A COMPARISON OF THE EFFECTS OF TWO MATHEMATICS PROGRAMS UPON SELECTED FIFTH, SIXTH, SEVENTH, AND EIGHTH GRADE REMEDIAL MATHEMATICS STUDENTS

DISSERTATION

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The problem with which this investigation was concerned is that of determining whether remedial mathematics students who receive individualized attention in small groups with many special materials would gain more knowledge in the areas of computation, concepts, problem solving, and total composite mathematics than would remedial mathematics students taught as sub-groups of regular mathematics classes.

The twofold purpose of this study was to test the effectiveness of the clinical approach to mathematics remediation and to assist school officials in the evaluation of such remedial programs.

Subjects were exposed to the remediation techniques for five months of the 1975-1976 school year, beginning in August, 1975. The study involved 338 students in grades five, six, seven, and eight, attending six elementary and two junior high schools in the North Central Texas area. In the clinical set, the class size was limited to eight students in grades five and six, with a limit of twelve students in grades seven and eight. This instruction was

given outside the regular classroom in a specially equipped room containing many different types of materials.

In the classroom set, the class size ranged from twenty-four to twenty-nine students, with the classroom remediation set being the lowest sub-group of the class. Materials and teaching strategies utilized with the classroom set were not greatly different from those used with other pupils in the regular mathematics classes.

Teachers for both the clinical and classroom sets were selected on the basis of their having comparable college credits in mathematics, years of experience, and their attitude toward remedial mathematics students.

The mathematical sub-tests of the _Metropolitan Achievement Test_, 1970 edition, served as the evaluation instruments. The _Otis-Lennon Mental Ability Test_ was used to establish a measure of general intelligence of the subjects. The _t_ test was used to test the significance of difference between the means obtained for pretest scores and IQ scores of the clinical and the classroom sets. At the .05 level of confidence, there was no significant difference in the two sets. However, in order to assure that any pre-existing differences would not confound the differences in achievement between the two sets of students, a one-way analysis of covariance with the IQ scores and pretest scores as covariates was used to test the sixteen hypotheses. The .05 level of confidence was used as a basis for the acceptance or rejection of the null hypothesis.

The statistical procedures utilized produced no significant difference at any of the four grade levels in computation, concepts, or problem solving. Significance was indicated in total composite mathematics at the sixth grade level, but not at grade levels five, seven, and eight. Additional data analysis did show a significant gain from pretesting to posttesting at all grade levels and sub-groups.

Conclusions drawn included the following:

Remedial mathematics students will experience as much gain in mathematical skills in a classroom remedial mathematics program as they would in a clinical mathematics program.

In all groups the mean scores did show a significant gain when comparing pretest means with posttest means. This would suggest that remedial mathematics students will show an improvement in mathematical skills when placed in remedial mathematics programs that are designed for their special needs.

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CHAPTER I

INTRODUCTION

In the early years of the Twentieth Century there was relatively little advanced mathematical competence in the United States. Only a few of the major universities had professors of outstanding quality, and an ambitious young man was well advised to go to Europe for his advanced training if he planned to be a research mathematician. The teaching of mathematics at the school and college level was apparently satisfactory for standards of the times.

About the time of World War I a conscious decision was made to allow the small number of research mathematicians to put their energy into the discovery of new theorems and the training of Ph.D.'s and to leave the problems of school and undergraduate mathematics to others. This policy was highly successful regarding research, for in less than forty years American mathematics had moved into a leading position in the world. However, during this same period of time school mathematics suffered a serious decline for lack of contact with the changes in the world of mathematical discovery.

Just before World War II a reform movement was under way to close the gap between school and research mathematics, but the war snuffed this movement out. Nothing further was accomplished until about 1950. At that time several individual mathematicians began experimentation using new materials with their college freshmen. As the results of the more successful of these experiments began to appear in books, school men began to take notice. In 1954 the College Entrance Examination Board appointed its Commission on Mathematics. This commission included both school and college teachers of mathematics, and its formation was an historic event since these groups had not met together for over forty years. The commission's final report was not issued until 1959, but preliminary drafts had been widely circulated for several years. The plan for reform ready, the occasion of the launching of Sputnik I caused the public to demand action.

In response to this demand the School Mathematics Study Group (SMSG) was established on the recommendation of the presidents of the American Mathematical Society and the Mathematical Association of America. Financial support in large amounts was provided by the National Science Foundation. SMSG established writing groups composed of university and school mathematicians and has published a very large number of experimental textbooks for elementary and secondary school use.

Private foundations financed writing teams at several universities, including the University of Illinois, Syracuse University, Stanford University, and the University of Minnesota. Their teams also published experimental textbooks which allowed schools to choose from several alternative modern presentations of mathematics. There was no official method of presentation, and any group desiring to do so was welcome to render its own presentation.

Some weaknesses, one of which is the fact that some of the new materials are too difficult for the less than average student, have been discovered in the new approaches; therefore, new versions of these materials are being written for less able pupils. Some schools went too far in the implementation of approaches which emphasized the understanding of concepts and neglected to teach skills. A search for a well-balanced approach to the teaching of mathematics is still in progress.

There has been some outspoken opposition to the revolution: part from congenital conservatives, part from those too lazy to change, part from the uninformed, and part from a small group of mathematicians who think extremists have taken over. Judged by the published works of its responsible leaders, the revolution is on firm ground; and its success will bring great benefits to the American people (1, pp. 35-37).

Educators have worked diligently in recent years to upgrade the content of the mathematics curriculum as well as to improve teaching methods and procedures. Many concerns have been generated by some of the changes that have taken place in the mathematics programs. These changes, coupled with the fact that far greater numbers of children enter school and remain there longer, are topics of discussion in many settings. Most educators agree, however, that what "new math" wanted to achieve--better performance through greater understanding--is a valid goal.

The content in most current mathematics programs is by no means a complete change from that found in programs experienced by many of today's parents and teachers. True, some new topics, such as "inequalities, variables, and set notations" appear. Greater precision of language, as well as greater emphasis on meanings, is a feature of today's program. Such features serve to unify the mathematics curriculum, make it more functional and provide more flexibility. For example, thorough understanding of the structural nature of the number system provides a framework upon which the student can base the development of computational skills and the acquisition of basic facts.

Basic arithmetic skills have received major attention. The ability to compute is an essential skill and there is no substitute for it. The outlook for the future indicates that this ability must continue to have primary importance in the curriculum. It also appears that more calculating devices will be used to support the basic arithmetic skills in many vocational and educational areas and that students should be able to utilize these devices (2, p. 6).

Despite this emphasis, research, and experimentation, many students are graduating from high school without competency in basic mathematics. The U. S. News & World Report states that during the past twenty years uncounted billions of dollars have been spent to improve the quality of the world's biggest educational system:

> These billions brought major overhauls of the curriculum, innovations in teaching methods, less toughness in grading and discipline, and new goals.
>
> Yet just in recent weeks--
>
> A report from the National Assessment of Educational Progress found young consumers aged 26 to 35 woefully lacking in such everyday mathematical skills as those needed for comparing prices, following cookbook directions, paying taxes or balancing checkbooks (10, p. 42).

Statement of the Problem

The problem of this study was to determine whether there would be a significant difference between the gains in mathematical skills made by two sets of remedial mathematics students, one set of students attending schools where the clinical approach to mathematics remediation was used and the other set of students attending schools where a classroom approach for mathematics remediation was used.

Purposes of the Study

1. The purpose of this study was to determine if a group of fifth, sixth, seventh, and eighth grade students who were exposed to remedial teaching in a clinical situation would acquire a greater mastery

of mathematical skills than those exposed to remedial teaching in a regular mathematics classroom program as measured by mathematical sub-tests of the <u>Metropolitan Achievement Tests</u> (1970 edition).

2. Another purpose was to assist school officials in assessing the value of add on programs as exemplified by the clinical remediation approach.

Statement of Hypothesis

The hypothesis of this study was that there would be no significant difference between the means of mathematical scores attained in the areas of (1) computation, (2) concepts, (3) problem solving, and (4) total mathematics by a set of students in a clinical remediation program and those attained by a set of students in a classroom remediation program during the first semester of the 1976-1976 school year.

Hypotheses to be Tested

1. There is no significant difference between the means of the fifth-grade clinical remediation set and the fifth-grade classroom remediation set in mathematical computation on the <u>Metropolitan Achievement Test, Intermediate</u>.

2. There is no significant difference between the means of the fifth-grade clinical remediation set and the

fifth-grade classroom remediation set in mathematical concepts on the _Metropolitan Achievement Test, Intermediate_.

3. There is no significant difference between the means of the fifth-grade clinical remediation set and the fifth-grade classroom remediation set in mathematical problem solving on the _Metropolitan Achievement Test, Intermediate_.

4. There is no significant difference between the means of the fifth-grade clinical remediation set and the fifth-grade classroom remediation set in total composite mathematics on the _Metropolitan Achievement Test, Intermediate_.

5. There is no significant difference between the means of the sixth-grade clinical remediation set and the sixth-grade classroom remediation set in mathematical computation on the _Metropolitan Achievement Test, Intermediate_.

6. There is no significant difference between the means of the sixth-grade clinical remediation set and the sixth-grade classroom remediation set in mathematical concepts on the _Metropolitan Achievement Test, Intermediate_.

7. There is no significant difference between the means of the sixth-grade clinical remediation set and the sixth-grade classroom remediation set in mathematical

problem solving on the _Metropolitan Achievement Test, Intermediate_.

8. There is no significant difference between the means of the sixth-grade clinical remediation set and the sixth-grade classroom remediation set in total composite mathematics on the _Metropolitan Achievement Test, Intermediate_.

9. There is no significant difference between the means of the seventh-grade clinical remediation set and the seventh-grade classroom remediation set in mathematical computation on the _Metropolitan Achievement Test, Advanced_.

10. There is no significant difference between the means of the seventh-grade clinical remediation set and the seventh-grade classroom remediation set in mathematical concepts on the _Metropolitan Achievement Test, Advanced_.

11. There is no significant difference between the means of the seventh-grade clinical remediation set and the seventh-grade classroom remediation set in mathematical problem solving on the _Metropolitan Achievement Test, Advanced_.

12. There is no significant difference between the means of the seventh-grade clinical remediation set and the seventh-grade classroom remediation set in total composite mathematics on the _Metropolitan Achievement Test, Advanced_.

13. There is no significant difference between the means of the eighth-grade clinical remediation set and the eighth-grade classroom remediation set in mathematical computation on the _Metropolitan Achievement Test, Advanced_.

14. There is no significant difference between the means of the eighth-grade clinical remediation set and the eighth-grade classroom remediation set in mathematical concepts on the _Metropolitan Achievement Test, Advanced_.

15. There is no significant difference between the means of the eighth-grade clinical remediation set and the eighth-grade classroom remediation set in mathematical problem solving on the _Metropolitan Achievement Test, Advanced_.

16. There is no significant difference between the means of the eighth-grade clinical remediation set and the eighth-grade classroom remediation set in total composite mathematics on the _Metropolitan Achievement Test, Advanced_.

Definition of Terms

Mathematical Achievement: The level of achievement reached by a student as measured by the _Metropolitan Achievement Tests_ in mathematics and reported in grade equivalent scores.

Mathematics Clinic: A special classroom outside the regular classroom limited to mathematical skills instruction for small groups of students using special equipment and materials.

Mathematical Diagnosis: Investigation or analysis of the causation of a problem or a condition.

Mathematical Disability: Lack of ability to perform mathematical skills due to some physical, mental, or other cause.

Mathematical Expectancy: The level at which a student should be able to perform, based on grade level and IQ score.

Post Test: A test given to a group or an individual following instructional activity.

Pretest: A test given to a group or an individual before instructional activity.

Regular Mathematics Classroom: A classroom in the school composed of from twenty-four to twenty-nine pupils wherein mathematics is taught utilizing the state-adopted textbooks and teachers' editions. Sub-groups are established in these classrooms to provide some measure of individualization.

Remedial Mathematics Program, Classroom: The teaching of mathematics to sub-groups of the class in a regular classroom situation. Pupils who evidenced some degree of learning difficulty were assigned to what are termed basic classes in both the elementary and junior high schools. Standardized test scores and teacher observations served as means of identification of pupils assigned to these instructional groups. The classroom remediation set of pupils in this study consisted of the lowest sub-groups of these basic classes in the one junior high school and the three elementary schools receiving this type of instruction. Although teacher-made diagnostic tests were used with each sub-group of these classrooms to discover specific weaknesses and as indicators for remedial needs, materials and teaching strategies utilized with these pupils were not significantly different from those used with other pupils in the regular mathematics program. Learning experiences were derived from the same state-adopted textbooks and teachers' editions used for other students in the regular mathematics classrooms. Learning activities for these remedial mathematics students were limited to traditional approaches using pencil, paper, and chalkboard, with emphasis placed on basic computational practice.

