupil. In grouping pupils, committees were formed for special assignments, groups were organized on the basis of special assignments, and other groups were given remedial instruction. According to the Philadelphia report, highly satisfactory results were achieved in this program. Snader (1937) individualized instruction in Algebra through providing study guides instead of textbooks, putting problems on practice cards, and giving end tests to each pupil at the completion of a unit. A pupil whose score fell below an arbitrary standard was required to do more practice. Rolker (1931) reported success in differentiating instruction for both bright and slow learning pupils within the same class by varying the amount and kind of content through selection of instructional materials, adaptations of assignments, variation in difficulty in type of questions and problems, methods of procedure and teaching techniques.

Individualization of Mathematics Instruction

A knowledge and understanding of individual differences and how they affect achievement in school is necessary before an adequate program of individualization in mathematics can be developed.

The inadequacy of present grouping procedures in arithmetic at the elementary level has already been widely recognized even when children are placed in ability groups.

This grouping process is often times based upon oral reading ability and thus children in any particular classroom are found to be working on a variety of ability levels as far as number work is concerned. Every elementary school child differs from his peers in many ways. Society has recognized some of the differences in physical traits and has provided facilities in the schools to meet these physical differences. Different sizes of desks and chairs, different heights in drinking fountains, left and right hand scissors, large mirrors which can be used for students of different heights, and special classes for hard of hearing and partially sighted or blind children are just a few of the facilities provided in the school to meet the individual differences in the school trait.

The literature indicates that, even though educators are equally aware that students differ in psychological characteristics they do not fully appreciate the extent to which they are different. Brueckner, Grossnickel and Reckzeh (1957) identified individual differences which effect mathematics achievement as being differences in ability, needs, interest and level of development. They indicated that teachers must adjust their methodology, materials and curriculum to meet these differences. A study of Keough (1960) supports the effect experimental background has upon achievement in arithmetic. In a study of 208 eighth grade students he found that there was

a positive relationship between cultural aspects of the home and arithmetic achievement. The study specifically indicated a positive relationship between the following aspects:

1. The more intellectual newspapers read in the home and the child's achievement in arithmetic.
2. The less intellectual and picture type newspaper and lack of a child's achievement in arithmetic.
3. Parents occupation in a profession and a child's achievement in arithmetic.
4. Successful parents who are foreign born and student's achievement in arithmetic.

Even though the sample was grouped for the study according to a child's general intelligence, overall school achievement and his family income, family's socio-economic background, the study was very limited. It was limited to the degree that the study included only white children from middle income groups and therefore does not reflect the effect that children of other races and from the extremes of the socio-economic continuum might have on the relationship studied.

Passy (1964) in a study of 1,865 third grade students from urban areas, found a positive relationship between a child's socio-economic background and his achievement in mathematics. The data, significant at the five percent level, indicated a direct relationship with the increased

level of education and skill of the bread-winning parent and a child's mathematics achievement. His study indicated that there needs to be a reappraisal of the mathematics instruction. An instructional program in mathematics should be one that will foster learning in all children, without cultural bias.

A study by Jarvis (1964) of 713 sixth-grade pupils supports the contention that there is wide variation in achievement in a given grade level. He measured the arithmetic achievement of sixth-grade students by administering the California Achievement Test Battery, Form W, to the students. The data indicated that there was a range of 6.9 years in achievement in arithmetic reasoning and 6.5 years in achievement in arithmetic fundamentals. Sixty-nine percent of the students were achieving above grade level, eleven percent at grade level, and twenty percent below grade level. Jarvis stated that teachers should not attempt to eliminate this range of ability, but they should attempt to identify the individual needs and plan their teaching to meet these needs.

Mouly (1960) supports the contention that individual students vary within themselves as to their abilities. When a teacher utilized a standardized test score as a measure of a student's ability, he is assuming that there is a high degree of correlation among the students' various abilities. Students also attend arithmetic classes

with differences in attitudes. It is generally accepted that people tend to do better in those subjects and activities which they like.

Bassham, Murphy and Murphy (1964) studied the relationship between pupil attitude toward arithmetic and pupil achievement in arithmetic. The sample for the study consisted of 159 pupils in sixth-grade classes in a metropolitan school district. Each student was given a battery of tests; the Kuhlman-Anderson Intelligence Tests, Iowa Tests of Basic Skills-Arithmetic Concepts, Iowa Tests of Basic Skills-Reading Comprehension and Duden's Scale for Measuring Attitudes toward Arithmetic. Individual differences due to intelligence and reading comprehension were controlled to a certain extent by the use of residual scores.

The authors found that a difference existed in the mean scores of the basic arithmetic concepts between students in the upper and lower two-fifths of the distribution of the attitude scale scores. Further analysis indicated that over four times as many students with a poor attitude were .65 of a grade level below the expected level of achievement as were .65 of a grade above the expected level of achievement. Of the students who were rated as having a high favorable attitude toward arithmetic, three times as many achieved, .65 of a grade level above the expected level of achievement as were .65 of a grade below the expected

level. The authors suggested that it would be hazardous to predict achievement of students on the basis of scores on an attitude test.

Whitaker (1962) reported on an individualized arithmetic program for elementary students in Culver City, California. The program offered each child a better education in terms of his ability and interests within the conventional organization of the school. Basic to the program was a wide range, three to five years of source materials; the permitting of students to progress at their own rate; the permitting of students to check their answers, and a one to one relationship with the teacher. No mention was made of the mean gain of achievement made by the students or of the control used to evaluate the program.

Potamkin (1963) designed an individualized arithmetic program for fourth-grade students in Montgomery County, Maryland. The program was designed to use one basic textbook for all students but to permit students to work from one assignment to the next at their own rate. Instruction was given to the individual student as he became ready for new work. Each student was permitted to check his own work with an answer sheet. The writer did not statistically report his work but gave the following advantages of individualized instruction in arithmetic:

1. Children have immediate knowledge of the results of their work.
2. The students have greater personal contact with the teacher.
3. No child is forced to follow a learning pattern established by another student.

An individualized arithmetic program was conducted in Monmouth, Oregon, under the direction of Redbird (1964) involving thirty-two fourth grade children participating in the two-year program. The students were average and above average in mental ability as measured by standardized tests. Basic to the program were the various levels of instructional materials used to meet the individual needs of the students. Each student was permitted to progress from topic to topic at his own rate. Even though no mention was made in the study of a comparison of the experimental group with a control group, it was noted that no child in the group was performing below the fifth-grade level in arithmetic testing at the end of the two-year program.

Searight (1964) reported that educators should do more than give lip service to the problem of individual differences within the classroom. Every effort should be made to develop a program which will better meet the needs and differences of each child. He based his statement on an individualized instructional program in arithmetic for fifth-grade students in a self-contained classroom.

The majority of the students attained the highest levels of achievement of which they were capable within the broad limits imposed by the author. Searight did not delineate on what basis he was able to determine the broad limits for each student.

Basic to the program was the feature that each child was permitted to progress at his own rate from one assignment to the next. This permits the faster student to enrich his arithmetic program by pursuing special fields of interests and permits the slower student to spend more time working in areas which are difficult for him to comprehend.

Graham (1964) reported on a fifth- and sixth-grade individualized arithmetic program carried out in the 1959-60 school year at the campus laboratory school at Florence State College in Florence, Alabama. Since a program of individualized reading had already been used in this school, only the curricular area of individualized arithmetic presented a new instructional approach for these teachers. Perhaps this explains the fact that the fifth-grade class did have access to three different fifth-grade texts in arithmetic; but there is no indication in this study, of pupil selection of texts or topics to study. Graham reported:

The class had access to three current fifth-grade texts and when the teacher felt that one of these presented a topic better than the others it was used by all needing help in that topic (p. 233).

The evaluations of this particular program by the teachers participating in it indicated that it was highly favored by pupils as well as teachers. Some outcomes of the program which were mentioned by the teachers in their evaluation statements were; heightened interest in mathematics, independence in working habits and wide diversions of growth rates.

It has been demonstrated in these and similar experimental studies that as far as the mechanics of this instructional method are concerned, programs of individualized instruction of arithmetic can be effectively carried out in elementary classrooms.

It has also been demonstrated in these and similar studies that individualized instructional programs in arithmetic, as they have been reported so far, do not include the opportunity for seeking and self-selecting on the part of the children participating in such programs.

Educators do feel that it is important for children to select their topics for study, at least to some extent. Minor (1964) criticized current teaching practices for lack of self-selection opportunities in the statement:

The world of the child is the same in substance atom for atom, brick for brick, stock for stock, as the world of the adult. One way in which teachers have deprived the youngsters of the active participation in shaping the content of his world derives from having given him "content" in established forms, pre-ordained and absolute. Tutored and trained in "proper" perspectives, the child loses his most precious birthright,

putting the stamp of his unique personality on the understanding of the freshness of his naivete. Instead teachers have made it the task in too many schools to learn the world is mandated, bit by bit (p. 54).

One of the most recent experimental studies involving individualized instruction in arithmetic has been reported by Scanlon (1966). There were twenty-eight fifth-grade students and twenty-two sixth-grade students involved in this study. The socio-economic makeup of the school, according to Scanlon, tends to be upper-middle class. This study is the forerunner of the nationally known program commonly referred to as Individually Prescribed Instruction. At the end of the four-month experimental period Scanlon concluded that:

1. Individualized instruction seems to be more self-initiated than non-individualized.
2. The amount of self-initiation in a classroom can be increased by the introduction of specific techniques to improve this activity.
3. Self-initiation has little relationship to intelligence, achievement, or sex of students.
4. Express interest in the subject of mathematics did not change over the four months of the study.
5. The treatments had no measurable effect on expressed interest.
6. The procedures used to encourage self-initiation in the individualized classes had little carry-over to the non-individualized classes.
7. The teacher ratings of the amount of extra activity students do for school had a correlation range between moderate to high with the student ratings of each other.

8. The student ratings of extra school activity for each other did not change over the four-month period.
9. The pupils expressed a desire to continue with some of the treatment in their mathematics classes.
10. The students hoped to obtain a professional occupation with "teacher" ranking high (pp. 71-72).

Scanlon's study suggests that self-initiation occur more often and at a higher rate in the individualized classes than in the non-individualized. It further suggested that the non-individualized classes were more teacher initiated. Furthermore, self-initiation can be improved by providing specific techniques to be used during the class period. It appears that self-initiation can be improved by providing specific techniques to be used during the class period. It appears that self-initiation has little relationship to usual school measures of classroom performance.

From the above cited study and several others cited in this section, further study is needed to help determine what treatments are most effective in encouraging self-initiation. More importantly, analysis is needed as to what effect each treatment has on the academic achievement in mathematics of individual students.

The attempts to individualize instruction have been limited. The study of reports of current experimental programs in individualized arithmetic instruction, together with observation in many elementary schools have led

the researcher to believe this is due to the following reasons:

1. Inadequate training of teachers.
2. Inadequately constructed textbooks, materials, manipulative devices, supplies, in-depth diagnostic tests, suitable for individual work.
3. Interference from "conservative parents" and school people.
4. A technical lag in the use of computers to assist in the management of instruction.

Summary

Educators have long been aware of the wide range in individual differences of students and have strived to meet the differences by adjusting the organization of the school and curriculum. Such efforts have included grouping by ability, or interest, team organization, non-graded organization, inter-class grouping, intra-class grouping, and differentiated assignments.

Research concerning the success of these measures is both ambiguous and inconsistent. At best, these attempts to meet individual differences have reduced, not eliminated, the range of differences. There remains a dire need for a better plan to meet the needs of the individual more adequately.

The literature indicates that there have been several attempts to organize plans for complete individualized instruction. Such plans are organized on the following premises:

1. Students differ greatly in the rate at which they learn, therefore, each student should progress through arithmetic at a rate that will permit him to develop to his full potential.
2. Learning is facilitated if immediate results are given to each response made by the student.
3. Learning is an individual affair which takes place within the individual.

In a sense, learning is a product of the student's own direction.

4. Instructional materials should be designed with simple, clearly written behavioral objectives and interventions that will permit self-instruction.

There is ample evidence that the individualized programs are making a significant contribution to education. However, research does not delineate the part each of the above premises contributes to the educational program. The desired outcome of this study was to provide more information concerning the contributions, the different facets, of an individualized mathematics program may make so that the construction of teacher programs will better meet the needs of the student.

CHAPTER III

DESCRIPTION OF THE STUDY

INTRODUCTION

The problem of this study was to determine the effect of an individualized instructional approach on the achievement gains in mathematics, specifically arithmetical computations, concepts, and applications of fourth grade inner-city school children. The study attempted to determine and analyze some effects of changing the educational environment of fourth grade students in mathematics. The educational environment was changed in order to achieve an individualized, diagnostic, prescriptive instructional approach for each of the experimental subjects.

The study compared students who were given individually prescribed work through independent study, small group discussions, large group activities and teacher-led discussions with students who received instruction in the traditional textbook, class group method of instruction in mathematics.

The content in mathematics, arithmetical computation, concepts, and applications as defined in the study, remained the same for the experimental and control group of students. Only the method of instruction was changed. In order to accomplish this, the State adopted textbooks were used as the basis for developing the scope and sequence, the behavioral objectives and to develop a comprehensive diagnostic test covering arithmetical operations involving the addition, subtraction, multiplication and division of whole numbers and fractional numbers. The goal of this study was to establish that greater achievement gains occur as a result of the process of individualizing instruction.

THE POPULATION AND SAMPLE

The population in this study is the set of all inner-city elementary school children, in the fourth grade, who are enrolled in a public school within the south and east Stockton core area. At the time of the study there were 1,360 students enrolled in 45 fourth-grade classes in twenty elementary schools in this core area. Stockton, California is located in the north central portion of the San Joaquin Valley, seventy-eight miles east of San Francisco. Stockton is basically an agricultural community. The Stockton Unified School District which serves the city of Stockton and several unincorporated

communities, enrolls 32,551 students of which 18,251 are elementary (K-6). There is a very wide mixture of socio-economic, ethnic and racial groups in this community. Table 1 illustrates that approximately twenty-three percent of the students are Mexican Americans, fourteen percent are Black, seven percent are Chinese, Japanese, Filipino, American-Indian and fifty-five percent are Caucasian. It is estimated that 10,975 or one-third of the District's total student enrollment are classified as low income. The unemployment rate for the south and east Stockton core areas has averaged fifteen percent per year during the past ten years.

The sample selection from the population of 1,360 fourth-grade pupils enrolled in 45 fourth-grade classes described above consisted of 14 classes that had 395 pupils enrolled. From these 14 classes, 12 classes consisting of 344 pupils were selected by the researcher from the sample to serve as experimental classes and two classes consisting of 51 pupils were selected to serve as control classes.

THE DESIGN

The design of this study is the "non-randomized control-group pre-test - post-test design," as defined by Van Dalen and Meyer (1966, p. 275). This design is utilized when the researcher is unable to provide full experimental

Table 1. Revised Racial and Ethnic Report, Stockton Unified School District (November 7, 1969).