Mathematics classes met daily for forty-five minute periods in the elementary schools and for fifty-five minute periods in the junior high school. The remedial mathematics instruction took place in the classroom where other course work was taught during the school day. No equipment was used or major adjustments were made in the room setting. Size of these instructional groups ranged from twenty-four to twenty-nine students, with up to three sub-groups in each instructional unit. The scope and depth of concept development moved at a slower pace for these classroom remediation students than for other students in the regular mathematics program. Although the instructional approach was different, the objectives which were listed in the course guide for each grade level, were the same for these classroom remediation units as for the clinical remediation units.

Remedial Mathematics Program, Clinical: The teaching of mathematics to small groups of students, with this instruction given outside the regular classroom and in lieu of classroom instruction in mathematics. Pupils in the schools where this type of instruction was used were selected for inclusion in the clinical program based on an IQ score of at least eighty, standardized test scores which indicated at least six months below expectancy, and recommendation of teachers.

Students attended these classes daily on the same schedule that regular mathematics students attended mathematics classes. The size of the clinical remedial mathematics class was limited to a maximum of eight students in the elementary schools and twelve students in the junior high school. Each teacher had six class periods of forty-five minutes in the elementary schools and five class periods of fifty-five minutes in the junior high school. This instruction took place in a room separate from the regular classroom, a room that was utilized only as a remedial mathematics clinic with special equipment and materials available for student and teacher use.

Inventory tests, based on the skills that should have been internalized in previous grades, were given to each student along with other diagnostic tests, both commercial and teacher-made. The results of these tests were used to indicate shortcomings in mathematical skills, to analyze the causes of these shortcomings, and to indicate remediation needs. Planned class and group work was conducted on the basis of those indicated student needs. Each child practiced a variety of techniques closely supervised by the teacher. Several different types of materials, including EDL controlled reader programs, math games, skill kits, and the Spectrum series of ungraded mathematical workbooks were used to reinforce the concepts being taught. Emphasis was placed on the use of manipulatives and concrete mathematical materials with students. A variety of high-interest low-level materials was available for student use.

Although a different approach was used in these mathematics clinics, the objectives, which were listed in the course guide for each grade level, were the same for these clinical remediation units as for the classroom remediation units.

Remedial Mathematics Student: A student whose mathematical performance is six months or more below the expectancy level and whose recorded intelligence quotient does not fall below eighty.

Limitations

The following limitations were imposed during the course of this study:

1. This study was limited to 161 fifth, sixth, seventh, and eighth grade remedial mathematics students assigned to the clinical remedial mathematics program and 177 fifth, sixth, seventh, and eighth grade remedial mathematics students assigned to classes where a classroom remediation program was utilized.

2. This study was limited to those students who were enrolled during the first semester of the 1975-1976 school year which began August 18, 1976, and extended through January 30, 1976.

Instruments

This study utilized two levels of the sub-test in mathematics of the *Metropolitan Achievement Test*, 1970 edition, intermediate for grades five and six; advanced for grades seven and eight. Areas of mathematics covered by these tests are computation, concepts, problem solving, and total composite mathematics, which is the sum of the first three areas listed.

An examination of these tests was made by school staff members, including administrators, supervisors, and the teachers of remedial mathematics. All agreed that the tests did adequately cover the stated objectives and concepts being presented to the students in the various grade levels involved in the study.

Method of Procedure

The subjects of this study were fifth, sixth, seventh, and eighth grade students attending six different elementary and two different junior high schools in the North Central Texas area. Practical limitations associated with the conduct of this experiment precluded the rigid control of several variables; however, the basis for matching, to seek as high a degree of comparability as possible, was as follows:

Schools

The six elementary schools were selected for inclusion in this study because of their being of similar size and their serving communities of similar socio-economic mix. The two junior high schools involved in the study were chosen in a like manner. School administrators made the decision as to which schools would use the clinical remediation approach. This decision was based on the percentage of educationally disadvantaged students attending the school in all grades. The schools with the highest percentage of such students were chosen as those that would use the clinical remediation approach. The schools using the clinical remediation approach averaged 22.5 percent educationally disadvantaged pupils, while schools using the classroom approach to remediation averaged 18.3 percent educationally disadvantaged pupils.

Teachers

The teachers for the remedial mathematics clinics were selected on the basis of their willingness to accept this type of full-time assignment without reservation and their having sufficient college credits in mathematics and/or sufficient teaching experience to assure a degree of competency with remedial mathematics students. The teachers for the classroom remedial mathematics program were selected on the basis of their willingness to accept this type of full-time assignment as their regular teaching duty and their having sufficient college credits in mathematics and/or sufficient teaching experience to assure a degree of competency with remedial mathematics students. Teachers of both the clinical and classroom remedial mathematics students were fully certified by the Texas Education Agency.

At the seventh and eighth grade levels the range of college credits in mathematics for teachers of the classroom units was from fifteen to thirty-two hours, with the range for the teachers of the clinical units being from seventeen to forty-eight hours. Of the classroom unit teachers, two held a Master's degree; of the clinical unit teachers, two held a Master's degree. Teaching experience ranged from five to thirty-eight years for the classroom unit teachers and from four to twenty-seven years for the clinical unit teachers.

At the fifth and sixth grade levels the range of college credits in mathematics for teachers of the classroom units was from six to thirteen hours, with the range for the teachers of the clinical units being from six to thirteen hours. Of the classroom unit teachers, three held a Master's degree; of the clinical unit teachers, two held a Master's degree. Teaching experience ranged from six to twenty-two years for the classroom unit teachers and from four to eighteen years for the clinical unit teachers.

Four days of in-service training at the beginning of the school year were devoted to the preparation of the remedial mathematics teachers for their assignments. In addition, a schedule of in-service training was followed at regular intervals during the school year for these teachers. The work of these remedial mathematics teachers was coordinated by an experienced teacher hired for this purpose. This coordinator was a fully certified teacher with a Master's degree and twenty-one years of teaching experience in math.

Students

The students assigned to the classroom remediation program and the students assigned to the clinical remediation program concentrated on the same scope and sequence of mathematical concepts programmed for their grade level. The objectives of each grade level were enumerated in course guides which were constructed with the assistance of the teachers. The schools were comparable in size and location, but to assure that students in the clinical remediation set were comparable in socio-economic status to students in the classroom remediation set, the Warner Test of Social Class was applied (11).

In comparing the clinical set of students with the classroom set of students by grade level and using the t test for independent samples, the results in Table I were obtained.

TABLE I

THE WARNER TEST OF SOCIAL CLASS
SUMMARY TABLE

Group	Grade	N	X	X^2	X	s^2	t
Clinical Classroom	5 5	49 41	940 727	18,682 13,559	19.184 17.732	14.972	1.773
Clinical Classroom	6 6	31 33	576 513	10,954 13,589	18.581 17.419	11.029	1.486
Clinical Classroom	7 7	33 47	513 707	8,159 10,785	15.545 15.043	4.285	1.068
Clinical Classroom	8 8	48 46	767 706	12,819 11,040	15.979 15.347	8.342	1.059

At the .05 level of confidence, with from 60 to 120 degrees of freedom, a t score of at least 1.980 is required for significance (4). As shown in Table I, the calculated values of t were 1.773 with 88 degrees of freedom for the fifth grade; 1.486 with 72 degrees of freedom for the sixth grade; 1.068 with 78 degrees of freedom for the seventh grade; and 1.059 with 92 degrees of freedom for the eighth grade. Based on the calculated values of these statistics, there was no significant difference in socio-economic status in any of the sets of students for the four grades tested.

Basic Assumptions

1. Each of the teachers in the study will work diligently and professionally in trying to accomplish the goals established for their grade level.

2. All data utilized in the study will be handled in an honest and professional manner.

Procedure for Collecting Data

The subjects selected for this study were fifth and sixth grade students enrolled in the elementary schools, along with seventh and eighth grade students enrolled in the junior high schools. A set of 80 elementary remedial mathematics students and 81 junior high remedial mathematics students was selected from those students participating in the clinical mathematics programs during the first semester of the 1975-1976 school year. The classroom remediation set was composed of 81 elementary remedial mathematics students and 93 junior high remedial mathematics students selected from those students participating in the classroom remediation program during the same semester. The mathematics sub-tests of the *Metropolitan Achievement Test*, form F, were given for the pretest, and form H of the same tests was given as the post test. These tests have been described elsewhere in this paper.

The *Otis-Lennon Mental Ability Test* served to establish a measure of the intelligence of the subjects involved in the study.

Procedure for Analysis of Data

A one-way analysis of covariance with two covariates was used to test the hypotheses of this study. The analysis of covariance is a treatment whereby a statistical, rather than an experimental, method may be used to control the effects of uncontrolled variables, and thereby permit a valid evaluation of the outcome of the experiment (4). In this study the raw pretest scores and the IQ scores were the uncontrolled variables or covariates, and the raw score of the post test was the dependent variable or criterion. The influence of the covariates was removed by a multiple regression method involving weights. The residual sums of squares was used to provide variance estimates which in turn were used to make tests of significance. The .05 level of confidence served as a basis for the acceptance or rejection of the hypotheses.

Significance of the Study

The ability to perform basic mathematical skills constitutes one of the most important accomplishments a student can acquire. Effective use of mathematical skills is required in order to make a satisfactory adjustment to living in this modern, complex world.

Parents, employers, and taxpayers are demanding that the schools produce graduates capable of performing in the area of basic mathematics. The responsibilities of the schools in this area have been effectively defined by Ragan and Shepherd, who said:

> Our society is committed to the goal of fostering the maximum development of the powers of the individual. The school is the chief formal agency for achieving this objective. Hence, the school curriculum, including the mathematics program, must be designed to help pupils achieve this objective. A mathematics curriculum consisting of sound and meaningful mathematical concepts is not sufficient; pupils must learn to use these concepts in problem solving situations (7, p. 340).

The United States Office of Education has given high priority to the early discovery and remediation of deficiencies in mathematics. Each school year various programs of remediation are implemented in schools throughout the nation. In school year 1973-1974 the total instructional cost for the State of Texas under the Elementary and Secondary Education Act, Title I, was over forty-seven million dollars. Of this amount, over four million dollars were spent in the area of remedial mathematics. Remedial services in mathematics were rendered to 58,962 students in the state during this period. Services in remedial mathematics are exceeded only by such services in reading instruction and by pre-school programs in Texas (8, pp. 10-12).

A great number of studies have been done since 1959 which show the need for improving the teaching of mathematics. Although the full extent of the need is not known, most evidence seems to indicate that a surprisingly large proportion of the school population is affected by disabilities in mathematics. This mathematical disability is due to many causes often operating together. Many disabilities are produced by factors in the child's environment at home, at play, and in school. It should also be recognized that other factors such as emotional instability and physical defects are often contributing causes (9, pp. 1-5).

The fact that there are a great number of students in school who are not performing at expected levels of mathematical achievement is disputed by almost no one. The question of how to deal with this problem is of concern to everyone involved in education. Johnson states that we need to use accepted techniques of research to investigate such problems as

1. What is the relative effectiveness of different methods of instruction?
2. What are significant factors in the formation of mathematical concepts?
3. What are effective ways of providing for individual differences?
4. What are the most effective ways to motivate learning?
5. What is the role of instructional materials in teaching mathematical ideals? (5, pp. 424-425).

The Editorial Panel of the National Council of Teachers of Mathematics in a call for research data included these areas:

> What is the proper balance between individualized and large-group instructional experiences for students?
> What students are most successful in individualized programs and how are they identified? Are these problems of specific grade levels?

The panel summed up the need for further research in the statement:

> Just as curricular innovation dominated mathematics education throughout the 1960s, instructional innovation has been the major goal of the 1970s. Most prominent among the emerging instructional alternatives are the varied approaches to individualized instruction. But progress toward the goal of individualization has created concern about the most appropriate modes for learning mathematics (3, p. 355).

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CHAPTER II

REVIEW OF THE LITERATURE

The purpose of this chapter is to survey the literature and research in the field of mathematics revelant to the various aspects of remediation and the low achiever.

Establishment of the Need for Special Programs for Low-Achievers in Mathematics

A recent article in American Education claims that "many Americans are duds in the market place simply because they don't know the basics of its mathematics" (4, p. 21). The study referred to was made by the National Assessment of Educational Progress (NAEP). Consumer mathematics exercises were given to a sample of 34,000 seventeen-year-olds and 4,200 young adults representing a cross section of the United States and covered practical examples of comparison shopping, income tax tables, checkbook balancing, percentages and discounts, along with many more areas in everyday living where mathematics is used.

Extremely high percentages of both students and adults were unable to perform satisfactorily in solving these basic tasks because of carelessness in the simple computation of addition, subtraction, division, and multiplication. Steps were taken during this study to prevent below average or poor reading ability from affecting the scores, yet,

> The level of performance as set by these exercises, particularly for 17-year-olds, suggests quite pointedly that the Nation's schools may need to check their account books, to see if they're teaching enough of the kind of math their students need to cope in the marketplace and the home and with the tax collector. Without some fluency in the language of numbers one is hard put to survive the complexities of our increasingly mathematical society (4, pp. 21-24).

An Associated Press article, datelined Austin, Texas, states that "Almost one-third of American adults cannot tell how much money has been deducted from their paychecks and 41 percent do not know how to fill out a bank deposit slip" (10, p. 20). This research, headed by a professor of the University of Texas, was funded by the United States Bureau of Adult Vocational-Technical Education and revealed that 30 percent of the adults of the nation cannot tell from looking at a thermometer if a person has fever. Thirty-four million Americans were described as "functionally incompetent" in such consumer matters as deciding which package of cereal is the best buy according to weight and price. It was claimed that only about one-half of the adult population in Texas functions proficiently.

Many critics of the mathematics programs being offered in our schools today are of the opinion that we have moved backwards during the past thirty years. In order to test this hypothesis, Beckmann and others readministered the same tests they had given to similar groups of students many years earlier (2, pp. 334-335). It was found that the students of the sixties did better on these tests than did their counterparts who preceded them by one or more decades.

Eugene P. Smith, president of the National Council of Teachers of Mathematics in 1973, pointed out a possible explanation for some of the criticism being heard (45). He said that we have a group of graduates today that would have dropped out of school had they lived a few decades earlier. They remain in school through graduation now because of the higher retention rate of our modern-day educational system. He found that approximately thirty percent of those students who had finished the fifth grade seven years earlier actually graduated from high school in 1935. In 1965, the number of high school graduates compared to those completing the fifth grade had climbed to seventy percent. An estimate was made that by the mid-1970's this retention rate would have climbed to the eighty or ninety percent range.

It was conceded that some of those graduating in the seventies did not have the skills and knowledge of those 1935 graduates. However, they probably had more academic skills than the students who quit school in the thirties at the age of sixteen, having reached only the fourth, fifth, or sixth grade.

The increased retention of students through high school has brought on many problems. These problems have been compounded by the fact that approximately thirty percent of those gainfully employed in the United States in 1935 were in unskilled-labor jobs, whereas in 1965 only five percent of those gainfully employed were doing unskilled labor. The number of jobs for the uneducated has continued to diminish. It follows, therefore, that educators must persist in finding ways to provide a better education for the non-college-bound students. These are the students whose needs we have not yet met (45, 27, 29).

To further emphasize a need of more concern for the below average achiever, Meserve (35) called attention to the assumptions established by the United States Office of Education in cooperation with the National Council of Teachers of Mathematics in 1964:

1. Our Nation needs the potential manpower of the low achiever in mathematics.
2. Low achievers will not be qualified for future employment unless they learn more mathematics than they are learning now.
3. The mathematical ability of low achievers can be developed to the extent necessary for a saleable skill.
4. The low achiever should have the mathematics instruction necessary for (a) a saleable skill, and (b) a rich cultural citizenship (35, p. 438).

Trafton and Suydam (50) stated the position of the Editoral Panel of The Arithmetic Teacher regarding the question, "Why don't children learn to compute better?" with the following statements:

1. Computational skill is one of the important, primary goals of a school mathematics program.
2. All children need proficiency in recalling basic number facts, in using standard algorithms with reasonable speed and accuracy and in estimating results and performing mental calculations, as well as an understanding of computational procedures.

3. Computation should be recognized as just one element of a comprehensive mathematics program.
4. The study of computation should promote broad, long-range goals of learning.
5. Computation needs to be continually related to the concepts of the operations and both concepts and skills should be developed in the context of real-world applications.
6. Instruction on computational skills needs to be meaningful to the learner.
7. Drill-and-practice plays an important role in the mastery of computational skills, but strong reliance on drill-and-practice alone is not an effective approach to learning.
8. The nature of learning computational processes and skills requires purposeful, systematic, and sensitive instruction.
9. Computational skills need to be analysed carefully in terms of effective sequencing of the work and difficulties posed by different types of examples.
10. Certain practices in teaching computation need thoughtful reexamination (50, pp. 529-537).

They offered the following advice to those concerned with improving the learning of number ideas and the acquisition of computational skills:

> The current focus on student achievement in computation can be a healthy one if the study is thoughtful, examines carefully what is known about effective teaching and learning in this area, and highlights practices that have demonstrated value and support in research. On the other hand, there are dangers in focusing on end products of learning apart from the developmental processes that underlie them, and the reliance on "rule-example" instructional strategies in which a heavy emphasis is placed on drill approaches (50, p. 529).

The Need for Relevancy In Mathematics Instruction

Leaders in the area of mathematics education have recognized for some time not only the need for remediation of under achievers, but the need that what is taught be relevant to the daily lives of the students. Call and Wiggins made this point in a 1966 publication:

> What is a mathematics problem? When most people think of mathematics, they think of numbers or numerals; they think of computation--of addition, subtraction, multiplication, square roots, and so forth. There is no question that these are parts of mathematics. These factors are operations. They are, in fact, pure mathematical concepts, which, in and of themselves are useless.
>
> Mathematics, to be of use, must be capable of application, and must be applied. Now, how do we apply mathematics in life? We are confronted with some kind of situation which must be resolved by the use of mathematics. It is not enough to know how to perform the operations. We must know which operations apply to a particular situation (5, p. 151).

Ferguson (19) calls attention to a project begun in 1966 by the SMSG which was to emphasize curriculum research and development. Through this project it was hoped that a curriculum would be developed that would provide students with a clear understanding of the nature of mathematical application and of the variety of ways in which mathematics can be useful in society. In the preliminary stages of this project, a panel met in March of 1966. These two main guiding maxims emerged from their discussions:

> 1. The initial segment of the secondary school mathematics curriculum should be devoted to those mathematical concepts which all citizens should know in order to function satisfactorily in our rapidly expanding technological society. It was felt that capable students would be able to complete the study of this mathematics in three years or less, while the less able students might profitably spend four, five, or even six years completing the sequence.
> 2. The exposition of this mathematics for the average to slow-moving student will need to be satisfactorily developed if the project is to be a success (19, p. 387).

Proctor summed up the need for relevancy in mathematics education:

> To look is one thing. To see what you look at is another. To understand what you see is a third. To learn from what you understand is still something else. But to be able to act on what you learn is really all that matters (40, p. 122).

The Search for an Effective Method of Remediation

Arithmetic is considered by many people to be a very difficult subject and has discouraged a large number of students. Over the years the rate of failure in arithmetic has been greater than in any other subject (20). This fact, and the important place mathematics has in modern society, has caused basic changes in arithmetic instruction during the past forty years.

Kaplan (28) disapproved of the time-honored notion that places one teacher at the head of a classroom, teaching all students in the room simultaneously. Of the students in such a situation he said:

> Those students who cannot keep up with the pace of the teacher or those who find the pace too slow fail to make the necessary responses and soon grow disinterested in what is being said. One suspects that what we have been calling "low achievers" are those who are "out of phase" with the teacher (28, p. 749).

Taback further questioned the traditional thinking of mathematics teachers in relation to their concept of children's thinking:

> It seems clear that we as teachers of young children must become more aware of the qualitative differences between children's thinking and adults' thinking; that is, differences in the extent to which language and physical actions are interchangeable and differences in the extent to which "logico-mathematical" abstractions and physical actions are interchangeable. Furthermore

> we need to know how these differences are affected by cultural or socioeconomic factors. We hope that this knowledge will better enable us to curb the imposition of adult standards on children's thinking and to recognize more easily sources of potential difficulties for children (49, p. 19).

The negative attitudes of slow learners are a factor that needs the careful attention of mathematics teachers. Dinkmyer and Dreikurs presented five suggestions for teachers to help change such attitudes:

1. Accept children as they are. Like them as they are so they can like themselves.
2. Show a faith in the child that enables the child to have faith in himself.
3. Make him feel that it is all right to try. If he fails, failure is no crime.
4. Be pleased with a reasonably good attempt.
5. Show confidence in his ability to become competent (12, pp. 48-50).

Another suggestion for teachers was made by Higgins:

> The teacher should always consider whether or not the student is at a developmental stage which would allow him to meet expectations. In the course of his studies, Piaget has created many cognative tasks to test aspects of the intelligence of children. Researchers are presently developing and standardizing such tests which promise to be of great use in grade or group placement or in identifying students who need remedial training programs (25, p. 85).

Malpass (34) stated that learning has been found to be most efficient if the learner has the opportunity to start at the point at which he meets a reasonable degree of success and if he is allowed to move ahead as fast and far as his rate of learning and capacity will let him. In exploring these relationships between student perception of school and achievement in school, he found that a positive relationship exists between attitudes and current academic success.

Ferguson (19) gives further insight into the needs of the mathematics programs, specifically at the junior high school level, along with a look at some new techniques:

> In the past, very little use was made of a curriculum coordinator to keep the mathematics curriculum up to date. Also, the requirements for a junior high mathematics teacher demanded little in subject matter. Teachers with practically no mathematical background were sometimes allowed to teach junior high mathematics. Of course, some of the junior high teachers of the past were well trained in mathematics, and fortunately, some who knew little about the subject could still lead students to enjoy and discover a lot of mathematics for themselves.
>
> . . . .
>
> In many junior high schools, experimentation is going on that will shape the future of junior high school mathematics. Some of these schools have clubs that encourage the members to explore mathematics on their own. Some have computers of various types and desk calculators in mathematics laboratories. Simple flow charting is appearing in some of the textbooks. Small pamphlets written for the junior high level are also available on many mathematical topics.
>
> In the junior high mathematics laboratories, teachers are using concrete materials to help students discover generalizations. Classes are being broken down into small sections so that real discussion can take place and all students have the opportunity to express their ideas (19, pp. 384-386).

Easterday in searching for an answer to his question, "What teaching techniques will best implement a noncollege preparatory program of mathematics?" (17, p. 519), concluded that there is no one answer. He believes that students must be guided "orally" through materials broken down into a "logical sequence of very small steps." This fits in well with Proctor's observation:

> Slow learners have poor memories. We try to reduce the number of facts they must remember by helping them

develop the ability to use the facts they know to arrive quickly at unknown facts (40, p. 121).

Learning mathematics involves a certain amount of "practice", which according to Morton (36) is a more respectable term than "drill". He maintains,

> There is no research which indicates that we can dispense with practice in arithmetic. There is sound psychological theory, on the other hand, which indicates that we must have practice. Also, there is research which tells us when the practice should come, something as to how it should be provided, and something as to the amount which is needed (36, p. 20).

Morton also gives as the main problem with drill or practice in the traditional school the fact that drill and practice come before meanings have been developed. Such drill provided too early causes a loss of effectiveness. "Drill should follow, not precede, the development of meaning" (36, p. 21).

Morton also advocates the use of games to stimulate practice. He cautions, however, that the child's interest may be in the game more than in the arithmetic. He points out that even though the game stimulates his interest in arithmetic, there is no guarantee that the game will increase the child's understanding of the subject (36, p. 23). What is being pointed out here is that research has found that teachers must select games with discrimination and must remain alert to the effects on the individual members of the group.

"New Math" and the Low Achiever

The "new mathematics programs" have not answered the needs of the under achievers in the elementary and secondary schools (48). Of these programs, Allendoefer says

> The first major change of the current mathematical revolution is to put emphasis on teaching with understanding in place of rote learning.
>
> This involves four steps: intuition, organization, deduction, application (1, p. 11).

However, many parents and patrons find the most noticeable change in mathematical education is the use of unfamiliar language. It has been found, also, that most teachers have made only those changes which are essential for precise statements of mathematical ideas (1).

Spitzer in writing about the new programs said,

> Critical analysis of the new programs has also revealed rather widespread misinterpretation of their general function. The erroneous belief is held that these new programs represent something distinctly new and superior which, when substituted for but not incorporated into the old programs, results in a panacea for all the problems of arithmetic instruction. Actually, the original purpose of all the new programs has been to experiment with untried procedures and new content for the purpose of improving current programs (48, p. 14).