School	Spanish Surname	Other White	Negro
Adams	37 (5.2%)	634 (88.7%)	5 (.7%)
August	146 (25.5%)	417 (72.7%)	--
Burbank	168 (56.9%)	35 (11.9%)	83 (28.1%)
Cleveland	43 (11.4%)	311 (82.7%)	4 (1.1%)
El Dorado	136 (13.3%)	811 (79.4%)	14 (1.4%)
Elmwood	103 (14.3%)	607 (84.4%)	--
*Fair Oaks	297 (41.6%)	155 (21.7%)	246 (34.5%)
Fillmore	105 (19.9%)	397 (75.3%)	9 (1.7%)
*Garfield	191 (31.3%)	68 (11.1%)	324 (53.0%)
Grant	114 (44.7%)	49 (19.2%)	56 (22.0%)
Grunsky	93 (18.8%)	388 (78.5%)	5 (1.0%)
Harrison	19 (6.4%)	272 (91.3%)	2 (.7%)
Hazelton	139 (42.9%)	115 (35.5%)	27 (8.3%)
Hoover	77 (9.0%)	708 (82.5%)	12 (1.4%)
Jackson	250 (39.6%)	91 (14.4%)	110 (17.4%)
Jefferson	178 (36.6%)	281 (57.8%)	14 (2.9%)
Kennedy	61 (6.2%)	874 (88.5%)	9 (.9%)
Lafayette	74 (33.8%)	21 (9.6%)	23 (10.5%)
Madison	50 (7.6%)	567 (86.3%)	6 (.9%)
*McKinley	253 (44.4%)	105 (18.4%)	144 (25.3%)
**Monroe	151 (32.6%)	79 (17.1%)	194 (41.9%)
Montezuma	97 (16.3%)	465 (78.0%)	11 (1.9%)
Nightingale	83 (27.3%)	99 (32.6%)	113 (37.2%)
Oxford	28 (25.0%)	51 (45.5%)	24 (21.4%)
Pulliam	51 (9.5%)	441 (81.8%)	11 (2.0%)
Roosevelt	257 (30.4%)	391 (46.3%)	137 (16.2%)
**Taft	134 (43.6%)	28 (9.1%)	131 (42.7%)
*Taylor	381 (38.2%)	128 (12.9%)	303 (30.4%)
Tyler	79 (12.3%)	516 (80.4%)	3 (.5%)
*Van Buren	154 (26.4%)	40 (6.9%)	382 (65.5%)
Victory	117 (15.1%)	551 (71.0%)	40 (5.2%)
Washington	128 (50.0%)	11 (4.3%)	110 (43.0%)
Wilson	41 (7.9%)	431 (83.2%)	2 (.4%)
Total Elementary	4235	10,137	2554
Percentage	23.18%	55.49%	13.98%

*Experimental Schools

**Control Schools

Oriental	American Indian	Other Nonwhite	Total
31 (4.3%)	1 (.1%)	7 (1.0%)	715
2 (.3%)	2 (.3%)	7 (1.2%)	574
--	--	9 (3.1%)	295
9 (2.4%)	--	9 (2.4%)	376
38 (3.7%)	2 (.2%)	21 (2.0%)	1022
1 (.1%)	3 (.4%)	5 (.7%)	719
3 (.4%)	3 (.4%)	10 (1.4%)	714
5 (.9%)	4 (.8%)	7 (1.3%)	527
5 (.8%)	1 (.2%)	22 (3.6%)	611
10 (3.9%)	3 (1.2%)	23 (9.0%)	255
3 (.6%)	1 (.2%)	4 (.8%)	494
4 (1.3%)	--	1 (.3%)	298
22 (6.8%)	--	21 (6.5%)	324
40 (4.7%)	4 (.4%)	17 (2.0%)	858
136 (21.5%)	2 (.3%)	43 (6.8%)	632
3 (.6%)	2 (.4%)	8 (1.6%)	486
18 (1.8%)	5 (.5%)	21 (2.1%)	988
75 (34.2%)	2 (.9%)	24 (11.0%)	219
29 (4.4%)	1 (.2%)	4 (.6%)	657
13 (2.3%)	--	55 (9.6%)	570
8 (1.7%)	1 (.2%)	30 (6.5%)	463
5 (.8%)	--	18 (3.0%)	596
--	--	9 (2.9%)	304
6 (5.4%)	--	3 (2.7%)	112
17 (3.2%)	1 (.2%)	18 (3.3%)	539
9 (1.1%)	15 (1.8%)	35 (4.1%)	844
--	--	14 (4.6%)	307
6 (.6%)	1 (.1%)	177 (17.8%)	996
27 (4.2%)	1 (.2%)	16 (2.5%)	642
1 (.2%)	--	6 (1.0%)	583
36 (4.6%)	4 (.5%)	28 (3.6%)	776
1 (.4%)	1 (.4%)	5 (1.9%)	256
36 (6.9%)	1 (.2%)	7 (1.4%)	518
599	61	684	18,270
3.28%	.33%	3.74%	

control through randomization. In this study the researcher was unable to achieve the rigorously controlled design that requires the subjects to be assigned to comparison groups at random, since preassembled groups for the experimental and control subjects had to be used.

Van Dalen and Meyer illustrate this design in the following manner:

	PRE-TEST	TREATMENT	POST-TEST
Experimental Group	T_{1E}	X	T_{2E}
Control Group	T_{1C}		T_{2C}

Where T_{1E} and T_{2E} represent pre-test and post-measures for the experimental group: T_{1C} and T_{2C} represent pre-test and post-test measures for the control group. X represents a treatment. The above model varies from the text model in that the groups were not randomly selected.

The authors explain:

If similar groups are selected and their similarity is confirmed by the t mean scores and standard deviations, this design controls several potential sources of internal invalidity. The presence of a control group enables the experimenter to assume that the main effects of history, pre-testing, maturation, and instrumentation will not be mistaken for the effect of the treatment, for both the experimental and control groups will experience these effects (p. 276).

Campbell and Stanley (1963) call this design "the non-equivalent control group design." These authors described and illustrate this design in the following manner:

One of the most widespread experimental designs in educational research involved an experimental and control group both given a pre-test and a post-test but in which the control group and the experimental group do not have pre-experimental sampling equivalence. Rather, the groups constitute naturally assembled collectives such as classrooms, as similar as availability permits but yet not so similar that one can dispense with the pre-test. The assignment of X to one group or the other is assumed to be random and under the experimenter's control (p. 217).

The authors explain this design, in spite of the fact that the experimental subjects are not assigned randomly from a common population to the experimental and control group, is well worth using in many instances where randomization is impossible.

PROCEDURE AND TREATMENT

Selection of Subjects. In September 1969, there were approximately 1,360 fourth-grade pupils enrolled in 45 classes from the south and east Stockton core area available for this study. From these 45 classes, 12 classes were selected that contained 344 pupils to receive the individualized, diagnostic, prescriptive, treatment in mathematics, arithmetic computation, concepts, and applications. Two classes containing 51 pupils were selected to serve as control classes.

The length of the treatment was approximately eight months. In order to insure that the children selected for this study were comparable, the researcher:

1. Compared the pre-test performance on I.Q. and standardized test of the children who are members of the experimental and control classes. The value for the t and the comparable variance were used in judging the groups to be similar in initial performance. These results are summarized in Chapter IV.
2. Made a comparison of the socio-economic data of the children who were members of the control and experimental classes. This socio-economic data included payments of aid to families with dependent children, numbers of children who were residents of public housing, children who were receiving free lunches and other data reflecting severe poverty. The result of this comparison is summarized in Chapter IV.
3. Made a comparison of the daily attendance patterns for both the experimental and control subjects. The school attendance pattern for the experimental and control subjects during the treatment period is summarized in Chapter IV.
4. Compared the racial and ethnic distribution in the experimental and control classes. The comparison

of racial and ethnic distribution of the experimental and control classes participating in the study is summarized in Chapter IV.

Experimental Group. In June 1969, the Stockton Unified School District received a federal grant to initiate an intensive program of instruction in mathematics for east and south Stockton core elementary students. The size of the grant did not permit serving all eligible students in the core area. It was necessary to select only a relatively small proportion of eligible students.

The selection of the experimental classes for this study was from those elementary schools that had the highest numerical concentration of children from low-income families. The number of elementary school children attending schools in the south and east Stockton core area who qualified and received Aid to Families With Dependent Children (AFDC) was provided by the San Joaquin County (California) Welfare Office. The number of children in each school receiving AFDC was multiplied by a low-income factor of 1.5. The factor of 1.5 was used as the standard to include those children who did not qualify for AFDC or whose families had not applied but who were otherwise low-income as indicated by the number who were residents of public housing, receiving free lunches and free medical and health services. Table 2 lists all the elementary schools in the south and east Stockton core area, and for

Table 2. Stockton Unified School District, Research and Federal Projects Office
February 23, 1970. Public Elementary Schools Eligible for Special
Federal Assistance.

Name of School	Number of AFDC Pupils	Low Income Factor AFDC x 1.5	Total School Population	% of Student Pop. on AFDC	% of Pupils Low Income Factor and AFDC
Burbank	100	150	310	32.2	48.4
Fair Oaks*	197	296	727	27.1	40.7
Garfield*	176	264	622	28.3	42.2
Grant	107	161	245	43.7	65.7
Hazelton	70	105	271	25.8	38.7
Jackson	141	212	593	23.8	35.8
Jefferson	147	221	459	32.0	48.1
Lafayette	94	141	220	48.7	64.1
McKinley*	256	384	570	44.9	67.4
Monroe**	151	227	446	33.9	50.9
Nightingale	85	128	269	31.6	47.6
Taft**	132	198	296	44.6	66.9
Taylor*	375	563	985	38.1	57.2
Van Buren*	377	566	596	63.3	95.0
Washington	83	125	245	33.9	51.0

*Experimental Schools - Mean Low Income Factor 60.5%

**Control Schools - Mean Low Income Factor 58.9%

each school; the number of AFDC pupils, the number of other low-income pupils (AFDC $\times$ 1.5), the total school population, the percent of each school's population on AFDC, and the percent of each school's population that was low-income (AFDC plus low-income children). Indicated by a single asterisk mark are those schools from which the experimental classes were selected and two asterisks marks indicate those schools from which the control classes were selected. The computed means low-income factor students for those schools from which the experimental classes were selected was 60.5% and for those schools from which the control classes were selected was 58.9%.

From the five core area elementary schools, 12 classes consisting of 344 fourth-grade pupils were selected to serve as the experimental group. In the present study the experimental subjects received treatments that were designed to individualize the instructional method in mathematics, arithmetic computation, concepts and applications.

The experimental treatment consisted of the services of a mathematics coordinator who supervised the overall program, five instructional specialists, seven mathematics specialists, sixty-three instructional aides, five materials clerks and special mathematics supplies, materials and equipment. These services supplemented the regular school allocation for supplies, materials, equipment and personnel.

Obviously the cost of the services provided the experimental group were greater than those provided the control group. The expenditure was approximately \$425 per experimental subject over and above the expenditure for each control subject.

The instructional method used with the experimental subjects was an individualized, diagnostic, prescriptive, continuous progress approach to teaching mathematics. An important component in this individualized instructional approach used with the experimental subjects was breaking down the mathematics instructional program in computational skills into sets of behavioral or performance objectives that were assigned as learning tasks. The objectives were not vague or general, such as, the subtraction of whole numbers, but rather specific and behavioral as, "given ten exercises, subtraction of whole numbers with hidden zeros, you will be expected to work correctly nine of the ten."

Those objectives were then coded into an orderly scope and sequence and related to the diagnostic tests and the instructional materials used. In the development of the list of objectives an attempt was made to avoid the trivial or insignificant at the same time to avoid the impossible. The complete list of behavioral objectives are found in appendix D.

With the aid of an IBM computer a diagnostic profile was used to analyze each experimental subject. The diagnostic

instrument used was locally developed by a team of District teachers. This instrument possessed content validity, since it measured what it purported to measure.

Two sample student profiles are shown below:

SUBSCORE AREAS - WHOLE NUMBERS													
Subscore Areas	A	B	C	D	E	F	G	H	I	J	K	L	Total
Maximum Score	8	12	6	9	4	6	4	6	8	5	2	4	73
Romero, Alicia	8	12	5	7	4	5	4	6	7	2	0	3	59
Saunders, John	6	7	6	9	3	6	4	5	8	1	1	3	59

The content areas measured in each of the above subscore areas:

- A. Adding whole numbers, no regrouping
- B. Adding whole numbers, regrouping
- C. Subtraction of whole numbers, no regrouping
- D. Subtraction of whole numbers, regrouping
- E. Multiplication of whole numbers, one digit multiplier, with and without regrouping
- F. Multiplication of whole numbers, two and three digit multipliers using zeros
- G. Multiplication of whole numbers, two and three digit multipliers
- H. Division of whole numbers, one digit divisors with and without remainder

- I. Division of whole numbers, one digit divisors, zeros in quotient, no remainder
- J. Division of whole numbers, two digit divisors with and without remainders
- K. Division of whole numbers, two digit divisors, zeros in quotient, no remainder
- L. Division of whole numbers, three digit divisors, remainders

The use of the individual diagnostic profile was the first step used by the staff in pinpointing specific areas of disability in arithmetical computation skills in whole numbers and fractional numbers. As indicated in the two sample student profiles cited, the two students have the same total raw score but have different areas in which they need attention.

Another profile similar to the one above was developed for each experimental subject in arithmetical computational skills, fractional numbers. This diagnostic instrument measured:

- A. Equivalent fractions
- B. Renaming numbers as mixed and improper fractions
- C. Adding unlike fractions and mixed numbers
- D. Adding like fractions and mixed numbers
- E. Subtracting like and unlike fractions, no regrouping
- F. Subtracting like, unlike fractions and mixed numbers, regrouping

- G. Multiplication, proper fractions and whole numbers
- H. Multiplication, mixed numbers, proper fractions and whole numbers
- I. Multiplication, three or more factors
- J. Division, proper fractions and whole numbers
- K. Division, proper fractions, whole numbers, mixed numbers

The additional staff, the instructional specialists, the mathematics specialists, and the instructional aides, working closely with the classroom teacher, cooperated in diagnosing the strengths and special educational needs and in providing prescriptions which most adequately focused upon each experimental subject's special educational needs.

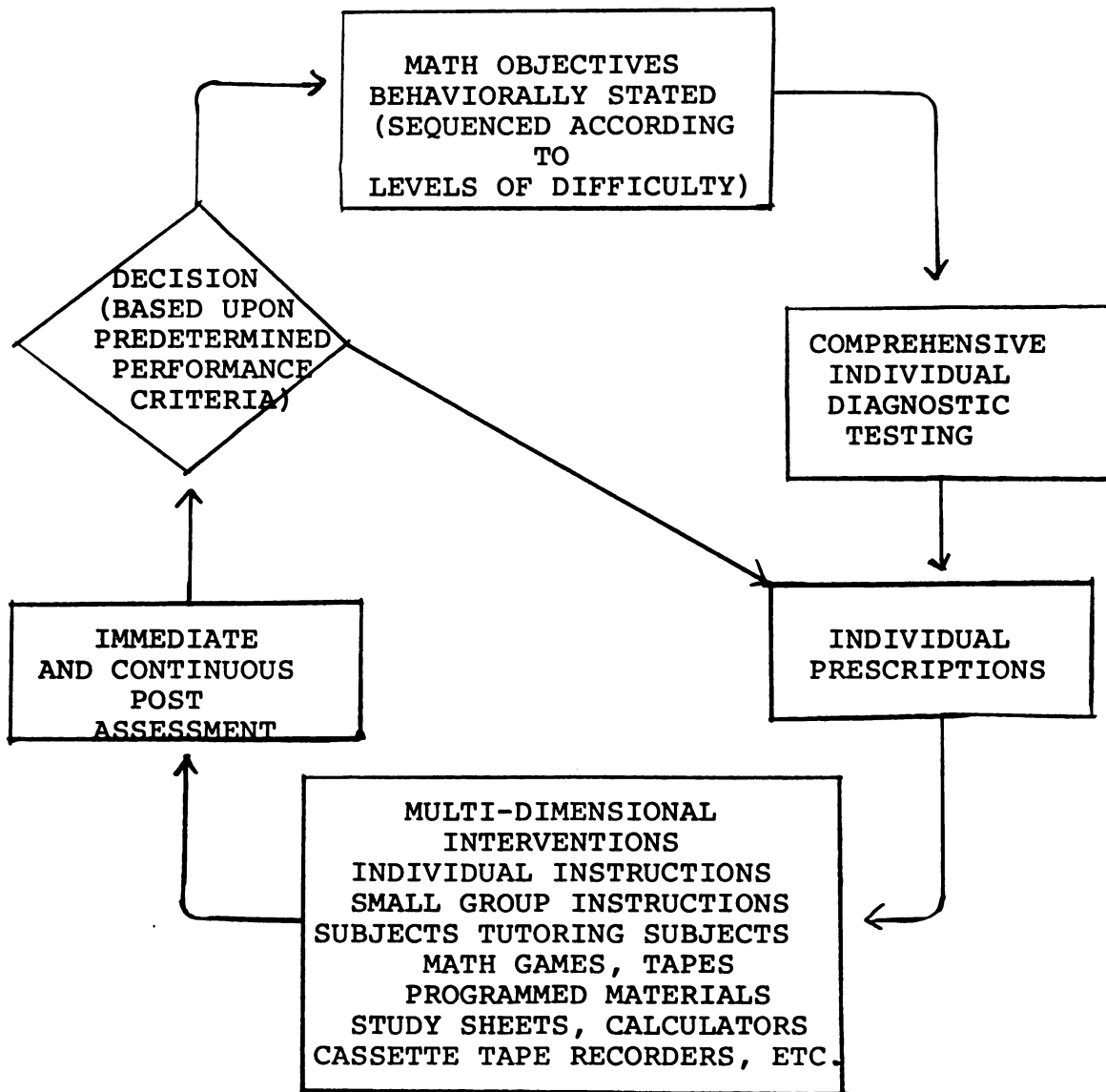
Each experimental subject received an average of forty-five minutes of intensive, individualized and small group instruction each day. Experimental subjects with particular learning problems had additional instruction on a pull-out basis. Control subjects with particular learning problems also received additional instruction on a pull-out basis. In such cases (the experimental subjects who were singled out for additional instruction) provision was made for their return to the classroom setting at the earliest feasible time. The number of subjects who were singled out for additional instruction were held to a minimum for the following reasons:

1. The negative effects of isolation on the image of the subject as a learner
2. The negative effects on the expectational level of the entire staff
3. The lack of opportunity for the subjects to learn from their peers
4. The necessity for the staff to begin to develop instructional techniques that would allow each child to progress at his own continuous rate of learning and style so that educationally alienated children would not have to be isolated in a setting that is economically, ethnically and racially balanced.
5. The necessity to maintain the validity of comparisons between the experimental and control groups, making it necessary to keep the instructional time as uniform as possible.

All the special efforts to give individual direction, attention, motivation and work to students comprised the experimental treatment. Individually developed prescriptions, special attention of the added staff, instructional tapes and playback machines with earphones, 8 mm concept and drill film loops, film strips with viewers, staff and commercially produced ditto masters for worksheets and programmed materials were all used in the experimental treatment.

The flow-chart diagram below illustrates graphically and succinctly the experimental treatment:

FIGURE I
EXPERIMENTAL TREATMENT



Control Group. The selection of the control classes for this study was from two elementary schools in the south and east Stockton core area that had a numerical concentration of children from low-income families that were comparable to the experimental classes selected from five elementary schools in the same core area. (See table 2). From the core area elementary schools, two fourth-grade classes consisting of 51 pupils were selected to serve as the control group.

The researcher, based on professional work in the south and east Stockton core area for 12 years, concludes that this sample size was adequate because the subjects under study were compatible with the experimental group. As previously indicated, to varify this conclusion that the experimental and control subjects were comparable the researcher compared pre-test performance of the two groups on I.Q., standardized achievement tests, made a comparison of the socio-economic data (See table II), compared the daily attendance patterns and the racial and ethnic distribution in the experimental and control classes. According to Van Dalen and Meyer (1966);

No specific rules on how to obtain an adequate sample have been formulated, for each situation presents its own problems. If the phenomena under study are homogeneous, a small sample is sufficient. . .In general, three factors determine the size of an adequate sample: the nature of the population, the type of the sampling design, and the degree of the precision desired. The researcher gives careful consideration to these factors and then selects the sampling design that will provide the desired precision at minimum cost (p. 298).

The control group classes maintained a traditional classroom approach to the same content material used in the experimental classes; lecture, class discussion and learning tasks were outlined, structured and paced for the group. Care was taken by the administrative staff to establish and maintain a difference in the instructional strategy between the control and experimental groups. The treatments described earlier for the experimental group were not used in the control group which emphasized instead a group discussion and lecture method of presentation.

Procedure. It was hypothesized that the experimental group after experiencing eight months of individualized instruction as defined in this study, will show significantly greater improvement of scores than the control group experiencing eight months of textbook oriented, class instruction.

It was assumed that the experimental group would show other differences, such as, a keener interest in mathematics, a more rapid pace of learning, a wider range of achievement scores and a marked autonomy and initiative in learning and more skill in arithmetical computations.

The spring prior to the implementation of the study, members of the teaching staffs, along with the principal and two consultants from the central administration staff worked to plan the program to be used in the fall with the experimental subjects. The teachers and the

administration determined that the approach would be pupil-centered and individualized. This group decided that the individualization of instruction in mathematics could only result from a comprehensive analysis of each pupil's strengths and educational needs. Therefore, the need for comprehensive diagnostic instruments, additional personnel, i.e., mathematics specialists, instructional aides, materials clerks, volunteer aides and tutors and special supplies and equipment and a continuous inservice education program for all staff members were realized and acquired prior to actual implementation. In the control group all instruction was given in class to the total group. Class discussions were frequent. Textbook assignments and common group testing was the practice. New material was begun by the entire class at the same time. The difference maintained was in the method of classroom work pursued. Individualized instruction was compared with class and group instruction.

DATA COLLECTION

Beginning in mid-September 1969, weekly visits were made to the experimental school sites for the purpose of facilitating the implementation of the individualized mathematics program in any way necessary and obtaining the data for the study. In December an outside consultant from the local university was retained to assist in the formative evaluation process. Bi-monthly meetings were held with the mathematics specialists assigned to the experimental

schools for the purpose of assisting them in the daily implementation process.

Data Concerning Staff Reaction. Short, informal conferences were held at frequent intervals with teachers, instructional specialists, mathematics specialists, instructional aides, materials clerk typists and principals who participated in the individualized program. During the final two weeks of the school year an outside consultant from the local university who served as an evaluator had occasion to interview these persons. The purpose of this inventory was to determine the attitudes of the staff concerning the program in general, its content, teachability, potential, and the mechanics used in its implementation. Appendix A contains a copy of this inventory instrument and the results are summarized in Chapter IV.

Data Collection Concerning Pupil Attitudes. Opportunities were available during observational visits to discuss with the students in the experimental schools their attitudes concerning the individualized program, its content and mechanics of implementation.

During the last two weeks of classes an attitude questionnaire was completed on a sample of subjects in the experimental groups. The sample of subjects for the attitude survey were taken from class lists provided by the teachers of the 12 experimental classes. The researcher selected

every seventh student, from each class list provided, to complete the attitude questionnaire. The children were instructed not to include their names on the questionnaire. It was felt that the omission of names might serve to lend more insight into the actual attitudes of these pupils. Appendix B contains a copy of this inventory instrument, and an analysis of responses may be found in Chapter IV.

Data Collection Concerning Parent's Attitudes. Formal parent meetings were held on a monthly basis beginning in October 1969. At each monthly meeting, parents representing all the experimental schools attended. The attendance was rated as excellent by outside observers. The purpose of these meetings was to solicit the assistance of parents of experimental subjects in an effort to mobilize and coordinate all the community's resources in a concentrated attack upon the problems of the children in the experimental program. During the final two weeks of the school year a questionnaire was administered to a selected group of parents. The sample of parents selected to complete the questionnaire were taken from those who had attended the formal parent meetings. The questionnaire used is found in Appendix C. The responses to this instrument are summarized in Chapter IV.

Data Collection Concerning Achievement. This study was conducted to test the feasibility of a program of

individualized mathematics instruction. One aspect of determining feasibility was concerned with the ability of the students in the individualized program to make significant academic gains in mathematics, arithmetical computational skills. To determine whether or not significant achievement gains had been made by the experimental subjects the following null hypotheses were established and the study designed in such a way that test score data could be applied to these hypotheses:

1. There is no difference in achievement gains arithmetical computational skills, between fourth-graders in the individualized mathematics program and fourth-graders in the traditional program.
2. There is no difference in achievement gains, arithmetical computational skills, between boys and girls in the two treatment groups.
3. There is no difference in achievement gains in mathematics, arithmetical computational skills, between the racial and ethnic groups in the experimental and control groups.
4. There is no difference in achievement gains arithmetical concepts between fourth-graders in the individualized mathematics program and fourth-graders in the traditional program.
5. There is no difference in achievement gains, arithmetic applications between fourth-graders in the

individualized mathematics program and fourth-graders in the traditional program.

6. There is no difference in achievement gains, total mathematics, i.e., arithmetic computation, arithmetic concepts, and arithmetic application between fourth-graders in the individualized mathematics program and fourth-graders in the traditional program.

MEASURING INSTRUMENTS

The standardized instrument used in this study was the Comprehensive Test of Basic Skills, Form R, Level I, Arithmetic Computation, Concepts and Applications. The test instrument, published by the California Test Bureau, Monterey, California, was administered in October 1969 (pre-test) and again in May 1970 (post-test).

Tables 3 and 4 show the psychometric characteristics of the instrument used in this study. These data were obtained from the publishers manuals.

Table 3. KR #20's, Standard Errors of Measurement and Related Data in Raw Score Units for Comprehensive Test of Basic Skills, Form R, Level I, Grade 4, N = 468.

TEST	No. of ITEMS	GRADE 4 N = 468			
		Mean	SD	KD #20	SE Means
Arithmetic Computation	60	49.35	11.2	.95	2.5
Concepts	30	20.39	6.3	.88	2.2
Applications	20	13.70	5.1	.89	1.7

Kunder-Richardson Formula #20 was used to estimate the reliability reported in Table 3. These coefficients of reliability reported for the Comprehensive Test of Basic Skills are based on scores from alternate forms administered with an intervening time interval. As a further test of the reliability of the Comprehensive Test of Basic Skills test students in one school district at the overlap grades, four, six and nine were administered Form Q of the lower level for the grade (Levels 1, 2 and 3, respectively) in October 1968 and Forms R of the next higher levels (Levels 2, 3 and 4, respectively) in December. The correlation coefficients for these inter-level/inter-form administration for each of the overlap grades are presented in Table 4.

Table 4. Inter-Level/Inter-Form Reliability Coefficients Based on Administration of Adjacent Levels of Comprehensive Tests of Basic Skills, Form Q and R, at an Interval of approximately six weeks to the same students in a school district in the overlap grades (4, 6, and 8).

TEST	Q1 and R2	Q2 and R3	Q3 and R3
	Grade 4-N=440	Grade 6-N=440	Grade 8-N=441
	γ *	γ *	γ *
Arithmetic			
Computation	.80	.73	.87
Concepts	.75	.79	.82
Applications	.60	.75	.80

* Pearson product-moment coefficient

This study examines the effects of a treatment on a large number of minority students, therefore, it is worthwhile to indicate that according to the publisher's manual, while no effort was made in the standardization to identify the race, color, or creed of the participating students, an effort was made to include minority races insofar as they are attending public schools. The ratio of each minority group to the total sample of 212,509 approximates the ratio of the total number of minority group students to the total school population sampled.

Content Validity of the Comprehensive Test of Basic Skills.

The basic principle concerning the validity of a test is

that a test must be constructed at each step in its development in accordance with valid processes of test development; no statistical manipulation will make a test valid if it is not constructed to ensure that it measures what it purports to measure and measures it reliably. A careful review by the researcher of the ancillary publications of the Comprehensive Test of Basic Skills indicated that the steps taken in the development of this test ensured content validity. In the last analysis the teachers, the mathematics specialists, the mathematics consultant and the central office staff involved in this study made the decision that the Comprehensive Test of Basic Skills was a valid measure of the objectives of the experimental and the control classes.

TREATMENT OF DATA

The test score data which were collected were to be used in determining pupil achievement during the time of participation in the study. Inasmuch as the experimental and control classes represented naturally pre-assembled groups, the non-randomized control group pre-test - post-test design, as defined by Van Dalen and Meyer (1966), was selected as the one for the pupil achievement phase of the study.

An analysis of covariance was used to insure the necessary adjustment for initial differences in ability and achievement. The covariance technique was selected because

the researcher was required to use fourth-grade classes as they were already organized. The experimental and control classes therefore, were not randomized and matched for the purpose of the study.

Inasmuch as the experimental and control groups were determined on a non-random basis, it was desirable to eliminate, as much as possible, the effects of variables associated with the obtained distribution of subjects. To this end, a three way orthogonal analysis of covariance was chosen with one of the independent variables being experimental-control, a second being sex of the subjects, and the third being the racial-ethnic background of the subjects. Pre-test scores on the Comprehensive Test of Basic Skills, Arithmetic Computations, Concepts and Applications, Form R, Level I served as the covariate to eliminate initial differences in ability and achievement.

In setting up the design and arriving at cell frequencies to determine the effects of sex on achievement in this study, the smallest cell size was two. This cell size of two was for the control group, female-Whites. Since the orthogonal design is deemed preferable to a non-orthogonal design according to Ferguson (1959):

In general, because of the complications associated with unequal frequencies, it is advisable, wherever possible, to design experiments with an equal number of cases in the subclasses. . . (p. 262).

In describing a study in which analysis of covariance was used, Lindquist (1953) reported, "In order to facilitate statistical analysis, cases should be rejected at random until each subgroup is equal in size to the smallest one (p. 337)." Following the procedures described by Lindquist would result in only two cases in each of the sixteen cells of the model. To do this would make the chances of choosing a non-random sample so large as to question the ability to generalize from the findings.

In that the variables of sex, racial and ethnic background were control variables considered for the purpose of establishing that the experimental variable was indeed responsible for the differences, if found, between experimental and control groups, separate tests using univariate analysis of covariance as described in Walker and Lev (1953), were substituted to determine if differences existed.