Elkind said of the "New Math,"

> In building materials for the New Math, it was hoped that the construction of a new (precise) language would facilitate instruction of set concepts . . . . It is likely that the new language created to teach the set concepts failed because it was geared to the logic of adults rather than to the reasoning of children. Attention to the research on children's thinking carried out (by Piaget) might have helped to avoid some of the difficulties of the "New Math" program (18, p. 59).

In 1959 the School Mathematics Study Group stated as part of their goal,

> . . . For the less capable student, our goal is a mastery and an understanding of as many mathematical skills as the student is capable of, and at the same time an understanding of the nature of mathematics and of the role of mathematics in our society (44, p. 1).

As can be seen from some of the observations just noted, there are many who question this goal and even more who doubt that it has been reached by the new program.

In 1973, the president of the National Council of Mathematics Teachers in a discussion of the "reform movement" called attention to the assumption made by many that the average and low achiever should have the same mathematics as the college-bound student. These students should receive this program, however, at a slower pace or at a more advanced age and grade level. Many supervisors and teachers have proudly announced, "We teach only good mathematics." In this case "good" means the courses in the college-preparatory sequence. Much concern that reflects doubts of the validity of this assumption is developing. There is a quickening of interest around the country in designing mathematics programs that will attract and be useful to the non-college-bound student (39, 45).

At the end of the summer of 1973 the National Science Foundation (NSF) began phasing out its in-service, academic year, and summer institutes as we have known them over the past twenty years. New activities of NSF on a severely reduced budget will involve closer work with given school systems to implement new programs or programs developed over the past two decades. Their efforts will be directed more toward helping teachers in their classrooms to make desirable changes, rather than having teachers come to institute programs which may or may not affect the ways they teach and the students with whom they come into contact (39).

Carpenter (6) calls attention to the National Assessment of Educational Process' report in the answer to his question: "What do these NAEP data say about the effect of 'new mathematics' programs?" After all, the 13-year-olds and 17-year-olds could have been taught throughout their school experience in new mathematics classrooms. If the critics of the new mathematics were correct, the computational skills of these age groups would be very low. In fact, the data show that 13-year-olds can do about as well as adults on most computational tasks, and 17-year-olds can do better. It must be remembered that the adult population would not have been affected by exposure to new mathematics programs.

Grouping for Individualized Instruction

Evidence available from general aptitude, special aptitude, and achievement tests, along with observations by highly skilled teachers of arithmetic, leads to the conclusion that not all pupils have the ability to master arithmetic skills according to a set schedule (30) yet, quite frequently, all pupils in any given class are taught the same arithmetic principles and processes simultaneously.

Keffer observed,

> Readiness to learn is determined largely by the sum of all the characteristics which make an individual more likely to respond positively in terms of the learning situation. It involves the pupil's mental equipment, his goals and needs, and his learned ideas and skills (30, p. 248)

Of individual differences, Jarvis said,

> The fact that there exists in the elementary school a wide range of individual differences in the area of arithmetic is an incontestable fact. The teacher cannot and should not seek to eliminate them. But what he does to meet these individual needs once they have been identified is the important issue and should be the goal which good arithmetic teaching is directed (26, p. 473)

In an experiment involving ability grouping in arithmetic classrooms, Provus' findings (41) were generally in favor of ability grouped classes. There was, however, a differential effect in which the more competent pupils profited most from ability grouping.

Wallen and Vowles (51) found that during the course of one year, no significant difference in achievement for grouping and non-grouping procedures was evident.

Henderson (24) pointed out that individualized instruction is not new. An individualized program was instituted into the public schools of Pueblo, Colorado, in 1890. An attempt was made in 1898 to individualize instruction by homogeneous grouping in Batavia, New York. In 1919 the Winnetka non-graded approach was initiated in Winnetka, Illinois. In 1920 the Dalton Plan, which involved giving an assignment with a specific amount of time to complete it, was used. This was an old version of the modern contract plan.

Duker (15) cautioned that individualized instruction should not be allowed to become isolated instruction. There should always be provisions made for sharing with the group as a whole and for opportunities to work with others in small or large temporary groups made up of peers who have similar needs.

McDonald (33) gave several points in favor of, or reasons for using, programmed instruction:

1. Each student progresses at his own rate . . . .
2. Classroom interruptions needn't halt class momentum as a class . . . .
3. Those who learn fast are not held up by the slower learners . . . .
4. Slower learners are not competing in the usual sense with the faster learners . . . .
5. In an extensive continuum of individualized learning materials, students of varying abilities and backgrounds can be accommodated within a single classroom at the same time . . . .
6. If a class interruption occurs, it invariably interrupts the teacher's work with a <u>single</u> student . . . .
7. Lecturing and preparing demonstrations are out . . . .
8. The program runs itself . . . .

He continues with a list of inherent difficulties with programmed instruction:

1. The student is on his own . . . .
2. The materials must teach . . . .
3. The student still must read, and if not read, he still must make mental connections between pictures, examples and diagrams that require mental activity at a level of difficulty on a par with reading . . . .
4. The teacher is asked over and over to "explain" the same concepts to various students--but at <u>different</u> times . . . .

5. What happens when several students stop working and desire different explanations at the same time? . . .
6. What is done with students who finish the program in the middle of a semester? . . .
7. Some teachers miss teaching, especially in the remedial class where this individualized format is most prevalent . . .
8. Students learn at their own "natural" rates. Yes, this could be considered a disadvantage; for what is one's own natural rate and is it acceptable (and if so, acceptable to whom)? . . . (33, pp. 575-576)

Newman and Seiser (37) contend that the ideal situation for individualizing instruction is on a tutorial basis. They also maintain that textbooks, curriculum materials, and teacher preparation that are oriented to the average pupil have little specific provision for the mathematically disadvantaged pupil.

Dewar's research in grouping for arithmetic instruction in the sixth grade (11) revealed that in actual practice individual differences are not being met in many cases. He found that in areas other than reading there is little in the literature that clearly defines provisions for differences. Recognized authorities agree that an essential element in a good arithmetic instruction program is the provision for differences in learning ability, but these authorities cannot agree as to the best means of providing for these differences. Spitzer, for example, is not convinced that the three-group method within the classroom is the answer to the problem (47).

Dewar, in his search of the literature found,

> Research evidence on the effectiveness of grouping in arithmetic instruction is scanty. I found five studies, completed between 1947 and 1959, addressed to this problem at the elementary school level. The studies included dissertations by Hamilton (23), Petty (38), and

and Spence (46), and, as a result of Petty's investigation, a publication in 1959 by the Cassis School faculty in Austin, Texas (8). Donald Durrell gave some attention to this area in a study on the adaption of instruction to the needs of children in the intermediate grades (16). None of these studies produced definitive results on the benefits the children derived from grouping for arithmetic instruction (11, p. 124).

In Dewar's own study he attempted to determine whether children benefit from grouping within the classroom for instruction in arithmetic. The major problem of the study was to determine whether pupils who receive instruction in arithmetic on their own level of achievement in a three-group organization within their classroom would show significantly better achievement than pupils who received instruction by the traditional whole-class organization. Results of the Stanford Achievement Test in arithmetic, along with teacher judgement, served as a method of dividing the experimental class into three groups for the purpose of instruction. The control group classes were divided into three groups in a similar manner for purposes of statistical analysis only, not for instruction.

A curriculum outline for each of the three groups in the experimental classes was prepared for the use and guidance of the teachers. Teachers of the control classes taught the whole class using the standard sixth-grade arithmetic curriculum. All classes used the World Book Company's <u>Growth in Arithmetic</u> series textbook materials.

The <u>t</u> test was applied to the pre-test scores with no significant difference being revealed, nor was there a significant difference in intelligence data. Comparison of post test means, however, revealed a significant gain in two of the three groups under study at the .05 level of confidence. The two groups which showed significant benefits from this type of organization were the high-achieving and the low-achieving groups in the population studied.

The results of an opinionaire of the teachers involved in the study indicated that the teachers could see more and better learning occurring in the grouped classes. The teachers generally agreed that although grouping for instruction took more time for planning, the actual instruction under this organization was no more difficult than under the whole-class method.

Students who were in the grouped instruction classes revealed in an opinionaire that "(1) the teacher had more time to help pupils, (2) there was no necessity to wait for slower pupils, (3) better understanding was accomplished, (4) fuller meaning was had under this system, and (5) more was learned" (11, p. 127).

Duker's summation of individual needs and ways to meet these needs was

> Any innovation that purports to meet the needs of individual students in American Education today must take into account the increasing demand that educational experiences be revelant. To assure revelance, all teachers must be past masters at accurate diagnosis of individual levels of achievement, rates of development, cultural backgrounds and personal patterns of cognitive development. Teachers must also be aware of educational alternatives so that the choices they make will be eminently appropriate in individual learners (15, p. 41).

Special Teaching Situations

The teaching strategy that focuses on a particular situation or incident might be termed situational teaching (25). In the use of this strategy students are asked to analyze the situation mathematically and, in the course of this analysis, discover new mathematical generalizations and information. The thing that sets situational teaching apart from merely a study of word problems is the use of physical materials. Students are given concrete materials which are so constructed that when they are combined or manipulated properly, mathematical relationships become apparent. Such teaching situations where there is reliance on physical materials are referred to as mathematics laboratories.

In giving the students something to do the mathematics laboratory makes learning an activity and children are by their basic nature active. Most laboratories provide a way of minimizing the importance of computation during the initial stages of discovery by substituting materials for pencil and paper. Finally, the mathematics laboratory makes clear the use of mathematics in the world of application.

Most mathematics laboratories depend on carrying out manipulations in a series of progressive situations which direct attention to changing aspects within the situation. It must be remembered, however, that

1. The timing of laboratory experiences is crucial.
2. The timing of laboratory experiences should emphasize discovery, not confirmation.

3. The best mathematics laboratories allow the student to reach an end result in more than one way.
4. A good discovery sequence must include enough cases for complete generalization.
5. A mathematics laboratory must generate useful mathematics (25, pp. 86-96).

Of the constant testing in the laboratory approach Fremont (21) suggests that the regular approach of pretest, prescription, treatment, post test boggs the student and teacher down in a testing program. A program of diagnosis of student weaknesses through action rather than testing is suggested.

> Diagnosis through action not only keeps the emphasis where it belongs--on the learning of mathematics--but it also frees both the teacher and student from the tedium of constant test taking and making. Finding suitable activities is not easy, but such a collection can grow gradually over a period of time. Diagnosis through action is also rewarding activity. Let diagnosis be the place where the action is (21, pp. 325-326).

Copeland (9) called attention to several advantages of the mathematics laboratory approach, calling it "a recognition of the need for first-hand experience by each child with objects in his physical world". He also indicated a belief that real learning of mathematical ideas is best accomplished when such ideas are abstracted from the physical world. The relation of geometry to the physical world is less difficult to see than that of numbers:

> If learning is to be on an individual basis with actual rather than vicarious experience, a different physical arrangement from the traditional classroom is necessary. Also, a more permissive classroom atmosphere must exist. Children should be allowed to move about as they seek answers to questions.
>
> . . . .

> In the experience-centered, math laboratory approach to learning, books are also necessary. Their use, however, is as a resource material just as are other materials in the math laboratory. They are not the only basis for learning mathematics as is the case in many classrooms (9, pp. 271-283).

In answering her own question, "What can teachers do to make excitement and creativity happen every day in mathematics?" Kennedy (31) advocates letting the children be creative. "They want to come up with new ideas and new ways of doing things, and they can." She admits that some of their ideas may be a bit "bizarre," but insists that "thinking and learning along with enjoying it is what education is all about".

Bitter and Mikesell (3) report that the enthusiasm which the teachers develop from finding that mathematics can be fun and that they can have the materials to make it fun, interesting, and revelant affects the childrens' attitude toward mathematics.

Newman and Seiser (37) made a study regarding a "floatiing teacher" program funded by ESEA, Title I. In this program the floating teacher offered tutorial help and remedial opportunities to pupils in small ungraded groups. The separate classroom used by this teacher came to be known as the mathematics laboratory. The length of time that pupils participated in the program varied according to need. The majority of teachers and principals associated with the program reported favorable reactions to the project. It was recommended that other studies be made to determine causes and cures for the educationally disadvantaged children.

Other Studies

Chandler (7) estimated that at least thirty percent of our elementary and secondary school students are either culturally deprived, socially disadvantaged, below-average achievers, or educationally disadvantaged. He stated that every school in the United States, whether rural or suburban, has pupils who are not achieving as expected. Most of the efforts, time, and money spent in recent years on mathematical instruction has been directed to average and above-average students.

The challenge to develop mathematics materials for low achievers was accepted by the Board of Directors of the National Council of Teachers of Mathematics after reviewing proposals presented to them by the Committee for the Non-College-Bound. The project became known as Experiences in Mathematical Ideas (EMI). This project centered on designing materials for students and teachers that would provide mathematical concepts to low achievers in grades five through eight. Experiences that grew out of the student's physical environment and developed through an assortment of teaching strategies which would often end in laboratory-oriented activities were provided.

The EMI project was carefully structured within a framework that included certain assumptions and beliefs. These characteristics included activity, individuality, success, meaning, and novelty. The units in the EMI project did not include complete mathematics programs for the low achievers. They were not intended solely for supplementary or enrichment purposes. The units did offer a model for teaching representative segments of mathematics usually taught to meet the needs of all students. The units were independent of each other.

In the Plus Program (42) a staff of skilled teachers was employed to teach remedial mathematics to small groups of students of a specified target area of Buffalo, New York. This project served students in grades one through eight in inter-city neighborhoods. In the school year 1966-1967 there were 2,210 pupils in the program, but enrollment had increased to 2,419 pupils in 1967-1968. The evaluation of the 1967-1968 school year's program showed a mean gain of nine months in mathematics during the eight months period between testing.

The objectives of the mathematics program were

1. To aid the classroom teacher in achieving the best mathematics program for her class.
2. To provide help for the classroom teacher in diagnosing and giving remedial assistance to students having poor achievement in mathematics.
3. To teach number concepts and operations and problem solving through small group instruction and to improve work and study habits (42, p. 145).

To meet the stated objectives, teachers trained as remedial mathematics instructors provided assistance on a tutorial basis to groups of no more than six children at one time. The remedial classes were designed to corrective rather than developmental.

Remedial teachers and classroom teachers worked closely in designing coordinated programs of activities. Manipulative materials were used where possible to give concrete examples of how numbers work. These manipulatives, which were selected by the teacher to fit the level of instruction, could be chosen from seventy-eight different visual items. In addition each teacher had available filmstrips and overhead transparancies along with appropriate equipment to utilize them. Many teachers supplemented the materials supplied with their own ideas to develop additional items.

Structured in-service training for all teachers at the beginning of the school year followed by monthly in-service training programs helped facilitate communications. The small groups which allowed for a great deal of individual attention enabled teachers to diagnose better the needs of each individual child and to develop specific mathematics skills required in each case. The instruction thus was geared to the child's own ability. With more successful experiences, a positive change of attitude was noted in many cases. Those too shy to participate in regular classroom discussions had more opportunities to do so in small groups.

Lach, (32), in a study of comparison between two seventh-grade mathematics classes, attempted to determine the effectiveness of programed workbooks used in conjunction with a conventional textbook to replace a portion of the teacher-led discussion in mathematics classes. The workbook used was designed specifically by the publishers of the textbook to be used along with the basic text.

The term "programed" indicated in this study that many of the exercises had been broken down into small steps to help students understand how to proceed with typical problems, and that correct responses were supplied on the page following a given item to help the students check their learning.

The teaching method used with the experimental group using the programed workbooks consisted of a short discussion, checking and explanation of assigned problems, presentation of new topics, and individual work in the programed workbooks. During the individual work period the teacher provided remedial help for students having difficulties and encouragement for the more able pupils.

The teaching method of the control group consisted of class discussion, checking and explanation of assignments, presentation of new topics, and teacher-led group work on exercises pertaining to the new topics. Supervised study was allowed during available time.

The comparison of the two methods ran from October through the end of March with the instructional approach as the only difference in the groups. Comparisons of the means of pretest vs. post test were made. One group was matched by sex and pretest scores while the other group was matched by sex and IQ scores. The results of the comparison of pretest and post-test scores of the group matched by sex and pretest scores showed a difference in favor of the experimental group. The difference was significant at the .05 confidence level. The results on the group matched by sex and IQ scores showed a difference in favor of the experimental group, but this difference was not significant at the .05 confidence level.

On the basis of this limited study it would appear that programed workbooks can be used effectively along with conventional textbooks to provide time for partially individualized instruction. Additionally, in the experimental classes the teacher had more time to attempt to develop attitudes and interests. This might be considered one of the most significant contributions of the programed workbooks program.

Riedesel (43) found that a variety of researchers had studied the "meaning method". The majority of studies were remarkably consistant in their findings. Typically, researchers found that rote rule and meaning produce about the same results when immediate computational ability is used as a criterion. When retention was used as a criterion, the meaning method was superior to the rote rule method. Greater transfer was facilitated by the meaning method, and this method produced greater understanding of mathematical principles and comprehension of complex analysis.

In an experiment regarding reviews and their effect on retention, Gay (22) attempted to find the interval best suited for review of mathematical rules to secure maximum retention.

It was found that review one and seven days after learning gave significantly better results than reviews placed one and two, or six and seven days after original learning.

The Use of Calculators in Mathematics Instruction

The National Council of Teachers of Mathematics has adopted a policy statement supporting the use of the mini-calculator as a "valuable instructional aid" that should be used "in imaginative ways to reinforce learning and to motivate the learner as he becomes proficient in mathematics" (14, p. 55). The National Association of Secondary School Principals agrees with this stand in stating that the mini-calculators should be viewed "not as a technological curiosity, but as an essential implement in the newest mathematics (14, p. 55).

Critics, however, argue that students, especially at the elementary level might become so dependent on calculators that they will forget or fail to learn basic computational skills. Proponents contend that minicalculators can be a significant force in moving schools away from "answer-orientated instruction," thus freeing teachers and students for concentration on more important underlying concepts (13, p. 12).

Regardless of arguments against the use of pocket calculators, the Board of Education in Berkeley, California agreed to submit a fifty-one-thousand-dollar request to the

National Science Foundation for funds to equip mathematically handicapped seventh and eighth-grade students with pocket calculators. The idea drew national attention, along with sharp retorts from The Chicago Tribune and others, including several university professors. The National Science Foundation turned down the request.

Be that as it may, pocket calculators have been employed in at least one experimental project at the elementary level and, claim those involved, students using the calculators performed "with good success" (13, p. 12).

The program, which included fifty-five sixth-grade students at South Colonie, New York, Village School, and Citizen Genet Middle School, in East Greenbush, New York, aimed at reinforcing basic mathematical skills among a heterogeneous grouping of low-, medium-, and high-ability pupils. The results were better test scores, higher student interest, and greater comprehension, according to state officials and teachers in the project.

> The calculators had a positive motivational influence which lasted pretty much throughout the year", reports Frank Hawthorne, assistant commissioner for instructional services at the New York State Education Department. "The children explored many topics not usually studied in depth in Grade 6: probability, sequences, series, palindromes, negative integers, divisibility, prime numbers, and an endless variety of puzzle-type math problems. (13, pp. 14).

At the end of the school year the students who had used the calculators were tested without their calculators. Their scores were compared with scores of a similar group of students who had never used the devices. The experimental group averaged 2.3 more correct responses on a sixty-seven-question exam. In a later test, when the experimental group was allowed to use calculators, they scored even higher in comparison to the group that had not used them.

The few that have tried minicalculators in the classroom seem convinced that they represent a genuine breakthrough for weaker pupils.

Summary

The foregoing study of the literature in mathematics for the under-achiever in the middle grades of public and private schools of the United States indicates that most of the research and programs relative to mathematics for this type of pupil are still in the formative stage. Although the special needs of these pupils have been recognized for many years, educators have just in the past several years began to put the full weight of their knowledge and expertise to work in search of a solution to the problem.

Remedial programs should be planned and organized for the individual student; however, there are some common elements among all programs of remediation. One important subset of the goals of any program should deal with those knowledges and skills that all individuals need to manage their personal affairs, to operate effectively as a member of a complex society, and to perform acceptably at some entry level in the job market.

A new element has thrust itself upon the scene of mathematics instruction. This is the minicalculator, which is now available in the price range of almost all socio-economic groups. Its effect on the teaching of mathematics and the learning process is yet to be evaluated. The leaders of several educational and mathematical organizations have stated their support of the use of these calculators in the educational programs of students at all levels. However, the importance of emphasis on pupil development over pupil achievement has been stressed by those who support the inclusion of these devices as educational tools.

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CHAPTER III

METHOD OF PROCEDURE

The purpose of this chapter is to set forth the procedures used in conducting the study.

Design of the Study

This study involved a total of 338 remedial mathematics students attending six elementary and two junior high schools in the North Central Texas area. The students were enrolled in grades five, six, seven, and eight during the first semester of school year 1975-1976. A set of 161 remedial mathematics students received instruction in mathematics in a clinical remedial program. Another set of 177 remedial mathematics students received instruction in mathematics as subsets of a regular mathematics classroom. All of the students involved in the study were enrolled during the entire semester.

The purpose of this study was to compare the gains made in mathematical skills of remedial mathematics students receiving instruction in the clinical remediation situation with the gains of remedial mathematics students who received instruction in a classroom remediation situation. The experiment was concerned with making a comparison of mathematical skills development, which included computation, concepts, problem solving, and total composite mathematics resulting from these two types of remediation. The study involved the comparison of the difference of the means of the test scores, made by the remedial mathematics students on the mathematics subtests of the Metropolitan Achievement Tests after the influence of IQ scores and pretest scores had been removed.

The nonequivalent control group design was used in the study.

$$\frac{O_1 \; X_1 \; O_2}{O_3 \; X_2 \; O_4}$$

The following time-table for testing was used:

The week of September 1, 1975, was selected for administering pretests. The Metropolitan Achievement Test, Form F, intermediate, was used for grades five and six; the advanced level of the same test was used for grades seven and eight.

The week of September 22, 1975, was selected for administration of the Otis-Lennon Mental Ability Test to all students involved in the study.

The week of January 26, 1976, was selected for administering post-tests. The Metropolitan Achievement Test, Form H, intermediate, was used for grades five and six; the advanced level of the same test was used for grades seven and eight.

Description of Remedial Mathematics Programs

The clinical Remedial mathematics program is characterized by providing remedial instruction in mathematics to small groups of students--eight in each class for grades five and six; twelve in each class for grades seven and eight. This program provides an opportunity for the student to work in an individualized situation, each working at his own level and to meet his individual needs with personal guidance from the teacher. Each student is encouraged to work independently and receives instruction and motivation to achieve the goals established for his grade level. An environment is maintained that is conducive to the student's exercising initiative in his learning process.

Each child practices a variety of techniques every day. Activities are directed toward concept development, computational skills, and problem solving with emphasis on relevancy to the daily lives of the students. This instruction is given outside the regular classroom in a room where no other subject is taught during the day. In this room concrete materials, math games, skill kits, and special audio-visual materials are available for student and teacher use.

Inventory tests, based on the skills that students should have internalized in previous grades, are given to each student along with other diagnostic tests, both commercial and teacher-made. The results of these tests are used to indicate shortcomings in mathematical skills and as indicators for remediation needs. The Spectrum series of ungraded mathematics workbooks is used to reinforce the concepts being taught and for practice in need areas identified by the diagnostic tests.

Students selected for this clinical remediation are those who need special help and have the potential to improve. Selection is made after careful study of the student's cumulative records, achievement test scores, and classroom teacher recommendation. Each student in grades five and six receives forty-five minutes of instruction with students in grades seven and eight receiving fifty-five minutes of instruction each school day. The program is limited to students whose mathematical performance is six months or more below expectancy and whose recorded IQ score does not fall below eighty.

The small groups allow for a greater amount of individual attention, thus enabling teachers to diagnose better the specific mathematics skills required in each case. The instruction is thus geared to the child's own ability. Those children too shy to participate in regular classroom discussions have more opportunity to do so in the clinical remediation program.

In the classroom remedial mathematics program the teacher works with the remedial students as a sub-group of the regular class. Teacher-made diagnostic tests are used with these students to discover specific weaknesses and as indicators for remedial needs. The teaching strategies used with these remedial mathematics pupils are not significantly different from those used with pupils in the regular mathematics program. The Holt, Rinehart and Winston series is used as the text for grades five and six, with the Addison-Wesley series being used for grades seven and eight.

The instruction for these remedial mathematics students takes place within the regular mathematics classroom where other subjects are taught during the course of each school day. The teaching method for these students consists of class discussion, checking and explanation of assignments, presentation of new topics, and teacher-led group work on exercises pertaining to the new topics. Supervised study is allowed as time permits. Learning activities are limited to traditional approaches using pencil, paper, and chalkboard, with emphasis placed on basic computational practice. No special equipment or major adjustments are made in the room setting. The size of these instructional groups ranges from twenty-four to twenty-nine students, with flexible grouping utilized to provide for differences in the abilities of pupils.

Mathematics classes for grades five and six meet daily for forty-five-minute periods; classes for grades seven and eight meet daily for fifty-five-minute periods. The scope and depth of concept development moves at a slower pace for the remedial students than for other students in the regular mathematics program.