The univariate analysis of covariance was applied to the following null hypotheses:

1. "There is no difference in achievement gains in mathematics, arithmetical computational skills between boys and girls in the study," and
2. "There is no difference in achievement gains in mathematics, arithmetical computational skills between racial and ethnic groups "

2. (Blacks, Mexican-American, Whites and other non-white, i.e., orientals, Filipinos and American Indian) in the study."
3. There is no difference in achievement gains, arithmetical computational skills between fourth-graders in the individualized mathematics program and fourth-graders in the traditional program.
4. There is no difference in academic achievement, arithmetical concepts between fourth-graders in the individualized mathematics program and fourth-graders in the traditional program.
5. There is no difference in academic achievement, arithmetic applications between fourth-graders in the individualized mathematics program and fourth-graders in the traditional program.
6. There is no difference in academic achievement total mathematics, i.e., arithmetic computation, arithmetic concepts, and arithmetic application between fourth-graders in the individualized mathematics program and fourth-graders in the traditional program."

The level of significance chosen for all F-ratios in the study was set at p less than .05.

In preparing the data for analysis, IBM cards were punched for each pupil in the study, experimental and control. Following the selection of the subjects to be

included in the research design and the preparation of the IBM cards, a program was set up in the Research Office and Computer Center of the Stockton Unified School District, Stockton Unified School District, Stockton, California, for an analysis of covariance of each set of these data. Results of these analyses are found in Chapter IV.

SUMMARY

As indicated at the beginning of this chapter, this study compares students who were given individually prescribed work through independent study, small group discussions, large group activities and teacher-led discussions with students who received instruction in the traditional textbook, class group method of instruction in mathematics. Conclusions concerning the results of this study were based upon the logical and meaningful use of the materials, the instructional method of individualization, the implementability of the program, teachers, pupil and parent attitudes, and pupil achievement. Experimental groups were identified, from which data could be gathered for all phases of the study; and a control group was selected for comparison purposes in the pupil achievement phase of the study. Data were collected and applied to the hypotheses in determining the success of the program.

CHAPTER IV

DESCRIPTIONS OF THE FINDINGS

INTRODUCTION

In studies of learning such as the present one, interest is centered in improvement or change in performance as a result of instruction. The basic idea of research design where control and experimental groups are used is to control extraneous differences and vary the experimental group's treatment measures while the control group's treatment is held constant. Post-test means are computed on all groups. The greater the difference between the means, the more the experimental treatment can be presumed to have operated. If there is little or no difference between means then the presumption must be that the experimental treatment has had little or no effect. Instruments such as achievement tests are commonly used to measure these changes in performance.

In the present study there was a comparison of pre-test and post-test measures to see if there was a difference in gain scores between the two treatments. There was a comparison of measures between the two treatment groups for indications of performance difference. This method of

differences required that dependent variables remain the same in regard to subjects of the study with the exception of the experimental treatment.

It was necessary to hypothesize what variables related to the subjects were most important and make an effort to bring them under some control. Some of these variables were sex, race, socio-economic class and ability. Approximately equal percents of sex, race, age groups, and socio-economic classes were found to be present in the control and the experimental groups. The results of the pre-test performance on I.Q. of the children who were members of the experimental and control classes showed them to be similar in initial academic aptitude.

Since the only difference between the two groups was the treatment it was presumed that any difference in performance was due to the experimental treatment. In the present study, the experimental treatment was the individualization of the instructional method. All the special efforts to give individual direction, attention, motivation and work to students comprised the experimental treatment. Individual learning prescriptions, instructional tapes, cassette play-back machines with earphones, 8mm film loops, filmstrip projectors, programmed materials, teacher-developed study sheets and the added staff of specialists and instructional aides were all used in the experimental treatment. These devices and methods were

not used in the control groups which emphasized instead a group discussion and lecture method of presentation. Any and all differences of this kind introduced into the instructional methods of the experimental group and not used with the control group in instruction were part of the experimental treatment.

RESULTS OF DATA COLLECTION

This study was to determine the effect of an individualized instructional approach on the academic achievement in mathematics of fourth-grade inner-city school children. A determination of this effect involved the investigation of the attitudes of participating teachers, pupils and parents toward this instructional method and the achievement of participating pupils.

Data collection was confined to the experimental subjects, their parents and the participating staff. The researcher and the school district's professional staff were cognizant of the attitudes of the control subjects, their parents and staff. The generally negative attitudes toward school life expressed by both experimental and control subjects, their parents, and the pervasive apathy of the experimental and control staffs prior to the experimental program, made comparison between experimental and traditional programs unnecessary since the primary concern was to assess the effectiveness of the implementation of the individualized diagnostic, prescriptive instructional method.

Results Concerning Staff Reaction. Participating teachers, instructional specialists, mathematics specialists and instructional aides reported that one of the most favorable aspects of the program was the fact that the effectiveness of the individualized diagnostic-prescriptive approach to learning used in the experimental treatment was producing more student growth than the previous years program of traditional textbook, class-group method of instruction.

Responses to the items on the attitude inventory served to illustrate the general reaction of the staff participating in the individualized program in mathematics. The complete inventory is found in appendix A. It was felt that a survey instrument of this nature would permit the staff to respond to the items in such a way as to lend insight into their true reactions regarding various aspects of the program. Table 5 illustrates the responses of the staff to items concerning the individualized instructional program in mathematics. These responses give some indication of the general attitude of the staff concerning the program. Staff responses to each item are given in percentages. The number in parenthesis identifies the item number on the inventory instrument. The total number of respondents was 120 teachers, twelve specialists and six instructional aides. This represented a return of 120 out of 130 possible or 92% for the participating teachers; for the specialists, 12 out of 17 or 70%; and 60 of a possible 70 or 85% for the instructional aides.

Table 5. Response of staff participants to attitude inventory items concerning the individualized instructional program in mathematics.

	Teachers	Specialists	Aides
(1) How many years have you been employed in the field of education?			
a. 1 year	10%	15%	26%
b. 2-3 years	24%	7%	47%
c. 4-10 years	39%	33%	25%
d. over 10 years	27%	44%	1%
(2) How many years have you been in your present assignment with the Stockton Unified School District?			
a. 1 year	37%	48%	41%
b. 2-3 years	27%	26%	43%
c. 4-10 years	23%	22%	15%
d. over 10 years	13%	4%	1%
(3) How helpful is the diagnostic-prescriptive program in assisting you to increase your effectiveness in teaching students?			
a. very helpful	45%	74%	78%
b. some help	55%	26%	22%
(4) Have you noticed any improvement in the students' attitudes toward school and learning as a result of this years' program?			
a. yes	65%	88%	84%
b. no	35%	12%	16%

TABLE 5 continued

	Teachers	Specialists	Aides
(5) If you answered yes to the above question, how widespread has this improvement been among students?			
a. improvement among all students	12%	5%	7%
b. improvement among most students	73%	77%	88%
c. improvement among a few students	15%	18%	5%
(6) How would you compare the effectiveness of the diagnostic-prescriptive approach to learning being used this year to the program that was used last year?			
a. it is producing more student growth than last year's program	62%	85%	77%
b. it is producing about the same amount of student growth as was achieved in last year's program	34%	5%	18%
c. it is not producing much student growth as was achieved in last year's program	4%	10%	5%
d. unable to compare the two programs	0%	0%	0%

TABLE 5 continued

	Teachers	Specialists	Aides
(7) How would you rate the effectiveness of the <u>math specialists</u> in <u>familiarizing</u> the teaching staff with the new materials and teaching techniques?			
a. very effective	21%	33%	60%
b. fairly effective	59%	60%	34%
c. ineffective	20%	7%	6%
(8) How would you rate the results of efforts to obtain greater parent involvement with the school?			
a. has had very positive results	16%	20%	33%
b. some positive results	57%	60%	48%
c. few positive results	19%	16%	13%
d. no noticeable results	8%	4%	6%
e. unable to say	0%	0%	0%

For items 9 - 17 please indicate what you feel are the features of this year's program that are working well and those that need improvement.

(9) Diagnostic materials available for identifying student needs			
a. very well	27%	37%	52%
b. working fairly well	42%	22%	32%
c. needs some improvement	21%	34%	14%
d. needs much improvement	10%	7%	2%

TABLE 5 continued

	Teachers	Specialists	Aides
(10) Prescriptive materials and equipment			
a. working very well	19%	22%	45%
b. working fairly well	32%	34%	28%
c. needs some improvement	33%	37%	19%
d. needs much improvement	16%	7%	8%
(11) Services provided by the math specialists			
a. working very well	17%	19%	55%
b. working fairly well	41%	63%	33%
c. needs some improvement	25%	12%	9%
d. needs much improvement	17%	6%	3%
(12) Cooperation and services provided by personnel from the district office for the individualized program in mathematics			
a. working very well	8%	24%	47%
b. working fairly well	31%	41%	39%
c. needs some improvement	31%	29%	12%
d. needs much improvement	30%	6%	2%

TABLE 5 continued

	Teachers	Specialists	Aides
(13) Overall direction of the individualized mathematics program from the district office			
a. working very well	7%	24%	28%
b. working fairly well	39%	36%	57%
c. needs some improvement	29%	32%	11%
d. needs much improvement	25%	8%	4%
(14) The manner in which the teacher aides are used			
a. working very well	47%	44%	73%
b. working fairly well	36%	24%	19%
c. needs some improvement	15%	24%	6%
d. needs much improvement	2%	8%	2%
(15) Inservice education program for the individualized mathematics program			
a. working very well	19%	4%	42%
b. working fairly well	39%	56%	48%
c. needs some improvement	27%	32%	8%
d. needs much improvement	16%	8%	2%

TABLE 5 continued

	Teachers	Specialists	Aides
(16) The manner in which the individualized mathematics program is directed by the administrators of your school			
a. working very well	43%	38%	66%
b. working fairly well	41%	50%	30%
c. needs some improvement	9%	8%	2%
d. needs much improvement	7%	4%	2%
(17) Adoption of the individualized diagnostic-prescriptive approach to mathematics instruction by the teachers in your school			
a. working very well	17%	19%	55%
b. working fairly well	55%	58%	34%
c. needs some improvement	22%	15%	9%
d. needs much improvement	6%	8%	2%

The responses to the inventory items confirmed the numerous remarks made by the staff throughout the course of the study indicating extremely positive attitudes toward the individualized instructional approach to teaching mathematics and high expectations for pupil achievement in mathematics. Reference to item five shows that 85% of the teachers, 82% of the specialists and 95% of the instructional aides observed improvement among most experimental pupils.

Results Concerning Pupil Attitudes. Much insight was gained concerning pupil attitudes toward the individualized mathematics program. Responses to the items on the attitude inventory served to illustrate the general reaction of pupils in the experimental group. Table 6 illustrates the responses of pupils in the experimental group to items from the attitude inventory which pertain to the individualized approach to learning mathematics. These responses give some indication of the general attitude of the pupils concerning the program. Close contact was maintained by the researcher and the participating students in the experimental group throughout the study. The outstanding impression resulting from the pupils responses to the inventory item was the extreme similarity of responses made by these participating students. For example, in response to the item "How do you like your arithmetic class this year?" 79% of pupils responded "much more than last year;" 15% of pupils responded "about the same as last year" and 6% of pupils responded "not as much as last year."

Pupil responses are given in percentages. The number in parenthesis identifies the item number on the inventory (see appendix B). The total number of responses was 48. This represented 48 out of 48 or 100% of the subjects sampled.

Table 6. Pupil responses to attitude inventory items concerning the individualized instructional program in mathematics.

ITEMS	PUPIL RESPONSES
(1) Are the things you have been doing in class this year	
a. much more interesting than last year	51%
b. about as interesting as last year	27%
c. not as interesting as last year	22%
(2) How do you like your arithmetic class this year?	
a. much more than last year	74%
b. about the same as last year	15%
c. not as much as last year	6%
(3) How much does the teacher aide help you?	
a. a lot	57%
b. a little bit	24%
c. not very much	19%
(4) How often did your teacher talk and work with you in class this year?	
a. much more than last year	49%
b. about as much as last year	32%
c. not as much as last year	19%
(5) How often has your teacher used a tape recorder, a motion picture, an overhead projector, or a T.V. in class this year?	
a. a lot	58%
b. a little bit	26%
c. not very much	26%

TABLE 6 continued

ITEMS	PUPIL RESPONSES
(6) Did the students in your class this year have	
a. more chances to do things in class besides listen to the teacher	38%
b. do a few things on their own but listened to the teacher talk a lot	26%
c. listened to the teacher talk most of the time	36%
(7) How often do your parents talk with you about your school work?	
a. a lot	51%
b. a little bit	24%
c. not very much	25%
(8) How do your parents feel about your school work this year?	
a. they think I am doing better than I did last year	71%
b. they think I am doing about as well as I did last year	16%
c. they do not think I am doing as well as I did last year	11%
d. I do not know how they feel about it	2%
(9) Have you gotten into trouble at school this year?	
a. more than last year	14%
b. about as much as last year	18%
c. not as much as last year	68%

TABLE 6 continued

ITEMS	PUPIL RESPONSES
(10) How do you think you are doing in school this year?	
a. better than last year	66%
b. about the same as last year	25%
c. not as well as last year	9%

The responses on the attitude inventory confirm the numerous casual remarks made by the pupils throughout the course of the study indicating extremely positive attitudes toward this method of studying mathematics. All observations of the experimental group by the researcher created the general impression that the vast majority of the children knew what they were doing, intent on accomplishing their task, and were basically engaged in using the various materials, supplies and equipment of the program in meaningful ways and following the leadership and directions of the classroom teacher, the specialists and the instructional aides.

Results Concerning Parent Attitudes. A systematic plan to involve parents of experimental pupils was an important part of the individualized mathematics program. This involvement included the employment of some parents as paid instructional aides. Other parents chose to volunteer their services as aides to assist in the program as tutors, materials

clerks and a variety of other related activities. Formal parent advisory committee meetings were held on a monthly basis. The purpose of these meetings was to inform the parents of the progress of the experimental subjects and to solicit their assistance in an effort to mobilize and coordinate the community's resources in a concentrated attack upon the varied problems of the children in the experimental program.

Close association was maintained by the researcher with the parents of participating pupils throughout the study and during the final two weeks an attitude inventory was administered to a selected group of 101 parents.

Table 7 illustrates the responses of these parents to items from the attitude inventory which pertain to the individualized mathematics program. A great deal of insight was gained concerning parent attitudes toward the program. The most salient factor resulting from the parent responses to the inventory was the positive attitude and support expressed by the vast majority of responding parents. For example, in response to the item "How well do you understand the individualized instructional program in mathematics currently operating in your child's school?" 22% of the parents responded "completely understand it," 74% responded "understand most of it," only 4% responded "very little" and 0% responded "not at all" or "not aware of program."

Parent responses are given in percentages. The number in parenthesis identified the item number on the inventory instrument (see appendix C). The total number of respondents was 101. This represented 101 out of 101 or 100% of the participating parents sampled.

Table 7. Parent responses to attitude inventory items concerning the individualized instructional program in mathematics.

ITEMS	PARENT RESPONSES
(1) How well do you understand the individualized instructional program in mathematics currently operating in your child's school?	
a. completely understand it	22%
b. understand most of it	74%
c. very little	4%
d. not at all	0%
e. not aware of program	0%
(2) Do you know the purpose of the program's Parent-Advisory Committee at your child's school	
a. yes	100%
b. no	0%
(3) Have you been invited to attend Parent Advisory Committee meetings this year?	
a. yes	95%
b. no	5%
(4) If you answered yes to the above question, how were you notified about the Parent Advisory Committee meeting?	
a. telephone	25%
b. personal note	20%
c. report card	0%
d. from your children	8%
e. from a committee member	18%
f. flyer from school	20%
g. by a friend or another parent	7%
h. other	2%

TABLE 7 continued

ITEMS	PARENT RESPONSES
(5) If you have attended Parent Advisory Committee meetings, approximately how many of these meetings have you attended?	
a. none	5%
b. 1-2	5%
c. 3-5	27%
d. 6-10	63%
(6) Did you go to school this year for parent-teacher conferences?	
a. yes	74%
b. no	26%
(7) If you have had a conference with your child's teacher this year, do you feel any different toward the school as a result of meeting your child's teacher?	
a. significant difference	43%
b. some difference	29%
c. little difference	19%
d. no difference	9%
(8) In what manner do you feel parents should be involved in the operation of the school's experimental program at your child's school	
a. advisory only	45%
b. decision & policy making	54%
c. teacher & administration selection	50%
d. curriculum planning	22%
e. volunteer tutors	54%
f. clerical aides	21%
g. assist on field trips & classroom parties	81%

TABLE 7 continued

ITEMS	PARENT RESPONSES
(9) How do you feel about teachers coming to your home for conferences?	
a. preferred	35%
b. rather go to school	9%
c. makes no difference	57%
(10) Please check the people below that you have had contact with this year at your child's school	
a. teacher	95%
b. counselor	68%
c. principal	23%
d. teacher corps	59%
e. secretary	54%
f. psychologist	28%
g. school nurse	28%
h. intergroup relations specialist	54%
i. mathematics specialist	54%
j. instructional specialist	50%
k. reading specialist	73%
l. custodian	59%
(11) How do you feel about your child being part of the individualized instructional program in mathematics as compared to the non-individualized program?	
a. better than	95%
b. same as	0%
c. less than	0%
d. no basis for comparison	5%

TABLE 7 continued

ITEMS	PARENT RESPONSES
(12) In the majority of cases, which of the following terms best describes the reception you received at your child's school from the teachers, specialists, and staff during your visit?	
a. cordial	45%
b. formal	4%
c. informal	31%
d. hostile	4%
e. defensive	4%
f. receptive	31%
g. friendly	90%
h. cold	0%
i. warm	28%
j. negative	4%
k. unfriendly	0%
l. positive	22%
(13) How many contacts have you had with your child's teacher this year?	
a. none	0%
b. 1-2	10%
c. 3-4	24%
d. 5-8	28%
e. 9 or over	38%
(14) How helpful were your contacts with your child's teacher?	
a. very helpful	73%
b. some help	27%
c. little help	0%
d. no help	0%

TABLE 7 continued

ITEMS	PARENT RESPONSES
(15) Approximately how many times have you visited your child's school this year?	
a. none	0%
b. 1-5	17%
c. 6-10	6%
d. 11-15	22%
e. 16 or over	56%
(16) By what means do you express your opinions about school policies?	
a. Parent Advisory Committee Meetings	87%
b. P.T.A. meetings	37%
c. to the administrators	59%
d. to the classroom teacher	50%
e. administration center	13%
f. through your children	4%
g. other	0%

The responses by randomly selected parents to the attitude inventory shows clearly a positive attitude toward the program and enthusiastic support for the continuation of this kind of instructional approach.

Results Concerning Pupil Achievement. In addition to considering the attitudes of participating teachers, pupils and parents toward the individualized instructional program, the following question was used as a basis for determining performance of the individualized instructional mathematics program: "Were the experimental pupils able to make

significant achievement gains in mathematics, arithmetical computational skills as compared to a control group while participating in the experimental program?" Conclusions concerning "significant achievement gains" were based upon the establishment and testing of six null hypotheses.

The first hypothesis used in judging "significant achievement gains" stated: "There is no difference in achievement gains in mathematics, arithmetical computational skills between boys and girls in the study. As indicated in Chapter III due to an insufficient number of females in cells, a one-way analysis of covariance was used. The mean scores for the boys and girls in the study when the Comprehensive Test of Basic Skills, Arithmetic Computation, was used as the dependent variable and sex served as the independent variable are shown in Table 8. The result of the F-test for sex differences is shown in Table 9.

The F-ratio for the hypothesis of the common slope was .396. This was not significant at p less than .05, the level of significance chosen for all F-ratios in the study. This indicated the need to retain the hypothesis of a common slope, thereby satisfying one of the assumptions of the analysis of covariance design.

The F-test for Beta equals zero was significant, at .05, the level chosen for the study, which indicates that the pre- and post-tests were related. The correlation coefficient was .612 and Beta was .503 for this analysis.

The F-ratio for the test of a single regression line fitting the data was not significant at the chosen level of .05. This indicates that no differences in achievement gains were found among boys and girls in this study. The null hypothesis was retained on the basis of the findings as measured by the Comprehensive Test of Basic Skills, Arithmetic Computation. On the basis of these findings it was concluded that sex differences did not significantly affect the academic achievement in mathematics, computational skills, of the subjects in this study.

Table 8. Mean and adjusted mean scores on the Comprehensive Test of Basic Skills, Arithmetic Computation by sex for experimental and control subjects in the individualized mathematics study.

GROUP	N	PRE-TEST MEAN	POST-TEST MEAN	ADJUSTED POST-TEST
MALES	214	32.131	48.164	49.013
FEMALES	181	35.818	51.088	50.084
TOTAL	395	33.820	49.504	

Table 9. Results of F-Tests for sex differences for Data in Table 8.

TEST	F	df1	df2	P
Hypothesis of Common Slope	0.396	1	391	P>.05 NS
Beta Equals Zero	234.149	1	391	P<.001*
Single Regression Line	1.509	1	392	P>.05 NS

* Sig. at P<.001

The second hypothesis used in determining "significant achievement gains" was: "There is no difference in achievement gains in mathematics, arithmetical computational skills, between racial and ethnic groups (Blacks, Mexican-Americans, Whites and other non-Whites, i.e., Orientals, Filipinos, and American Indians) in the study." The mean scores for the racial and ethnic groups when the Comprehensive Test of Basic Skills, Arithmetic Computation was used as the dependent variable are shown in Table 10. The results of F-tests for racial and ethnic differences are listed in Table 11.

The F-ratio for the hypothesis of the common slope was 2.371. This was not significant at p less than .05, the level of significance chosen for all F-ratios in the study. This indicated the need to retain the hypothesis of a common slope, thereby satisfying one of the assumptions of the analysis of covariance design.

The F-test for Beta equals zero was significant, at p less than .001, far beyond p less than .05 chosen for the study, which indicates that the pre- and post-tests were related. The correlation coefficient was .596 and Beta was .489 for this analysis.

The F-ratio for the test of a single regression line fitting the data was not significant at the chosen level of .05. This indicates that no differences in achievement gains were found among racial and ethnic groups in this study.

The null hypothesis was retained on the basis of the findings as measured by the Comprehensive Test of Basic Skills, Arithmetic Computation. On the basis of these findings it was concluded that the racial and ethnic differences did not significantly affect the achievement gains in mathematics, computational skills of the subjects in this study.

Table 10. Mean and adjusted mean scores on the Comprehensive Test of Basic Skills, Arithmetic Computation by Racial and ethnic Groups of Subjects in the individualized mathematics study (Experimental and Control).

GROUP	N	PRE-TEST MEAN	POST-TEST MEAN	ADJUSTED POST-TEST MEAN
Blacks	160	30.838	46.681	48.140
Mexican-Americans	155	34.419	50.432	50.139
Whites	47	36.362	51.974	50.736
Other non-whites	33	41.849	55.303	51.378
TOTALS	395	33.8203	49.5038	

Table 11. Results of F-Tests for Racial and Ethnic Differences for Data in Table 10.

TEST	F	df1	df2	P
Hypothesis of Common Slope	2.371	3	387	$p > .05$ NS
Beta Equals Zero	213.791	1	387	$p < .001^*$
Single Regression Line	2.401	3	390	$p > .05$ NS

* Sig. at $P < .001$

The third hypothesis used in judging "significant achievement gains" stated: "There is no difference in achievement gains, arithmetical computational skills between

fourth graders in the individualized mathematics program and fourth graders in the traditional program." The mean scores for the experimental and control groups when the Comprehensive Test of Basic Skills, Arithmetic Computation was used as the dependent variable; and treatment served as the independent variable are shown in Table 12. The results of the F-test for the experimental and control groups are shown in Table 13.

The F-ratio for the hypothesis of the common slope was 2.552. This was not significant at p less than .05, the level of significance chosen for all F-ratios in the study. This indicated the need to retain the hypothesis of a common slope, thereby satisfying one of the assumptions of the analysis of covariance design.

The F-test for Beta equals zero was significant, at .05, the level chosen for the study, which indicates that the pre- and post-tests were highly related. The correlation coefficient was .632 and Beta was .518 for this analysis.

The F-ratio, 13.821, for the test of a single regression line fitting the data in this study was significant at $p > .05$, the chosen level for this study. This indicates that significant differences existed between the experimental and control subjects in this study. These differences favored the experimental subjects.

The null hypothesis which stated "There is no difference in achievement gains, arithmetical computational skills between fourth-graders in the individualized mathematics program and the fourth-graders in the traditional program" was rejected on the basis of the findings as measured by the Comprehensive Test of Basic Skills, Arithmetic Computation.

On the basis of these findings it was concluded that fourth-graders in the individualized mathematics program achieved significantly higher gain scores than fourth-graders in the traditional program, when the Comprehensive Test of Basic Skills, Arithmetic Computation was used to measure achievement.

Table 12. Mean and adjusted mean scores on the Comprehensive Test of Basic Skills, Arithmetic Computation for Experimental and Control Subjects in the Individualized Mathematics Study.

SUBJECTS	N	PRE-TEST MEAN	POST-TEST MEAN	ADJUSTED POST-TEST MEANS
Experimental	344	33.430	49.901	50.112
Control	51	36.451	46.765	45.4030
TOTAL	395	33.820	49.504	

Table 13. Results of F-Tests for Experimental and Control Groups for Data in Table 12.

TEST	F	df1	df2	P
Hypothesis of Common Slope	2.552	1	391	$p > .05$ NS
Beta Equals Zero	259.334	1	391	$p < .001^*$
Single Re- gression Line	13.821	1	392	$p < .001^*$

* Sig. at $P < .001$

The fourth hypothesis used in determining "significant achievement gains in mathematics, arithmetic concepts stated: "There is no difference in achievement gains, arithmetical concepts between fourth-graders in the

individualized mathematics program and fourth-graders in the traditional program." The mean scores for the experimental and control groups when the Comprehensive Test of Basic Skills, Arithmetic Concepts was used as the dependent variable; and treatment served as the independent variable are shown in Table 14. The results of the F-test for the experimental and control groups are shown in Table 15.

The F-ratio for the hypothesis of the common slope was .3729. This was not significant at p less than .05, the level of significance chosen for all F-ratios in the study. This indicated the need to retain the hypothesis of a common slope, thereby satisfying one of the assumptions of the analysis of covariance design.

The F-test for Beta equals zero was significant at p less than .05, the level chosen for the study, which indicates again that the pre- and post-tests were highly related. The correlation coefficient was .721 and Beta was .766 for this analysis.

The F-ratio, 5.341 for the test of a single regression line fitting the data in this study was significant at p less than .05 the chosen level for the study. This indicates that statistically significant differences existed between the experimental and control subjects in arithmetic concepts. These differences favored the experimental subjects.

The null hypothesis was therefore rejected on the basis of the findings as measured by the Comprehensive Test of Basic Skills, Arithmetic Concepts.

On the basis of these findings, it was concluded that fourth-graders in the individualized mathematics program, in the area of arithmetic concepts, achieved significantly higher gain scores than fourth-graders in the traditional program, when the Comprehensive Test of Basic Skills, Arithmetic Concepts was used to measure achievement.

Table 14. Mean and adjusted mean scores on the Comprehensive Test of Basic Skills, Arithmetic Concepts for Experimental and Control Subjects in the Individualized Mathematics Study.

SUBJECTS	N	PRE-TEST MEAN	POST-TEST MEAN	ADJUSTED POST-TEST MEANS
Experimental	322	12.478	17.842	18.072
Control	53	14.604	17.962	16.565
TOTAL	375	12.779	17.859	

Table 15. Results of F-Tests for Experimental and Control Groups for Data in Table 14.

TEST	F	df1	df2	P
Hypothesis of Common Slope	.373	1	371	$p > .05$ NS
Beta Equals Zero	400.896	1	371	$p < .001^*$
Single Regression Line	5.341	1	372	$p < .05^{**}$

* Sig. at $p < .001$

**Sig. at $p < .05$

The fifth hypothesis used in judging "significant achievement gains" in arithmetic applications stated: "There is no difference in achievement gains, arithmetic applications between fourth-graders in the individualized mathematics program and fourth-graders in the traditional program." The mean scores for the experimental and control groups when the Comprehensive Test of Basic Skills, Arithmetic Applications was used as the dependent variable; and treatment served as the independent variable are shown in Table 16. The results of the F-test for the experimental and control groups are shown in Table 17.

The F-ratio for the hypothesis of the common slope was .238. This was not significant at p less than .05, the level of significance chosen for all F-ratios in the

study. This indicated the need to retain the hypothesis of a common slope, thereby satisfying one of the assumptions of the analysis of covariance design.

The F-test for Beta equals zero was significant, at p less than .05, the level chosen for the study, which indicates once again that the pre- and post-tests were highly related. The correlation coefficient was .619 and Beta was .688 for this analysis.

The F-ratio, .082, for the test of a single regression line fitting the data in this study was not significant at p less than .05, the level chosen for this study. This indicates that no differences were found among the experimental and control groups in achievement gains, arithmetic applications.

The null hypothesis was retained on the basis of the findings as measured by the Comprehensive Test of Basic Skills, Arithmetic Applications.

Table 16. Mean and adjusted mean scores on the Comprehensive Test of Basic Skills, Arithmetic Application for Experimental and Control Subjects in the Individualized Mathematics Study.

SUBJECTS	N	PRE-TEST MEAN	POST-TEST MEAN	ADJUSTED POST-TEST MEANS
Experimental	307	8.521	12.401	12.404
Control	50	8.560	12.600	12.577
TOTAL	357	8.527	12.427	

Table 17. Results of F-Tests for Experimental and Control Groups for Data in Table 16.

TEST	F	df1	df2	P
Hypothesis of Common Slope	.238	1	353	$p > .05$ NS
Beta Equals Zero	218.804	1	353	$p < .001$ *
Single Re- gression Line	.082	1	354	$p > .05$ NS

* Sig. at $P < .001$

On the basis of these findings it was concluded that there was no difference in the achievement gain of pupils in the two treatment groups when the Comprehensive Test of Basic Skills, Arithmetic Applications, was used to measure achievement.

The sixth null hypothesis used in determining "significant achievement gains" in mathematics, total mathematics, i.e., arithmetic computation, arithmetic concepts and arithmetic applications stated: "There is no difference in achievement gains, total mathematics, i.e., arithmetic computation, arithmetic concepts, and arithmetic applications between fourth-graders in the individualized mathematics program and fourth-graders in the traditional program." The mean scores for the experimental and control groups when the Comprehensive Test of Basic Skills, Total Mathematics Battery (arithmetic computation, arithmetic concepts, and arithmetic applications) was used as the dependent variable; and treatment served as the independent variable are shown in Table 18. The results of the F-test for the experimental and control groups are shown in Table 19. The F-ratio for the hypothesis of the common slope was 1.641. This was not significant at p less than .05 the level of significance chosen for all F-ratios in the study. This indicated the need to retain the hypothesis of a common slope, thereby satisfying one of the assumptions of the analysis of covariance design.