Although the instructional approach is different for the clinical remediation set and the classroom remediation set, the stated objectives for each grade level are the same. These objectives were developed cooperatively by administrators, supervisors, and the teachers of remedial mathematics students.

Teachers of Remedial Mathematics

The teachers for the remedial mathematics clinics were selected on the basis of their positive attitude toward remedial students, their having completed an above-average number of college credits in mathematics, and/or their amount of teaching experience. The range of college credits in mathematics for these teachers was from six to forty-eight hours. Teaching experience ranged from four to twenty-seven years.

The teachers for the classroom remediation units were selected on the basis of attitude, college credits in mathematics, and/or teaching experience. The range of college credits in mathematics for these teachers was from six to thirty-two hours. Teaching experience ranged from five to thirty-eight years.

The teachers in the mathematics clinics were assigned six forty-five-minute periods daily in grades five and six with the teachers of grades seven and eight assigned five fifty-five-minute periods daily. These teachers taught only mathematics.

The work of these remedial mathematics teachers was supervised by their building principal, along with special assistance from a coordinator of mathematics. This remedial mathematics coordinator held a Master's degree in mathematics and had twenty-seven years of experience in teaching mathematics. Special in-service training for the remedial mathematics teachers was conducted by the coordinator on a weekly basis.

Evaluative Instruments

The mathematical sub-tests of the *Metropolitan Achievement Test*, Form F, were administered to all participating students at the beginning of the fall semester of 1975, and the same sub-tests of the *Metropolitan Achievement Test*, Form H, were administered at the end of the study in January of 1976. These are comprehensive tests designed for the threefold purpose of facilitating evaluation, measuring educational achievement, and diagnosing educational weaknesses. The tests are so designed that they may be used by teachers with a minimum of formal training in standardized testing and diagnostic procedures.

These tests provide a useful measure of mathematical computation, concepts, and problem solving, as well as a composite score for all three areas. The mathematical computation test is composed of forty items, each giving a choice among five answers including one choice indicating that the answer is not known. The mathematical concepts test is composed of forty items, each giving a choice among five answers including one choice indicating that the answer is not known. The mathematical problem solving test is composed of thirty-five items, each giving a choice among five answers including one choice indicating that the answer is not known. These tests are designed to reveal strengths and weaknesses in the several general areas of mathematics.

The _Otis-Lennon Mental Ability Test_ served to provide information that was needed to help determine the student's mathematical expectancy. The various levels comprising these tests series have been designed to provide comprehensive, carefully articulated assessment of the general mental ability, or scholastic aptitude, of students. Emphasis is placed upon measuring the student's facility in reasoning and in dealing abstractly with verbal, symbolic, and figural test content sampling a broad range of cognitive abilities.

Population

The subjects selected for this study were fifth, sixth, seventh, and eighth grade students enrolled in six elementary and two junior high schools in the North Central Texas area. The clinical remediation set of 161 remedial mathematics students was matched as closely as practical limitations would allow with the classroom remediation set of 177 remedial mathematics students. Both sets of students were enrolled for the entire period of this study, August 18, 1975, to January 30, 1976. Students in these two sets were selected on the basis of grade level, IQ score, and mathematics achievement. The Warner Test of Social Class was applied to assure comparability of socio-economic status of the two sets of students. The results of this comparison are given in Table I.

Procedures for Treating Data

A one-way analysis of covariance was made, using the pretest scores and IQ scores as the covariates. A comparison was made of the achievement of students in the classroom remediation set with the achievement of students in the clinical remediation set by utilizing the raw test scores attained at each grade level in the four areas of computation, concepts, problem solving, and total composite mathematics. The .05 level of confidence was used as a basis for the acceptance or rejection of the hypotheses.

CHAPTER IV

ANALYSIS OF DATA

The major task of this study was to compare the mathematical gains of remedial mathematics students receiving instruction in a clinical remediation situation with the mathematical gains of remedial mathematics students receiving instruction in a classroom remediation situation. The problem of the study was to determine whether there was a significant difference between the gains in mathematical skills made by these two sets of remedial mathematics students.

The purpose of this chapter is to present the results of the statistical treatment employed to test each hypothesis. In order to facilitate a more complete interpretation, additional data analysis is presented and interpreted.

Pre-Experiment Analysis

Tests were used to insure that the two sets of students were as nearly comparable as possible. It is obvious, however, that the two sets of students did not start the semester with exactly the same amount of knowledge and the same level of general intelligence. The analysis of covariance was used in testing each hypothesis to control statistically the initial differences which were present and which might confound differences in achievement between the two sets of students.

The *t* test for independent samples was used to test for pre-existing differences in intelligence that were statistically significant prior to the experiment. Table II presents the pre-experimental data for the *Otis-Lennon Mental Ability Test*. This data revealed that there were no significant differences among the sub-sets being compared.

TABLE II

Pre-Experiment Analysis of the *Otis-Lennon Mental Ability Test* Scores

Set	Grade	N	ΣX	ΣX^2	$\bar{X}$	S D	*t*
Clinical Classroom	5 5	49 41	4411 3788	400064 352474	90.020 93.244	7.967 8.318	-1.8807
Clinical Classroom	6 6	31 43	2844 4004	263270 377893	91.742 93.116	8.862 11.001	-0.6897
Clinical Classroom	7 7	33 47	2998 4300	275198 394642	90.848 91.489	9.411 5.187	-0.3336
Clinical Classroom	8 8	48 46	4337 4261	394711 398135	90.354 92.630	7.780 8.739	-1.3044

The *t* test for independent samples was used to test for pre-existing differences in the total composite mathematics grade placement that were statistically significant prior to the experiment. Table III presents the pre-experimental data for the *Metropolitan Achievement Test*, Form F. This data revealed that there were no significant differences among the sub-sets being compared.

TABLE III

Pre-Experimental Analysis of the Metropolitan Achievement Test, Form F, Total Composite Mathematics Grade Placement

Set	Grade	N	ΣX	ΣX^2	$\bar{X}$	s^2	*t*
Clinical	5	49	179.0	665.14	3.653	0.239	-1.165
Classroom	5	41	156.7	608.69	3.822		
Clinical	6	31	141.2	654.24	4.555	0.665	-0.406
Classroom	6	43	199.2	959.62	4.633		
Clinical	7	33	157.9	779.43	4.785	0.660	+0.092
Classroom	7	47	224.1	1096.14	4.768		
Clinical	8	48	249.7	1334.45	5.202	0.841	-0.910
Classroom	8	46	247.2	1370.34	5.374		

Testing the Hypotheses

Hypothesis 1

Hypothesis 1 stated that there would be no significant difference between the means of the fifth-grade clinical remedial set and the fifth-grade classroom remedial set in mathematical computation on the Metropolitan Achievement Test, intermediate. Data showing the composite of this sub-set are given in Table IV. A one-way analysis of covariance using the IQ scores and pretest scores as covariates was employed to determine if there was a significant difference between the adjusted means of the fifth-grade clinical set and the fifth-grade classroom set. At the .05 level of confidence, using the appropriate number of degrees of freedom, an F score of 3.954 is required for significance. The adjusted means of the posttest scores were 14.8613 for the clinical set and 13.7268 for the classroom set. As shown in Table IV, the calculated value of F was 1.2464. Based on the calculated value of the statistic, the null hypothesis was not rejected. Therefore, there was no significant difference between the means of the fifth-grade clincial set and the fifth-grade classroom set in mathematical computation.

Hypothesis 2

Hypothesis 2 stated that there would be no significant difference between the means of the fifth-grade clincial remedial set and the fifth-grade classroom remedial set in mathematical concepts on the Metropolitan Achievement Test, intermediate. Data showing the composite of this sub-set are given in Table IV. A one-way analysis of covariance using the IQ scores and pretest scores as covariates was employed to determine if there was a significant difference between the adjusted means of the fifth-grade clinical set and the fifth-grade classroom set. At the .05 level of confidence using the appropriate number of degrees of freedom, an F score of 3.954 is required for significance. The adjusted means of the posttest scores were 11.2781 for the clinical set and 12.7164 for the classroom set. As shown in Table IV, the calculated value of F was 2.9714. Based on

TABLE IV

SUMMARY TABLE FOR GRADE FIVE, METROPOLITAN ACHIEVEMENT TEST
POSTTEST, FORM H OVER PRETEST, FORM F

Condition	Set	Source of Variation	Criterion			df	Sum of Squares	Mean Square	F	p
			Obtained		Adjusted					
			M	SD	M					
Computation	Clinical	. .	14.2041	4.7740	14.8613	. .	. .	. .	. .	. .
	Classroom	. .	14.5122	5.2731	13.7268	. .	. .	. .	. .	. .
		Between	. .	. .	. .	1	25.0854	25.0854	1.2464	0.2673
		Within	. .	. .	. .	86	1730.8784	20.1265	. .	. .
		Total	. .	. .	. .	87	1755.9639	. .	. .	. .
Concepts	Clinical	. .	11.1224	4.2848	11.2781	. .	. .	. .	. .	. .
	Classroom	. .	12.9024	4.3232	12.7164	. .	. .	. .	. .	. .
		Between	. .	. .	. .	1	44.1182	44.1182	2.9714	0.0883
		Within	. .	. .	. .	86	1276.9053	14.8477	. .	. .
		Total	. .	. .	. .	87	1321.0234	. .	. .	. .
Problem Solving	Clinical	. .	9.8571	4.2328	10.1816	. .	. .	. .	. .	. .
	Classroom	. .	11.8293	5.3661	11.4415	. .	. .	. .	. .	. .
		Between	. .	. .	. .	1	34.0112	34.0112	1.9358	0.1677
		Within	. .	. .	. .	86	1510.9734	17.5695	. .	. .
		Total	. .	. .	. .	87	1544.9846	. .	. .	. .
Total Composite	Clinical	. .	35.1633	11.4152	36.5517	. .	. .	. .	. .	. .
	Classroom	. .	39.2439	12.7765	37.5844	. .	. .	. .	. .	. .
		Between	. .	. .	. .	1	22.6875	22.6875	0.2319	0.6314
		Within	. .	. .	. .	86	8415.2148	97.8513	. .	. .
		Total	. .	. .	. .	87	8437.9023	. .	. .	. .

*Significant at the .05 level of confidence.

the calculated value of the statistic, the null hypothesis was not rejected. Therefore, there was no significant difference between the means of the fifth-grade clinical set and the fifth-grade classroom set in mathematical concepts.

Hypothesis 3

Hypothesis 3 stated that there would be no significant difference between the means of the fifth-grade clinical remedial set and the fifth-grade classroom remedial set in mathematical problem solving on the Metropolitan Achievement Test, intermediate. Data showing the composite of this sub-set are given in Table IV. A one-way analysis of covariance using the IQ scores and pretest scores as covariates was employed to determine if there was a significant difference between the adjusted means of the fifth-grade clinical set and the fifth-grade classroom set. At the .05 level of confidence using the appropriate number of degrees of freedom, an F score of 3.954 is required for significance. The adjusted means of the posttest scores were 10.1816 for the clinical set and 11.4415 for the classroom set. As shown in Table IV, the calculated value of F was 1.9358. Based on the calculated value of the statistic, the null hypothesis was not rejected. Therefore, there was no significant difference between the means of the fifth-grade clinical set and the fifth-grade classroom set in mathematical problem solving.

Hypothesis 4

Hypothesis 4 stated that there would be no significant difference between the means of the fifth-grade clinical remedial set and the fifth-grade classroom remedial set in total composite mathematics on the Metropolitan Achievement Test, intermediate. Data showing the composite of this subset are given in Table IV. A one-way analysis of covariance using the IQ scores and pretest scores as covariates was employed to determine if there was a significant difference between the adjusted means of the fifth-grade clinical set and the fifth-grade classroom set. At the .05 level of confidence using the appropriate number of degrees of freedom, an F score of 3.954 is required for significance. The adjusted means of the posttest scores were 36.5517 for the clinical set and 37.5844 for the classroom set. As shown in Table IV, the calculated value of F was 0.2319. Based on the calculated value of the statistic, the null hypothesis was not rejected. Therefore, there was no significant difference between the means of the fifth-grade clinical set and the fifth-grade classroom set in total composite mathematics.