The F-test for Beta equal zero was significant, at p less than .05, the level chosen for the study which indicates that the pre- and post-tests were highly related. The correlation coefficient was .748 and Beta was .687 for this analysis. The F-ratio, 11.591, for the test of a single

regression line fitting the data in this study was significant at p less than .05, the chosen level for this study. This indicates that differences existed between the experimental and control subjects in total mathematics, i.e., arithmetic computation, arithmetic concepts, and arithmetic applications. These differences favor the experimental subjects by the Comprehensive Test of Basic Skills, Total Battery, i.e., arithmetic computation, arithmetic concepts, and arithmetic applications.

On the basis of these findings it was concluded that fourth-graders in the individualized mathematics program achieved significantly higher gain scores than fourth-graders in the traditional program, when the Comprehensive Test of Basic Skills, Total Battery, i.e., arithmetic computation, arithmetic concepts and arithmetic applications was used to measure achievement.

Table 18. Mean and adjusted mean scores on the Comprehensive Test of Basic Skills, Total Battery, Arithmetic Computation, Arithmetic Concepts and Arithmetic Application for Experimental and Control Subjects in the Individualized Mathematics Study.

SUBJECTS	N	PRE-TEST MEAN	POST-TEST MEAN	ADJUSTED POST-TEST MEANS
Experimental	278	55.543	81.345	81.832
Control	49	60.265	77.755	74.996
TOTAL	327	56.251	80.807	

Table 19. Results of F-Tests for Experimental and Control Groups for Data in Table 18.

TEST	F	df1	df2	P
Hypothesis of Common Slope	1.641	1	323	$p > .05$ NS
Beta Equals Zero	409.924	1	323	$p < .001^*$
Single Re- gression Line	11.591	1	324	$p < .001^*$

* Sig. at $P < .001$

SUMMARY

Within the basic framework of this study, certain hypotheses and questions were posed for the purpose of lending insight to the various facets of the feasibility of an experimental program in the individualization of instruction in mathematics. Objective as well as subjective analyses were applied to the data and observations of the program. On the basis of these observations and analyses, it was found that participating teachers, specialists, instructional aides as well as the pupils and parents were generally very positive in their statements of attitudes toward the program.

All test data analyses were reported for determining whether or not pupils involved in the program made significant academic gains in mathematics.

In the analysis of covariance it was found that when the Comprehensive Test of Basic Skills, Arithmetic Computation and Arithmetic Concepts, were used as the dependent variables to measure arithmetic achievement gains and when the Total Mathematics (arithmetic computations, concepts, and application) there was a statistically significant difference in achievement gains between pupils in the individualized mathematics program and pupils in a traditional instructional program. Additionally, using the analysis of covariance, no differences in achievement gains were found among boys and girls, racial and

ethnic groups and achievement gains in arithmetic applications of the subjects in the study.

CHAPTER V

SUMMARY, CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

SUMMARY OF RESULTS

This study examined the effects of individualization of instruction on certain sets of academic achievement by inner-city fourth grade pupils. Ability grouping as a way of organizing for instruction is finding less support in the literature. Individualized instruction has replaced it as a focus and vehicle of educational reform. A major factor in the increasing attention being given to individualization is the development of technological devices and learning programs suitable for independent study. At the same time recent research has led to a growing disenchantment with ability grouping as a way of organizing for instruction.

In this study considerable success was achieved in the primary task which was to change the educational environment of a group of inner-city fourth grade students in mathematics. The content in mathematics remain the same for the experimental and traditional students and only the method of instruction was changed. The

experimental treatment was the individualization of instruction. Every effort was made to arrange a self-instructional situation for each experimental subject. The control group maintained a traditional classroom approach to essentially the same content material. Lecture, class discussion, and learning tasks were ordered, structured, and paced for the group. Care was taken by the administrators, instructional supervisors and the teachers to establish and maintain this critical difference between the control and experimental groups.

In another area of the present study, some success was achieved in the internalizing of the motives for learning by the learner. Evidence of increased intrinsic motivation was observed both in the cognitive and affective domains. Quotations from students, parents, teachers, and other members of the instructional staff support the conclusion that students who received the experimental treatment became more task oriented. Cognitive intrinsic motivations were evidenced and the students wanted to achieve objectives for cognitive reasons. In addition, these quotations support the claim that students who received the experimental treatment increased their enjoyment of learning, indulged their curiosity and imagination more, and, in general, increased their intrinsic affective motivations.

The results of the testing in the study have been presented comprehensively in Chapter IV, and a very brief summary of these findings will serve here.

The experimental group scores when compared to the control group scores on the post-test showed statistically significant gains in mathematics, arithmetic computation, arithmetic concepts and total mathematics, i.e., arithmetic computation, arithmetic concepts and arithmetic application. In the mathematics area of application, while the gains were not statistically greater, the subjects exposed to the experimental treatment were equivalent to the gains of the subjects in the control group.

It is worth noting that the subjects participating in this study were fourth-grade inner-city disadvantaged children. These children were from families of low-income, living in areas of the inner-city having the highest concentrations of poverty. The schools they attended were economically and racially imbalanced. The vast majority of the subjects were members of minority groups (Blacks, Mexican-Americans, Filipinos, Orientals, and American Indians) who were culturally, racially, and ethnically isolated and alienated from the larger community. From the results of the present study, it appears, that the individualized instructional method has achieved high gain scores for the subjects from inner-city disadvantaged areas.

CONCLUSIONS

The results of the present study suggest several conclusions. First and foremost, they suggest that the experimental treatment made significant differences in and for the children in the experimental group. Some of these differences are gains in test scores on the Comprehensive Test of Basic Skills, Arithmetic Computation, Arithmetic Concepts and Total Battery i.e., Arithmetic Computation, Arithmetic Concepts and Arithmetic Applications. Compared to the years prior to the implementation of the experimental program, differences in attitude, behavior, and work habits are seen in results of attitude inventories given to students, parents, teachers, and other members of the instructional team. It seem logical to presume that the independent variable accounts for these differences. The conclusion is that the individualization of instruction in mathematics used in the experimental groups accounts for increased gains and achievement scores on the Comprehensive Test of Basic Skills, Arithmetic Computation, Arithmetic Concepts and Total Battery i.e., Arithmetic Computation, Arithmetic Concepts and Arithmetic Applications. Further, it may be credited with desirable changes in behavior, attitude, and learning strategies on the part of the learners.

It would be remiss to overlook some of the problems encountered in this study. There were many and most of

them at the teacher-administrative-supervisory level of operation. These difficulties produced some debilitating effect on the experimental treatment. The effect was probably one of omission of desired influences rather than one of commission of undesired influences in the treatment.

Another difficult problem was in the writing and developing individual learning prescriptions. The writing and developing of individual learning prescriptions for the teachers was a constant and pressing chore for them. The task of managing the classroom activities of work, inquiry, investigation and the evaluating of the learners was increased in complication by this individualized instructional method. Teachers and students alike were exploring a new approach to learning.

IMPLICATIONS

The education of the nations young is a crucial subject and therefore innovations, such as the present one, in education are under constant scrutiny by those who would reject, develop, improve, or implement them. Innovations are also looked upon as objects or ideas which are completely new, at least to the discipline under discussion. Admittedly, the individualization of instruction is not new. It has been with us for many years, with heavy emphasis in the curricular area of reading. A study of educational history readily illustrates that innovations

are seldom if ever, completely new theories or ideas. Educationists study, combine and re-combine ideas, shift emphasis, and generally manipulate theories to adequately solve the problems of the moment. So it has been with the innovation with which this study has been concerned.

In recent years, the public schools involved in this study and others throughout the country have been front-page news. Strikes, riots, disruptions, and exposures have revealed deep-rooted problems, have caused seemingly unabridgeable polarizations. Many parents maintain that they are treated as outsiders. Students reject the traditional power relationships of decisions from above and obedience from below. Administrators explain that they are the victims of bad budgets. Books, by disenchanted teachers revealing the inadequacies, absurdities, and injustices of the system have become popular reading. Educators and laymen alike, tend to agree that the schools at this time are indeed a mess, that the nation has betrayed its young. And yet there are communities that are confident that the professionals know what they are doing, that the morass is merely temporary, that all we need is more money, more time, more patience.

More money, more supplies, more experienced staff, and updated curriculum, new buildings, better working conditions for teachers, more adequate counseling services

for students, and new instructional strategies, as in the present study; all these promised improvements may result in better schools than now exist. This researcher, based on insights gained from the present study, believes that the essential ingredient of education is a two-way learning; mutual understanding, mutual respect, and dialogue. Therefore, many of the teachers under the present system are in many ways less than competent to teach disadvantaged inner-city minority children. They are less than competent because they have too little knowledge of, too little appreciation for, and too little professional encouragement to learn about the children who are from the disadvantaged minorities in the inner-city.

The classroom observations made in the course of this study, convinced this researcher that it is dangerous to believe that inner-city Blacks, Mexican-Americans, Filipinos, Orientals and American-Indians are the "all-American boys" next door who grew up with American Protestant outlooks, within the traditional western families, upholding the secular values, the sense of history, and the sense of destiny characteristic of European-Americans. It is equally dangerous and naive to assume that these disadvantaged minorities differ merely because they are not quite up to par; that they are the "all-American boys" at heart but they are just a little too backward, or a little too poor, or a little too uncivilized, or a little too ungroomed.

The inner-city disadvantaged children in this study were none of these. They were simply different. They had acquired language, religious beliefs, eating habits, notions of common sense, sexual attitudes, concepts of beauty and justice, standards of excellence, and responses to pleasure and pain, from the people who raised them, a people with their own mores and traditions.

From observations in the present study, the first thing that needs to be understood is that these inner-city disadvantaged children are different. The word "different" should not carry the connotation of being "inferior." The individualized instructional strategy in the present study indicates promise for providing for these differences in the classroom. On the evidence of this study it seems clear that the instructional strategy of individualization will help teachers to be more competent in meeting the individual needs of all students, advantaged and disadvantaged alike who differ in many ways including academic ability and cultural background as well. Understanding of these differences and providing individual instructional interventions is necessary if the classroom teacher intends to make the educational system at all real.

RECOMMENDATIONS

The findings and conclusions of this study point inexorably to the need to replicate the study. Statistical

significance has been found and to the degree that further investigation should be undertaken to ascertain whether these differences were in fact coincidental. In such a replication the conditions should be controlled as to check whether the differences observed in the present study occur again. Such items as the overall gains made by the experimental subjects beyond the overall gains made by the control subjects should be given additional attention. Every effort should be given to confirm or refute the conclusion that the technique of individualization of instruction has a profoundly favorable effect on the achievement and motivation of inner-city disadvantaged children. Additionally, it is recommended that the individualized instructional strategy implemented in this study be replicated in the curricular area of reading. It is possible that the same achievement gains may be achieved with a similar broadly based group of inner-city school children.

Although we have accepted the conclusion that the experimental treatment made statistically significant differences in the experimental group, we do not know yet what specifics within the treatment made the differences. It may be that the total unified, multi-faceted, multi-dimensional treatment accounted for the differences. Or it may be that certain items or variables within the treatment made the differences. By varying ingredients in the replication, every one of the items that is part of the

treatment could be tested for effect to discover whether any specific item has an influence and what kind of influence it has. It is worthy of investigation to find the relationships of all these variables with what was observed as outcomes.

There is evidence from student, teacher, and parent reactions that a combination of individually prescribed instruction and the class discussion treatment may be an effective method of instruction. It is recommended that a modification of the individualized instructional strategy be tried. Instead of exclusive use of individually prescribed instructional materials, a method of combining what happened in this experimental treatment to what happened in the controlled treatment should be tried. A study to compare results from such a treatment with the individually prescribed instructional treatment and the exclusive class-lecture treatment should be conducted.

It is recommended that further investigation be carried out to discover what happened to teachers in the individualized instructional approach. There may be a change in behavior occurring in teachers that is important in achieving the differences observed in the learning behavior of the subjects. It is worthwhile to look at teaching strategies, and attitudes to see how and what differences there are from other teachers who are using classroom group instructional methods.

An additional recommendation in the replication of the individualized instructional approach is a continuous, mandatory inservice program for the entire staff. A staff development program should not only include such items as content in the particular discipline, techniques in classroom management, principles of differential staffing, diagnosing and prescribing instructions, writing behavioral objectives, and evaluating student progress they must also deal with the dimensions of poverty, and their effects on children. Additionally, the continuous staff development program must lead the teachers who come into contact with children, especially disadvantaged Blacks, Mexican-Americans, Filipinos, Orientals, and American Indians and similar disadvantaged groups, to think more clearly and more honestly than they have been trained to, to react more authentically to what they experience directly with disadvantaged children, rather than to what they think they know of the disadvantaged, even to find and to adopt a nonwhite perspective.

Finally, it is recommended that this individualized instructional strategy be examined for its possible role in converting an elementary school from the traditional lock-step grade school into a continuous progress, flexibly scheduled school covering all content areas. Real possibilities present themselves when one contemplates how conveniently the individualization of instruction concept fits

the needs of a continuous progress school. Data processing techniques under the leadership and nurture of a knowledgeable staff may one day bring into being a school for all different children and their constantly varying needs.

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APPENDICES

APPENDIX A
TEACHERS AND STAFF INVENTORY

APPENDIX A

TEACHERS AND STAFF INVENTORY

Individualized Mathematics Program

This inventory is admittedly a very general overview of the program but it can provide an opportunity for you to register your views on how the individualized mathematics instructional program has functioned during the year.

Please put the completed inventory in the envelope provided, seal and leave it in your school's office today. All replies are anonymous. Thank you for your cooperation.

1. What is your major assignment this year?

- ☐ a. teacher
- ☐ b. specialist
- ☐ c. teacher aide

2. How many years have you been employed in the field of education?

- | | Teacher | Specialist | Aides |
|------------------|---------|------------|-------|
| a. 1 year | | | |
| b. 2-3 years | | | |
| c. 4-10 years | | | |
| d. over 10 years | | | |

3. How many years have you been in your present assignment with the Stockton Unified School District?

- | | Teacher | Specialist | Aides |
|------------------|---------|------------|-------|
| a. 1 year | | | |
| b. 2-3 years | | | |
| c. 4-10 years | | | |
| d. over 10 years | | | |

4. How helpful is the diagnostic-prescriptive program in assisting you to increase your effectiveness in teaching students?

- | | Teacher | Specialist | Aides |
|-----------------|---------|------------|-------|
| a. very helpful | | | |
| b. some help | | | |

5. Have you noticed any improvement in the students' attitudes toward school and learning as a result of this year's program?

Teachers Specialist Aides

- a. yes
- b. no

6. If you answered yes to the above question, how widespread has this improvement been among students?

Teachers Specialists Aides

- a. improvement among all students
- b. improvement among most students
- c. improvement among a few students

7. How would you compare the effectiveness of the diagnostic prescriptive approach to learning being used this year to the program that was used last year?

Teachers Specialists Aides

- a. it is producing more student growth than last year's program
- b. it is producing about the same amount of student growth as was achieved in last year's program
- c. it is not producing as much student growth as was achieved in last year's program
- d. unable to compare the two programs

8. How would you rate the effectiveness of the math specialists in familiarizing the teaching staff with new materials and teaching techniques?

Teachers Specialists Aides

- a. very effective
- b. fairly effective
- c. ineffective

9. How would you rate the results of efforts to obtain greater parent involvement with the school?

Teachers Specialists Aides

- a. has had very positive results
- b. some positive results
- c. few positive results
- d. no noticeable results
- e. unable to say

For items 10 - 17 please indicate what you feel are the features of this year's program that are working well and those that need improvement.

10. Diagnostic materials available for identifying student needs

Teachers Specialists Aides

- a. very well
- b. working fairly well
- c. needs some improvement
- d. needs much improvement

11. Prescriptive materials and equipment

Teachers Specialists Aides

- a. working very well
- b. working fairly well
- c. needs some improvement
- d. needs much improvement

12. Services provided by the math specialists

Teachers Specialists Aides

- a. working very well
- b. working fairly well
- c. needs some improvement
- d. needs much improvement

13. Cooperation and services provided by personnel from the district office for the individualized program in mathematics.

Teachers Specialists Aides

- a. working very well
- b. working fairly well
- c. needs some improvement
- d. needs much improvement

14. Overall direction of the individualized mathematics program from the district office

Teachers Specialists Aides

- a. working very well
- b. working fairly well
- c. needs some improvement
- d. needs much improvement

15. The manner in which the teacher aides are used
 Teachers Specialists Aides
- a. working very well
 - b. working fairly well
 - c. needs some improvement
 - d. needs much improvement
16. Inservice education program for the individualized mathematics program
 Teachers Specialists Aides
- a. working very well
 - b. working fairly well
 - c. needs some improvement
 - d. needs much improvement
17. The manner in which the individualized mathematics program is directed by the administrators of your school
 Teachers Specialists Aides
- a. working very well
 - b. working fairly well
 - c. needs some improvement
 - d. needs much improvement
18. Adoption of the individualized diagnostic-prescriptive approach to mathematics instruction by the teachers in your school
 Teachers Specialists Aides
- a. working very well
 - b. working fairly well
 - c. needs some improvement
 - d. needs much improvement

APPENDIX B
STUDENT INVENTORY

APPENDIX B

STUDENT INVENTORY

Individualized Mathematics

DIRECTIONS? DRAW A CIRCLE AROUND THE ANSWER THAT IS MOST LIKE THE WAY YOU FEEL ON EACH QUESTION. THIS IS NOT A TEST AND IN NO WAY AFFECTS YOUR GRADE. PLEASE DO NOT SIGN YOUR NAME ON THIS SHEET. THANK YOU.

1. Are the things you have been doing in your class this year
 1. much more interesting than last year
 2. about as interesting as last year
 3. not as interesting as last year
2. How do you like your arithmetic class this year?
 1. much more than last year
 2. about the same as last year
 3. not as much as last year
3. How much does the teacher aide help you?
 1. a lot
 2. a little bit
 3. not very much
4. How often did your teacher talk and work with you in class this year?
 1. much more than last year
 2. about as much as last year
 3. not as much as last year
5. How often has your teacher used a tape recorder, a motion picture, an overhead projector, or a T.V. in class this year?
 1. a lot
 2. a little bit
 3. not very much
6. Did the students in your class this year have
 1. more chances to do things in class besides listen to the teacher
 2. do a few things on their own but listened to the teacher talk a lot
 3. listened to the teacher talk most of the time

7. How often do your parents talk with you about your school work?
 1. a lot
 2. a little bit
 3. not very much
8. How do your parents feel about your school work this year?
 1. they think I am doing better than I did last year
 2. they think I am doing about as well as I did last year
 3. they do not think I am doing as well as I did last year
 4. I do not know how they feel about it
9. Have you gotten into trouble at school this year?
 1. more than last year
 2. about as much as last year
 3. not as much as last year
10. How do you think you are doing in school this year?
 1. better than last year
 2. about the same as last year
 3. not as well as last year

APPENDIX C
PARENT INVENTORY

APPENDIX C

PARENT INVENTORY

Individualized Mathematics Program

Parent involvement is a very important part of the educational program in the experimental schools. Parents were to be involved in as many activities as possible to make them aware of the schools individualized instructional program in mathematics and to keep parents informed of their children's progress.

Your opinion will assist us in evaluating your child's school-parent involvement program currently operating and in planning next years program.

Please fill out this form as it applies to your children only. The information you supply will be held completely confidential by the school.

1. How well do you understand the individualized instructional program in mathematics currently operating in your child's school?

- ☐ a. completely understand it
- ☐ b. understand most of it
- ☐ c. very little
- ☐ d. not at all
- ☐ e. not aware of program

2. Do you know the purpose of the Program's Parent-Advisory Committee at your child's school?

- ☐ a. yes
- ☐ b. no

3. Have you been invited to attend Parent-Advisory Committee meetings this year?

- ☐ a. yes
- ☐ b. no

4. If you answered yes to question three, how were you notified about the Parent-Advisory Committee meeting?

- ☐ a. telephone
- ☐ b. personal note
- ☐ c. report card
- ☐ d. from your children
- ☐ e. from a committee member
- ☐ f. flyer from school
- ☐ g. by a friend or other parent
- ☐ h. other

5. If you have attended Parent-Advisory Committee meetings approximately how many of these meetings have you attended?

- ☐ a. none
- ☐ b. 1-2
- ☐ c. 3-5
- ☐ d. 6-10

6. Did you go to school this year for parent-teacher conferences?

- ☐ a. yes
- ☐ b. no

7. If you have had a conference with your child's teacher this year, do you feel any different toward the school as a result of meeting your child's teacher?

- ☐ a. significant difference
- ☐ b. some difference
- ☐ c. little difference
- ☐ d. no difference

8. In what manner do you feel parents should be involved in the operation of the school's experimental program at your child's school?

- ☐ a. advisory only
- ☐ b. decision & policy making
- ☐ c. teacher & administration selection
- ☐ d. curriculum planning
- ☐ e. volunteer tutors
- ☐ f. clerical aides
- ☐ g. assist on field trips & classroom parties

9. How do you feel about teachers coming to your home for conferences?

- ☐ a. preferred
- ☐ b. rather go to school
- ☐ c. makes no difference

10. Please check the people below that you have had contact with this year at your child's school

- ☐ a. teacher
- ☐ b. counselor
- ☐ c. principal
- ☐ d. teacher corps
- ☐ e. secretary
- ☐ f. psychologist
- ☐ g. school nurse
- ☐ h. intergroup relations specialist
- ☐ i. mathematics specialist
- ☐ j. instructional specialist
- ☐ k. reading specialist
- ☐ l. custodian

11. How do you feel about your child being a part of the individualized instructional program in mathematics as compared to the non-individualized program?

- ☐ a. better than
- ☐ b. same as
- ☐ c. less than
- ☐ d. no basis for comparison

12. In the majority of cases, which of the following terms best describes the reception you received at your child's school from the teachers, specialists and staff during your visit? (You may check more than one.)

- | | |
|---------------------------------------|--|
| ☐ a. cordial | ☐ h. cold |
| ☐ b. formal | ☐ i. warm |
| ☐ c. informal | ☐ j. negative |
| ☐ d. hostile | ☐ k. unfriendly |
| ☐ e. defensive | ☐ l. positive |
| ☐ f. receptive | ☐ m. other |
| ☐ g. friendly | |

13. How many contacts have you had with your child's teacher this year? (include all contacts)

- ☐ a. none
- ☐ b. 1-2
- ☐ c. 3-4
- ☐ d. 5-8
- ☐ e. 9 or over

14. How helpful were your contacts with your child's teacher?

- ☐ a. very helpful
- ☐ b. some help
- ☐ c. little help
- ☐ d. no help

15. Approximately how many times have you visited your child's school this year?

- ☐ a. none
- ☐ b. 1-5
- ☐ c. 6-10
- ☐ d. 11-15
- ☐ e. 16 or over

16. By what means do you express your opinions about school policies?

- ☐ a. Parent-Advisory Committee meetings
- ☐ b. PTA meetings
- ☐ c. to the administrators
- ☐ d. to the classroom teacher
- ☐ e. administration center
- ☐ f. through your children
- ☐ g. other

Please put questionnaire in the envelope provided, seal it and give it to your child to return to school. All replies are anonymous.

Thank You

APPENDIX D

MATHEMATIC BEHAVIORAL OBJECTIVES

FOR THE

INDIVIDUALIZED MATHEMATICS PROGRAM

MATHEMATICS BEHAVIORAL OBJECTIVES
FOR THE
INDIVIDUALIZED MATHEMATICS PROGRAM

Numeration:

By May 15, 1970, each fourth-grade student will, with 100% accuracy?

1. Identifies same, different; top, bottom, smaller, largest, smallest.
 2. Counts orally from 1 to 30.
 3. Presented with numbers 1 to 10 in order, reads them orally from left to right.
 4. Counts orally from 1 to 10 objects by pointing to object and saying number.
 5. Matches two equivalent sets of objects in a 1 to 1 relationship. Matches sets to 10.
 - *6. Identifies the cardinal numbers of structured groups to 10.
 7. Selects or constructs a set that contains as many objects as a given number.
 8. Identifies the empty set or the set with zero numbers.
 9. Matches two non-equivalent sets of 1 to 1 and indicates which has more or less.
 10. Tells what number comes before or after a given number, or in-between two numbers. Numbers to 10.
 11. Writes the numbers from 1 to 10.
 - **12. Writes numbers 1 to 10 from left to right on an ordered set of pictures.
- * Structured Group - An arrangement of parts according to some form or pattern.
- ** Example - "On this picture number the ducks from 1 to 10."

MATHEMATICS BEHAVIORAL OBJECTIVES
FOR THE
INDIVIDUALIZED MATHEMATICS PROGRAM

Numeration:

By May 15, 1970, each fourth-grade student will, with 100% accuracy:

1. Given number words for numbers zero to ten, reads words orally and matches words with numerals or structured groups.
2. Counts orally by 10's to 100 starting with tens only.
3. Counts orally by 1's to 100 in short sequences.
4. Presented with an ordered arrangement of numerals, 0 to 100, reads them on request from any starting point.
5. Writes numerals from 1 to 100 in sequential order or on an ordered set of pictures for small blocks of numbers.
6. States, selects or writes the cardinal number of a structured group to 100.
7. Identifies what number comes after a given number, between two numbers, or before any given number for numbers to 100, with or without structured groups.
8. Selects which of two (or three) numbers is greater (greatest), smaller (smallest) for numbers to 100.
9. Places < or > between two numbers to indicate the greater or lesser with or without structured groups; to 100.
10. Places an X on the object with the specified ordinal position to "tenth."

MATHEMATICS BEHAVIORAL OBJECTIVES
FOR THE
INDIVIDUALIZED MATHEMATICS PROGRAM

Numeration:

By May 15, 1970, each fourth-grade student will, with 100% accuracy:

- *1. Reads and writes short sequences of numbers from any starting point to 100.
- **2. Reads or writes short sequences of numbers from any starting point to 200.
- 3. Supplies the number which is one more, one less, or in-between two given numbers. Limit of 200.
- 4. Completes exercises for counting by 10's from any starting point. Limit of 200.
- 5. Completes exercises for counting by 5's from 0 to 200 starting at multiples of 5.
- 6. Completes exercises for counting by 2's from any starting point to 200. Identifies number as odd or even.
- 7. Completes exercises for counting by 10's, 5's or 2's. Limit of 200; starting only with multiples of the index number.
- * Example - "Read these numbers starting here and ending here." 195-199. Write the following numbers - "say 152 - 173."
- ** "Either one or both."

MATHEMATICS BEHAVIORAL OBJECTIVES
FOR THE
INDIVIDUALIZED MATHEMATICS PROGRAM

Numeration:

By May 15, 1970, each fourth-grade student will, with 100% accuracy:

1. Reads and write numbers to 1000. Reads and writes short sequences backward or forward.
2. Skip counts by 3's to 1000 backward or forward.
4. Converts decimals to fractions and words. Vice versa. Fills in number line. Tenths.
5. Converts decimals to fractions and words. Vice versa. Hundredths.
6. Reads and writes Roman Numerals I - X. (I, II, III, IV, V, VI, VII, VIII, IX, X).
7. Rounds numbers to 10's, 100's, for comparison and estimating answers in sample problems.

MATHEMATICS BEHAVIORAL OBJECTIVES
FOR THE
INDIVIDUALIZED MATHEMATICS PROGRAM

Numeration:

By May 15, 1970, each fourth-grade student will, with 100% accuracy:

1. Counts, reads, write to 1,000,000, any starting point.
2. Identifies odd-even numbers. States, uses rules for addition, subtraction, multiplication 2 numbers.
3. Gives numeral for 2, 3, 4 place number in words.
4. Writes decimal fractions for common or mixed fractions of 10 or 100 denominator - vice versa.
5. Number words for mixed decimals to 1000ths. Vice versa.
6. Converts decimal fractions (to thousandths to other forms).
7. Orders mixed and pure decimals. To 100.001.

Common $\frac{3}{4} = \frac{75}{100}$ or $\frac{1}{5} = \frac{2}{10}$ mixed $1 \frac{1}{2} = \frac{3}{2} = \frac{15}{10}$

3.07 = three and seven tenths

53.125 = fifth-three and one hundred twenty-five thousandths.

$\frac{7}{10} = \frac{700}{1000} = \frac{70}{100}$ or $\frac{35}{100} = \frac{350}{1000} = \frac{3.5}{10}$

Given 3.5, .305, 3.005 the order is for smallest to largest .305, 3.005, 3.5. This might also be done by pictures or by using the numberline.

MATHEMATICS BEHAVIORAL OBJECTIVES
FOR THE
INDIVIDUALIZED MATHEMATICS PROGRAM

Numeration:

By May 15, 1970, each fourth-grade student will, with 100% accuracy:

1. Rounds numbers to nearest thousands, ten thousands, millions, for estimating answers.
2. Writes numerals for a 5, 6, or more place number, writes words.
3. Locates prime numbers to 100 on a chart.
4. Knows the prime numbers from 2 - 47.

MATHEMATICS BEHAVIORAL OBJECTIVES
FOR THE
INDIVIDUALIZED MATHEMATICS PROGRAM

Numeration:

By May 15, 1970, each fourth-grade student will, with 100% accuracy:

1. Identifies place value of 1's, 10's, 100's, 1000's in words or numbers.
2. Uses $>$, $<$ to 1000.
3. Writes number before or after a given number or between 2 numbers to 1000.
4. Writes numbers in expanded notation. To 1000.
5. Regroups, renames numbers for borrowing/carrying.
6. Adds and subtracts problems related by multiples of 10.
7. Writes decimals in expanded notation. Words, fractions, decimals.
8. Identifies place value of decimals, words, fractions, decimals. To hundredths.
9. Place value chart. Decimals. To hundredths.

MATHEMATICS BEHAVIORAL OBJECTIVES
FOR THE
INDIVIDUALIZED MATHEMATICS PROGRAM

Numeration:

By May 15, 1970, each fourth-grade student will, with 100% accuracy:

1. Identifies place value digits to 1,000,000.
2. Writes numbers to 1,000,000 in expanded notation, words/numbers "+" signs. Place value chart.
3. Uses > or < to 1,000,000.
- *4. Uses multiples of 10 to generalize multiplication and division facts. Uses factors to 5×10 .
5. Identifies place value to mixed decimals to 1000ths.
6. Writes decimal as whole number plus sum of decimal part to thousandths place.
7. Place value chart for mixed decimals to 1000.001.