Hypothesis 5

Hypothesis 5 stated that there would be no significant difference between the means of the sixth-grade clinical remedial set and the sixth-grade classroom remedial set in mathematical computation on the Metropolitan Achievement Test, intermediate. Data showing the composite of this subset are given in Table V. A one-way analysis of covariance using the IQ scores and pretest scores as covariates was employed to determine if there was a significant difference between the adjusted means of the sixth-grade clinical set and the sixth-grade classroom set. At the .05 level of confidence using the appropriate number of degrees of freedom, an F score of 3.980 is required for significance. The adjusted means of the posttest scores were 19.4254 for the clinical set and 17.6235 for the classroom set. As shown in Table V, the calculated value of F was 2.9537. Based on the calculated value of the statistic, the null hypothesis was not rejected. Therefore, there was no significant difference between the means of the sixth-grade clinical set and the sixth-grade classroom set in mathematical computation.

Hypothesis 6

Hypothesis 6 stated that there would be no significant difference between the means of the sixth-grade clinical remedial set and the sixth-grade classroom remedial set in mathematical concepts on the Metropolitan Achievement Test, intermediate. Data showing the composite of this sub-set are given in Table V. A one-way analysis of covariance using the IQ scores and pretest scores as covariates was employed to determine if there was a significant difference between the adjusted means of the sixth-grade clinical set

TABLE V

SUMMARY TABLE FOR GRADE SIX, METROPOLITAN ACHIEVEMENT TEST POSTTEST, FORM H OVER PRETEST, FORM F

Condition	Set	Source of Variation	Criterion Obtained M	Criterion Obtained SD	Criterion Adjusted M	df	Sum of Squares	Mean Square	F	p
Computation	Clinical	. .	19.0323	4.1832	19.4254	. .	. .	. .	. .	. .
	Classroom	. .	17.9070	5.8221	17.6253	. .	. .	. .	. .	. .
		Between	. .	. .	. .	1	57.6682	57.6682	2.9537	0.0901
		Within	. .	. .	. .	70	1366.6748	19.5239	. .	. .
		Total	. .	. .	. .	71	1424.3430	. .	. .	. .
Concepts	Clinical	. .	16.7097	5.0080	17.1977	. .	. .	. .	. .	. .
	Classroom	. .	16.8372	6.0156	16.4854	. .	. .	. .	. .	. .
		Between	. .	. .	. .	1	9.0474	9.0474	0.6132	0.4363
		Within	. .	. .	. .	70	1032.8730	14.7553	. .	. .
		Total	. .	. .	. .	71	1041.9204	. .	. .	. .
Problem Solving	Clinical	. .	15.6129	5.0641	15.4875	. .	. .	. .	. .	. .
	Classroom	. .	13.7674	5.4895	13.8578	. .	. .	. .	. .	. .
		Between	. .	. .	. .	1	47.2949	47.2949	2.3511	0.1297
		Within	. .	. .	. .	70	1408.1404	20.1163	. .	. .
		Total	. .	. .	. .	71	1455.4353	. .	. .	. .
Total Composite	Clinical	. .	51.3548	10.8492	52.2792	. .	. .	. .	. .	. .
	Classroom	. .	48.5116	14.8859	47.8452	. .	. .	. .	. .	. .
		Between	. .	. .	. .	1	351.7227	351.7227	4.5757	0.0359*
		Within	. .	. .	. .	70	5380.7695	76.8681	. .	. .
		Total	. .	. .	. .	71	5732.4922	. .	. .	. .

*Significant at the .05 level of confidence.

and the sixth-grade classroom set. At the .05 level of confidence using the appropriate number of degrees of freedom, an F score of 3.980 is required for significance. The adjusted means of the posttest scores were 17.1977 for the clinical set and 16.4854 for the classroom set. As shown in Table V, the calculated value of F was 0.6132. Based on the calculated value of the statistic, the null hypothesis was not rejected. Therefore, there was no significant difference between the means of the sixth-grade clinical set and the sixth-grade classroom set in mathematical concepts.

Hypothesis 7

Hypothesis 7 stated that there would be no significant difference between the means of the sixth-grade clinical remedial set and the sixth-grade classroom remedial set in mathematical problem solving on the *Metropolitan Achievement Test*, intermediate. Data showing the composite of this subset are given in Table V. A one-way analysis of covariance using the IQ scores and pretest scores as covariates was employed to determine if there was a significant difference between the adjusted means of the sixth-grade clinical set and the sixth-grade classroom set. At the .05 level of confidence using the appropriate number of degrees of freedom, an F score of 3.980 is required for significance. The adjusted means of the posttest scores were 15.4875 for the clinical set and 13.8578 for the classroom set. As shown in Table V, the calculated value of F was 2.3511. Based on the calculated value of the statistic, the null hypothesis was not rejected. Therefore, there was no significant difference between the means of the sixth-grade clinical set and the sixth-grade classroom set in mathematical problem solving.

Hypothesis 8

Hypothesis 8 stated that there would be no significant difference between the means of the sixth-grade clinical remedial set and the sixth-grade classroom remedial set in total composite mathematics on the Metropolitan Achievement Test, intermediate. Data showing the composite of this subset are given in Table V. A one-way analysis of covariance using the IQ scores and pretest scores as covariates was employed to determine if there was a significant difference between the adjusted means of the sixth-grade clinical set and the sixth-grade classroom set. At the .05 level of confidence using the appropriate number of degrees of freedom, an F score of 3.980 is required for significance. The adjusted means of the posttest scores were 52.2792 for the clinical set and 47.8452 for the classroom set. As shown in Table V, the calculated value of F was 4.5757. Based on the calculated value of the statistic, the null hypothesis was rejected. Therefore, there was a significant difference between the means of the sixth-grade clinical set and the sixth-grade classroom set in total composite mathematics.

Hypothesis 9

Hypothesis 9 stated that there would be no significant difference between the means of the seventh-grade clinical remedial set and the seventh-grade classroom remedial set in mathematical computation on the Metropolitan Achievement Test, advanced. Data showing the composite of this sub-set are given in Table VI. A one-way analysis of covariance using the IQ scores and pretest scores as covariates was employed to determine if there was a significant difference between the adjusted means of the seventh-grade clinical set and the seventh-grade classroom set. At the .05 level of confidence using the appropriate number of degrees of freedom, an F score of 3.968 is required for significance. The adjusted means of the posttest scores were 14.9861 for the clinical set and 13.1374 for the classroom set. As shown in Table VI, the calculated value of F was 3.8616. Based on the calculated value of the statistic, the null hypothesis was not rejected. Therefore, there was no significant difference between the means of the seventh-grade clinical set and the seventh-grade classroom set in mathematical computation.

Hypothesis 10

Hypothesis 10 stated that there would be no significant difference between the means of the seventh-grade clinical remedial set and the seventh-grade classroom remedial set in mathematical concepts on the Metropolitan Achievement

TABLE VI

SUMMARY TABLE FOR GRADE SEVEN, METROPOLITAN ACHIEVEMENT TEST
POSTTEST, FORM H OVER PRETEST, FORM F

Condition	Set	Variation	Criterion Obtained M	Criterion Obtained SD	Criterion Adjusted M	df	Sum of Squares	Mean Square	F	p
Computation	Clinical	. .	15.1515	5.4550	14.9861	. .	. .	. .	. .	. .
	Classroom	. .	13.0213	4.0673	13.1374	. .	. .	. .	. .	. .
		Between	. .	. .	. .	1	65.4858	65.4858	3.8616	0.0531
		Within	. .	. .	. .	76	1288.8140	16.9581	. .	. .
		Total	. .	. .	. .	77	1354.2998	. .	. .	. .
Concepts	Clinical	. .	13.6970	4.6870	14.0998	. .	. .	. .	. .	. .
	Classroom	. .	15.1064	4.5599	14.8235	. .	. .	. .	. .	. .
		Between	. .	. .	. .	1	9.9961	9.9961	0.7238	0.3976
		Within	. .	. .	. .	76	1049.5754	13.8102	. .	. .
		Total	. .	. .	. .	77	1059.5715	. .	. .	. .
Problem Solving	Clinical	. .	12.1212	4.6888	12.0005	. .	. .	. .	. .	. .
	Classroom	. .	13.0213	4.2859	13.1060	. .	. .	. .	. .	. .
		Between	. .	. .	. .	1	23.4480	23.4480	1.5796	0.2126
		Within	. .	. .	. .	76	1123.1677	14.8443	. .	. .
		Total	. .	. .	. .	77	1151.6157	. .	. .	. .
Total Composite	Clinical	. .	41.2727	13.1203	41.2558	. .	. .	. .	. .	. .
	Classroom	. .	41.1489	10.3714	41.1608	. .	. .	. .	. .	. .
		Between	. .	. .	. .	1	0.1719	0.1719	0.0026	0.9596
		Within	. .	. .	. .	76	5065.1641	66.6469	. .	. .
		Total	. .	. .	. .	77	5065.3359	. .	. .	. .

*Significant at the .05 level of confidence

Test, advanced. Data showing the composite of this sub-set are given in Table VI. A one-way analysis of covariance using the IQ scores and pretest scores as covariates was employed to determine if there was a significant difference between the adjusted means of the seventh-grade clinical set and the seventh-grade classroom set. At the .05 level of confidence using the appropriate number of degrees of freedom, an F score of 3.968 is required for significance. The adjusted means of the posttest scores were 14.0998 for the clinical set and 14.8235 for the classroom set. As shown in Table VI, the calculated value of F was 0.7238. Based on the calculated value of the statistic, the null hypothesis was not rejected. Therefore, there was no significant difference between the means of the seventh-grade clinical set and the seventh-grade classroom set in mathematical concepts.

Hypothesis 11

Hypothesis 11 stated that there would be no significant difference between the means of the seventh-grade clinical remedial set and the seventh-grade classroom remedial set in mathematical problem solving on the Metropolitan Achievement Test, advanced. Data showing the composite of this sub-set are given in Table VI. A one-way analysis of covariance using the IQ scores and pretest scores as covariates was employed to determine if there was significant difference between the adjusted means of the seventh-grade clinical set and the seventh-grade classroom set. At the .05 level of confidence using the appropriate number of degrees of freedom, an F score of 3.968 is required for significance. The adjusted means of the posttest scores were 12.0005 for the clinical set and 13.1060 for the classroom set. As shown in Table VI, the calculated value of F was 1.5796. Based on the calculated value of the statistic, the null hypothesis was not rejected. Therefore, there was no significant difference between the means of the seventh-grade clinical set and the seventh-grade classroom set in mathematical problem solving.

Hypothesis 12

Hypothesis 12 stated that there would be no significant difference between the means of the seventh-grade clinical remedial set and the seventh-grade classroom remedial set in total composite mathematics on the *Metropolitan Achievement Test*, advanced. Data showing the composite of this subset are given in Table VI. A one-way analysis of covariance using the IQ scores and pretest scores as covariates was employed to determine if there was a significant difference between the adjusted means of the seventh-grade clinical set and the seventh-grade classroom set. At the .05 level of confidence using the appropriate number of degrees of freedom, an F score of 3.968 is required for significance. The adjusted means of the posttest scores were 41.2558 for the clinical set and 41.1608 for the classroom set. As shown in Table VI, the calculated value of F was 0.0026. Based on the calculated value of the statistic, the null hypothesis was not rejected. Therefore, there was no significant difference between the means of the seventh-grade clinical set and the seventh-grade classroom set in total composite mathematics.

Hypothesis 13

Hypothesis 13 stated that there would be no significance difference between the means of the eighth-grade clinical remedial set and the eighth-grade classroom remedial set in mathematical computation on the Metropolitan Achievement Test, advanced. Data showing the composite of this sub-set are given in Table VII. A one-way analysis of covariance using the IQ scores and pretest scores as covariates was employed to determine if there was a significant difference between the adjusted means of the eighth-grade clinical set and the eighth-grade classroom set. At the .05 level of confidence using the appropriate number of degrees of freedom, an F score of 3.950 is required for significance. The adjusted means of the posttest scores were 16.1926 for the clinical set and 16.7772 for the classroom set. As shown in Table VII, the calculated value of F was 0.4111. Based on the calculated value of the statistic, the null hypothesis

TABLE VII

SUMMARY TABLE FOR GRADE EIGHT, METROPOLITAN ACHIEVEMENT TEST
POSTTEST, FORM H OVER PRETEST, FORM F

Condition	Set	Source of Variation	Criterion Obtained M	Criterion Obtained SD	Criterion Adjusted M	df	Sum of Squares	Mean Square	F	p
Computation	Clinical	. .	15.6042	5.0476	16.1926	. .	. .	. .	. .	. .
	Classroom	. .	17.3913	5.6509	16.7772	. .	. .	. .	. .	. .
		Between	. .	. .	. .	1	7.7334	7.7334	0.4111	0.5231
		Within	. .	. .	. .	90	1693.1577	18.8129	. .	. .
		Total	. .	. .	. .	91	1700.8911	. .	. .	. .
Concepts	Clinical	. .	16.0000	4.0000	16.3193	. .	. .	. .	. .	. .
	Classroom	. .	16.0435	5.5856	15.7103	. .	. .	. .	. .	. .
		Between	. .	. .	. .	1	8.5361	8.5361	0.6824	0.4110
		Within	. .	. .	. .	90	1125.7834	12.5087	. .	. .
		Total	. .	. .	. .	91	1134.3196	. .	. .	. .
Problem Solving	Clinical	. .	12.8125	4.3937	13.0986	. .	. .	. .	. .	. .
	Classroom	. .	14.0435	6.7362	13.7450	. .	. .	. .	. .	. .
		Between	. .	. .	. .	1	9.6252	9.6252	0.3990	0.5292
		Within	. .	. .	. .	90	2171.2371	24.1248	. .	. .
		Total	. .	. .	. .	91	2180.8623	. .	. .	. .
Total Composite	Clinical	. .	44.9375	11.3201	46.2735	. .	. .	. .	. .	. .
	Classroom	. .	47.3043	15.3780	45.9103	. .	. .	. .	. .	. .
		Between	. .	. .	. .	1	3.0195	3.0195	0.0365	0.8490
		Within	. .	. .	. .	90	7450.2891	82.7810	. .	. .
		Total	. .	. .	. .	91	7453.3086	. .	. .	. .