* "Find the Product"

$$3 \times 7 = \underline{21}$$

$$3 \times 70 = \underline{210}$$

$$3 \times 700 = \underline{2100}$$

$$3 \times 7000 = \underline{21000}$$

↓

$$5 \times \underline{\quad} = \underline{\quad}$$

MATHEMATICS BEHAVIORAL OBJECTIVES
FOR THE
INDIVIDUALIZED MATHEMATICS PROGRAM

Numeration:

By May 15, 1970, each fourth-grade student will, with 100% accuracy:

1. Place value chart for 4 or more digit numbers.
2. Writes 10 as a power. Identifies the base and exponent or power of a term.
3. Writes number with 1 non-zero digit as a whole number < 10 times a power of 10 , i.e., 7×10 .
4. Writes a number, 1 thru 9 multiplied by itself a number of times in exponential form.
5. Reads and charts decimal numbers to millionths.

Addition:

By May 15, 1970, each fourth-grade student will, with 100% accuracy:

1. Does column addition with two addends for any two or three digit numbers, no carrying. Checks addition problems by adding in reverse direction.
2. Solves column addition problems with three or more addends and sums to 20.
3. Places $>$, $<$ or $=$ between two additions expressions to show their relationship. Sums to 18.
4. Adds three single digit numbers in two different ways to illustrate the associative principle for addition. Puts in parentheses to show which numbers are added first. Sums to 12.
5. Adds two numbers to sum of 20 using expanded notations.
6. Mastery sums thru 20. Timed test.
7. Column addition 2 addends, 3 + digits. No carrying.
8. Finds missing addends. 3 single digits. Sums thru 20.
9. Uses words sum, addend - labels part.
10. Adds carrying to 10's using 2 digit numerals, 2 or more addends. To 200.
11. Adds, carrying to 10's/100's, using 3 digit numerals, 2 or more addends. To 2000.
12. Adds, carry 10's, 100's using 3 digit numerals, 2 or more addends. To 2000.
13. Finds sums, column addition. Using 3 or more addends of 1 digit. To 50.

Addition:

By May 15, 1970, each fourth-grade student will, with 100% accuracy:

14. Column addition, no carrying, 3 or more digit numbers, more than 2 addends.
15. Uses commutative principle of addition.
16. Uses associative principle for addition to add 2 or more place numerals.
17. Adds with carrying for 4 or more place numerals with 2 addends.
18. Adds 2 mixed numbers to thousands (whole numbers) and hundredths (decimals).
19. Solves multiple-step word problems.
20. Adds - carrying 4 or more place numbers, more than 2 addends.
21. Adds, 2 or more numbers with whole number parts and decimals to the millionths.
22. Adds 2 negative numbers, uses number line or thermometer.
23. Adds negative and positive numbers. Uses number line or thermometer.
24. Adds any 2 numbers which are multiplied by the same base to the same positive power.

Subtraction:

By May 15, 1970, each fourth-grade student will, with 100% accuracy:

1. Subtracts problems - sums to 18.
2. Subtracts 2 digits - no borrowing.
3. Finds missing addend - 2 single digits.
4. Uses $>$, $<$ or $=$ between subtraction expressions.
5. Mastery subtraction facts, numbers to 20.
6. Subtraction no borrowing - 3 or more digits.
7. Subtraction borrowing 10's place - 2 digits.
8. Subtraction borrowing 10's, or 100's - 3 digits.
9. Subtraction borrowing 10's, and 100's - 3 digits.
10. Subtraction with borrowing, 4 or more place numbers.
11. Subtraction 2 numbers, whole number parts to thousands, decimals to hundredths.
12. Solves multiple-step word problems.
13. Subtracts 2 decimal numbers with whole number parts and decimals to the millionths.

Multiplication:

By May 15, 1970, each fourth-grade student will, with 100% accuracy:

1. Groups sets to complete statements.
2. Repeat addition to solve multiplication problems, limit 5×10 .
3. Multiplies using 0 - 1 as factors.
4. Oral-written multiplication factors 2, 3, 4 and 5.
5. Fill-in frames-missing factors. To 5×10 .
6. Completes 2 multiplication statement, illustrates commutative principle.
7. Uses term: product, factors.
8. Solves 1-step word problems, multiplication, to 5×10 .
9. Uses repeated addition to solve multiplication problems. 1 place times 1, 2, 3 place number. Combinations 9×9 .
10. Uses commutative principle for multiplication. Solves problems, 1 place times 2 place factor.
11. Uses associative principle for multiplication. Multiplies more than 2 numbers with single digit factors.
12. Uses distributive principle to simplify multiplication problems.
13. Multiplies 1 digit factor times 2 digit factor. Uses multiplication algorithm.
14. Multiplies 1 digit factor times a 3 or more digit factor. Uses multiplication algorithm.
15. Finds squares of number 1 - 10. Writes exponential form - identifies base and exponent.
16. Uses algorithm for multiplication by 10's to 100,000.
17. Multiplies 2 digits by 2 digits using algorithm.

18. Solves multiple-step word problems.
19. Timed test products through 9 x 9.

Division:

By May 15, 1970, each fourth-grade student will, with 100% accuracy:

1. Divides a set into subsets.
2. Uses multiplication facts to solve division. To 5×10 , including 0 and 1.
3. Uses terms: dividend, divisor, quotient.
4. Divides problems thru $50 \div 5$.
5. Divides 2, 3, 4, 5 by 1 and into 0.
6. Fill-in frames, missing quotient.
7. Solves 1-step problems thru 5×10 .
8. Finds missing factors or quotients for division problems thru $81 \div 9$. Timed.
9. Uses distributive principle, simple numbers, simplify division problems.
10. Uses "ladder" division with 1 digit divisor, 2 or more digit dividend. No remainder.
11. Divides with remainders, 1 digit factor and product.
12. Divides with remainders, 1 digit factor, 2 or more digit products.
13. Checks division problems by inverse operation of multiplication for 2 or more digit products.
14. Solves 1 and 2 step word problems.

Combination of Processes:

By May 15, 1970, each fourth-grade student will, with 100% accuracy:

1. Adds, subtracts mixed sets of problems. No borrowing. No carrying. Vertical or horizontal form. Sums to 99.
2. Sums and differences in money, measurement, time and geometry problems. No unit conversion. Sums to 18.
3. Solves one-step problems, adding and subtracting money, time and measurement values to 18.
4. Fills in $>$, $<$, $=$, $\neq$ in addition, subtraction problems using money, time and measurement values to 18. No unit conversion.
5. Inserts $\div$ or $_$ to complete an equation.
6. Fills in missing addend in 2-step equations combining addition and subtraction.
7. Addition, subtraction. Vertical or horizontal. Money, time and measurement. No carrying/borrowing. To 2000.
8. Same with carrying and borrowing.
9. Multiplication and division. Any earlier skills. Through 5×10 .
10. Solves 1 or 2-step word problems.
11. Supplies missing operational signs.
12. Adds, subtracts, with/without carrying to 1,000 in any direction -- money to \$1.00, time units.
13. Solves equations -- "N" as a variable. Multiplies, divides, combinations thru 9×9 , 81 9.
14. Supplies missing sign $>$, $\leq$ or $=$ for combinations of $+$, $-$, $\times$, or $\div$.
15. Finds averages for numbers. To 1000.
16. Selects principle describing equation and vice versa.
17. Solves 1 or 2 step word problems with fractions to $1/8$, time, money, measurement units, number to 1,000.

Fractions:

By May 15, 1970, each fourth-grade student will, with 100% accuracy:

1. Divides a whole object into halves, thirds, or fourths and identifies an object divided into halves, thirds or fourths.
2. Identifies $\frac{1}{2}$, $\frac{1}{3}$, and $\frac{1}{4}$ of a whole object. Circles fraction which shows what part of an object is shaded. States that the terms one-half, one-third, and one-fourth mean "one of ____ equal parts."
3. Divides a set of objects into 2, 3, or 4 equal parts when instructed to divide a set into halves, thirds, or fourths and identifies sets of objects divided into halves, thirds or fourths.
4. Draws a circle around $\frac{1}{2}$, $\frac{1}{3}$ or $\frac{1}{4}$ of a set of objects and selects the fraction which describes the circled part of a given set.
5. Identifies objects using $\frac{1}{6}$, $\frac{1}{8}$, $\frac{2}{3}$, $\frac{3}{4}$.
6. Divides sets of objects into parts.
7. Adds any 2 fractions with same denominator.
8. Adds 2 fractions, same denominator - $\frac{1}{2}$'s, $\frac{1}{3}$'s, $\frac{1}{4}$'s, $\frac{1}{6}$'s, $\frac{1}{8}$'s only. Sums equal 1, 2, 3.
9. Identifies an equivalent fraction for a given fraction, using pictures.
10. Uses all common fractions in dividing objects and sets. Responds to names.
11. Finds fractional parts of whole numbers giving a whole answer number.
12. Uses "numerator" - "denominator" to identify fraction parts.
13. Changes fraction to an equivalent fraction, with a different denominator, without the aid of pictures. Reduces fraction to lowest terms as a special case of the above.

Fractions:

By May 15, 1970, each fourth-grade student will, with 100% accuracy:

14. Places $>$, $<$ or $=$ between 2 simple fractions to show relationship. Reduces fractions to lowest terms.
15. Adds 2 or more fractions same denominator. Performs subtraction of fraction. Reduces to lowest terms.
16. Identifies an improper fraction and changes improper fractions to mixed fractions in lowest terms.
17. Performs simple addition, subtraction and multiplication with fractions having unlike denominators using picture regions, number lines, etc.
18. Finds greatest common factor for a set of numbers and uses the greatest common factor to reduce fractions to lowest terms.
19. Finds LCM for a given set of whole numbers and finds the LCM for a given set of fractions.
20. Uses algorithm for addition and subtraction of fractions, finds LCD.
21. Performs addition, subtraction of fractions, unlike denominators. Reduces to lowest terms. Use commutative, associative and inverse properties in checking problems
22. Performs column addition, 2 or more simple fractions, like and unlike denominators. Reduces to lowest terms. Performs column subtraction.
23. Adds, subtracts fractions and whole numbers with improper fractions and mixed fractions. Answers, lowest terms.
24. Uses $>$, $<$ $=$ or $\neq$ to show relationship between pairs of fractions.
25. Rearranges groups of fractions into ordered set.
26. Uses $>$, $<$ and $=$ to show relationship between 2-step equations using fractional expressions with $+$, $-$, and $\times$.

Fractions:

By May 15, 1970, each fourth-grade student will, with 100% accuracy:

27. Writes decimal equivalent for simple fractions ($1/2$, $1/4$, etc.). Changes decimal equivalents to fractions.
28. Performs more complex multiplication of fractions including improper and mixed fractions. Finds common divisor, lowest terms.
29. Solves one-step word problems.

Money:

By May 15, 1970, each fourth-grade student will, with 100% accuracy:

1. Matches a quarter with its numerical value or with value in other coins.
2. Finds the value of pennies, nickels, dimes, and quarters. Finds equivalent coin combinations. Limit 99¢.
3. Identifies coins using pennies, nickels, dimes, and/or quarters. Totals a collection of coins and indicates if they are enough to buy an article. Limit 99¢.
4. Uses decimal point and \$ in writing money values, for \$.10, \$.25, \$1.00 and \$1.50 only.
5. Identifies 1/2 dollar, dollar, finds value, uses dollar sign.
6. Adds, subtracts money value. Horizontal/vertical. 2 addends. Sums to \$1.00.
7. Totals coins, bills, greater, less equal.
8. Writes money values using signs.
9. Identifies change in coins.
10. Solves one-step word problems.
11. Identifies change in coins with purchase amounts up to \$10.00.
12. Adds-subtracts money values, using cent and decimal notation.
13. Totals purchases, amounts less than \$10.00. Indicate change. Counts out change starting with the total value of the purchase.

Time:

By May 15, 1970, each fourth-grade student will, with 100% accuracy:

1. Selects matching clock faces.
2. Matches clock face to printed time.
3. Selects printed time to match clock face.
4. Draws hour, minute hand, draws both to show printed time.
5. Writes down other way to state times.
6. Matches time statements and clock faces.
7. Supplies minute count.
8. Supplies hour statement.
9. Writes time from clock face.
10. Draws time on face from statement.
11. Identifies calendar units, number of days in week, number of days in each month. Completes calendars. Word problems. Writes given date in words and numbers or in numbers.
12. Reads any time on clock face, shows any time using clock face. Writes and reads time using appropriate vocabulary and punctuation.
13. Uses "morning," "afternoon," "night" dividing day at noon and midnight writes time and "A.M." and "P.M."
14. Finds minutes elapsed between 2 minute hand readings. Limit 2 hours. Calculates passage of time.
15. Solves problems adding/subtracting hours/half hours on clock face.
16. Identifies second hand. Reads time on clock with second hand. Says there are 60 seconds in a minute.
17. Adds, subtracts time units. One step problems. No regrouping. Limit 2 1/2 hours. Problems in reading, bus, train, plane schedules.

Time:

By May 15, 1970, each fourth-grade student will, with 100% accuracy:

18. Addition/subtraction 2-3 time units. 1-2 regroupings. Seconds through years.

Systems of Measurement:

By May 15, 1970, each fourth-grade student will, with 100% accuracy:

1. Measures objects to nearest inch.
2. Solves measurement problems involving 12 inches in a foot. Differentiates measurements stated in inches and feet. Limit 3 feet.
3. Starts and shows cups per pint, pints per quart and reverse.
4. Problems - 3 ft. = 1 yd., 36 in. = 1 yd.
5. Uses equivalent liquid measures.
6. Word problems - equivalent measures.
7. Measures length of lines or objects (up to 36 inches) nearest $\frac{1}{4}$ inch.
8. Measures lines, objects to nearest $\frac{1}{4}$ inch.
9. Solves problems requiring conversion of tons into pounds, pounds into ounces, equivalent measures of ounces-pounds, pounds-tons.
10. Adds, subtracts, multiplies, divides, denominant numbers, uses regrouping to combine same units.
11. Reads speedometers. d = st problems. Problems using temperatures. Above and below zero. C and F. No conversion.
12. Uses equivalent measures - feet, rod, yard, mile. Solves problems using these conversions.
13. Uses a ruler to measure in centimeters. Measures lines - nearest inch and centimeter. Makes comparisons.

Geometry:

By May 15, 1970, each fourth-grade student will, with 100% accuracy:

1. Identifies curves, lines, segments, corners.
2. Labels points in line. Names line segments by end-points.
3. Draws pictured representations of solids or selects correct pictured representation when name of solid is given. Names pictured representations of solids.
4. Identifies parts of a line segment. Names a line for any 2 points in it.
5. Identifies a right angle and names angles by three points.
6. Given words equilateral triangle, right triangle, quadrilateral, draws or selects figure. Vice versa.
7. Identifies lines which "look parallel."
8. Uses compass - draws circle.
9. Identifies intersecting lines, locates point of intersection.
10. Names points in a line, dot used as a representation of a point.
11. Measures line segment to nearest $\frac{1}{2}$ and $\frac{1}{4}$ inch.
12. Identifies lines which are perpendicular.

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