*Significant at the .05 level of confidence.

was not rejected. Therefore, there was no significant difference between the means of the eighth-grade clinical set and the eighth-grade classroom set in mathematical computation.

Hypothesis 14

Hypothesis 14 stated that there would be no significant difference between the means of the eighth-grade clinical remedial set and the eighth-grade classroom remedial set in mathematical concepts on the Metropolitan Achievement Test, advanced. Data showing the composite of this sub-set are given in Table VII. A one-way analysis of covariance using the IQ scores and pretest scores as covariates was employed to determine if there was a significant difference between the adjusted means of the eighth-grade clinical set and the eighth-grade classroom set. At the .05 level of confidence using the appropriate number of degrees of freedom, an F score of 3.950 is required for significance. The adjusted means of the posttest scores were 16.3193 for the clinical set and 15.7103 for the classroom set. As shown in Table VII, the calculated value of F was 0.6824. Based on the calculated value of the statistic, the null hypothesis was not rejected. Therefore, there was no significant difference between the means of the eighth-grade clinical set and the eighth-grade classroom set in mathematical concepts.

Hypothesis 15

Hypothesis 15 stated that there would be no significant difference between the means of the eighth-grade clinical remedial set and the eighth-grade classroom remedial set in mathematical problem solving on the Metropolitan Achievement Test, advanced. Data showing the composite of this sub-set are given in Table VII. A one-way analysis of covariance using the IQ scores and pretest scores as covariates was employed to determine if there was a significant difference between the adjusted means of the eighth-grade clinical set and the eighth-grade classroom set. At the .05 level of confidence using the appropriate number of degrees of freedom, an F score of 3.950 is required for significance. The adjusted means of the posttest scores were 13.0986 for the clinical set and 13.7450 for the classroom set. As shown in Table VII, the calculated value of F was 0.3990. Based on the calculated value of the statistic, the null hypothesis was not rejected. Therefore, there was no significant difference between the means of the eighth-grade clinical set and the eighth-grade classroom set in mathematical problem solving.

Hypothesis 16

Hypothesis 16 stated that there would be no significant difference between the means of the eighth-grade clinical remedial set and the eighth-grade classroom remedial set in total composite mathematics on the Metropolitan Achievement Test, advanced. Data showing the composite of this sub-set are given in Table VII. A one-way analysis of covariance using the IQ scores and pretest scores as covariates was employed to determine if there was a significant difference between the adjusted means of the eighth-grade clinical set and the eighth-grade classroom set. At the .05 level of confidence using the appropriate number of degrees of freedom, an F score of 3.950 is required for significance. The adjusted means of the posttest scores were 46.2735 for the clinical set and 45.9103 for the classroom set. As shown in Table VII, the calculated value of F was 0.0365. Based on the calculated value of the statistic, the null hypothesis was not rejected. Therefore, there was no significant difference between the means of the eighth-grade clinical set and the eighth-grade classroom set in total composite mathematics.

Additional Analysis

Further analysis was performed on the composite mathematics scores of the Metropolitan Achievement Test in order to clarify the change in the student's mathematical skills from pretest to posttest. The Pearson Product-Moment correlation coefficient (r) was used to describe the correlation of pretest and posttest scores for each set. A test of significance of correlation was employed to determine whether each correlation was significantly different from zero. Table VIII presents these correlation coeficients.

TABLE VIII

THE RELATIONSHIP BETWEEN PRETEST AND POSTTEST COMPOSITE MATHEMATICS SCORES AS MEASURED BY THE PEARSON PRODUCT-MOMENT CORRELATION COEFFICIENT

Grade	Set	N	Calculated r	r required for significance at .05 level of confidence
Five	Clinical	49	0.549*	0.276
	Classroom	41	.524*	.301
Six	Clinical	31	.419*	.344
	Classroom	43	.757*	.295
Seven	Clinical	33	.717*	.334
	Classroom	47	.625*	.282
Eight	Clinical	48	.582*	.279
	Classroom	46	0.773*	0.285

*Significant at the .05 level of confidence.

The data in Table VIII indicates that every set showed a significant correlation between pretest and posttest on the composite mathematics section of the Metropolitan Achievement Test. The correlations were tested for significance at the .05 level of confidence.

A t test for correlated means was chosen for the statistical treatment to determine whether there was a significant change from pretest to posttest. Data showing the comparisons made of the composite mathematics section of the Metropolitan Achievement Test are noted in Table IX. This information indicated that all the t scores were significant at the .05 level of confidence.

TABLE IX

A COMPARISON OF THE CHANGES ON TOTAL COMPOSITE MATHEMATICS SCORES

Grade	Set	N	Raw Score Means Total Mathematics		Calculated t Value
			Pretest	Posttest	
Five	Clinical	49	26.959	35.163	6.278*
	Classroom	41	29.000	39.244	5.420*
Six	Clinical	31	41.129	51.355	6.762*
	Classroom	43	42.837	48.512	3.837*
Seven	Clinical	33	33.303	41.273	5.408*
	Classroom	47	33.043	41.149	7.202*
Eight	Clinical	48	37.396	44.938	6.034*
	Classroom	46	39.696	47.304	4.828*

*Significant at the .05 level of confidence.

Data showing the pretest and posttest comparisons of the grade placement scores between the clinical and classroom sets on the composite mathematics section of the Metropolitan Achievement Test are presented in Table X. As noted in the Table, all sets did experience gains in mathematics. The gains ranged from a low of 3.51 months for grade six of the classroom set to a high of 9.68 months for grade seven of the classroom set.

TABLE X

A COMPARISON OF THE GRADE PLACEMENT SCORES IN COMPOSITE MATHEMATICS ON THE METROPOLITAN ACHIEVEMENT TEST

Grade	Set	Grade Placement Means Total Mathematics		Months
		Pretest	Posttest	
Five	Clinical	3.653	4.178	5.25
	Classroom	3.822	4.422	6.00
Six	Clinical	4.555	5.177	6.22
	Classroom	4.633	4.984	3.51
Seven	Clinical	4.785	5.712	9.27
	Classroom	4.768	5.736	9.68
Eight	Clinical	5.202	6.069	8.67
	Classroom	5.374	6.274	9.00

Summary

The purpose of this chapter was to summarize statistical methodology and to define the statistical distributions used to test the hypotheses considered in this study. Sixteen hypotheses were presented and tested statistically. The data, when analyzed, revealed no statistically significant difference between the clinical and classroom sets on any of the criterion measures. Further analysis revealed a consistant correlation between pretest and posttest scores on the composite mathematics section of the *Metropolitan Achievement Test*. Also, there were statistically significant differences, at the the .05 level of confidence, between pretest and posttest scores on the composite mathematics section of the Metropolitan Achievement Test for each clinical and classroom grade level. The raw scores on the composite mathematics section were converted to grade placement scores and these converted scores revealed that the gains ranged from 5.25 months to 9.27 months for the clincial set and from 3.51 months to 9.68 months for the classroom set.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This chapter is divided into three parts. First, a general summary will be given. This summary will be followed by the conclusions and recommendations for future research.

Summary

The acquisition of useful mathematical skills is one of the most urgent and crucial tasks of a lifetime. Failure, or partial failure, in learning these skills is apt to handicap an individual's work in school, as well as his total adjustment to life situations. There is still much to learn about students who have problems with mathematics--why some learn and others do not; what materials best support mathematics instruction; what separate skills combine to turn low achievers into discriminating students.

In the past two decades most of the attention and experimentation in mathematics has been directed toward the average and above average student. During the past few years the below-average achiever has received more attention from educators and from the general public. With the infusion of compensatory funds to support experimentation and innovation, more new approaches have been tried than ever before. The results of research in regard to mathematics instruction indicate that no one method will serve the needs of all the children. One of the significant generalizations that can be drawn from a perusal of the investigations in mathematics instruction is that educators are attempting a wide variety of procedures in mathematics instruction programs. The evolving evaluation of the results of these programs and continued investigation and research are important with respect to future progress in the effective teaching of mathematics.

School administrators have long been interested in determining the effectiveness of the add-on approach exemplified by the clinical program for remedial mathematics students. There has been a real need for a type of study which would yield results that could be used in making decisions regarding the future of these remedial programs in the pre-high school grades. Thus, this study was conducted.

The major purpose of this study was to compare the gains in mathematical skills of remedial mathematics students receiving instruction in a clinical remediation situation with the gains of remedial mathematics students receiving instruction as sub-sets of a regular mathematics classroom. This study was concerned with making a comparison of mathematics skills development resulting from each of these two types of remediation at four different pre-high school grade levels.

The subjects selected for this study were fifth, sixth, seventh, and eighth grade students attending six elementary and two junior high schools in the North Central Texas area. A set of 161 remedial mathematics students was selected from those participating in the clinical remediation program during the 1975-1976 school year. The classroom set included 177 remedial mathematics students enrolled in a regular classroom remedial mathematics program during the same school year.

Standardized tests were administered to determine mathematical achievement levels and intelligence quotients of the students involved. The Metropolitan Achievement Test, Form F, was given as the pretest and Form H of the same test was given as the posttest. The Otis-Lennon Mental Ability Test was given to establish the intelligence quotient of the 338 participants. Using a one-way analysis of covariance with the raw scores from the four mathematics areas of the Metropolitan Achievement Test, the gains of the sets were compared. Conclusions were drawn from the various scores obtained.

Conclusions

On the basis of the findings of this study, the following conclusions were drawn:

1. In grade five the comparison of the clinical set with the classroom set resulted in F values for each area as follows: Computation - 1.2464; Concepts - 2.9714; Problem solving - 1.9358; Total composite mathematics - 0.2319. An

F value of 3.954 was required for significance at this grade level. It was concluded, therefore, that mathematical skill acquisition at this grade level was not improved by using the clinical approach to mathematics remediation over the classroom approach.

2. In grade six the comparison of the clinical set with the classroom set resulted in F values for each as follows: Computation - 2.9537; Concepts - 0.6132; Problem solving - 2.3511; Total composite mathematics - 4.5757. An F value of 3.980 was required for significance at this grade level. Although a significant difference was indicated in total composite mathematics as a comprehensive measure, it was concluded that since there was no significant difference in any of the component areas of the total mathematics scores, mathematics skills are not improved more by using the clinical approach at this grade level.

3. In grade seven the comparison of the clinical set with the classroom set resulted in F values for each area as follows: Computation - 3.8616; Concepts - 0.7238; Problem solving - 1.5796; Total composite mathematics - 0.0026. An F value of 3.968 was required for significance at this grade level. It was concluded, therefore, that mathematical skill acquisition at this grade level was not improved by using the clinical approach to mathematics remediation over the classroom approach.

4. In grade eight the comparison of the clinical set with the classroom set resulted in F values for each area as follows: Computation - 0.4111; Concepts - 0.6524; Problem solving - 0.3990; Total composite mathematics - 0.0365. An F value of 3.950 was required for significance at this grade level. It was concluded, therefore, that mathematical skill acquisition at this grade level was not improved by using the clinical approach to mathematics remediation over the classroom approach.

5. As shown by the F values, there were no significant differences indicated at any of the four grade levels in mathematical computation, concepts, or problem solving. There was no significant difference in total composite mathematics at grades five, seven, and eight. There was, however, a significant difference in favor of the clinical approach in total composite mathematics for grade six, but since this composite is made up of the areas computation, concepts, and problem solving combined and since no significance was indicated in any of these individual areas, it was judged that the clinical approach did not make a significant difference at the sixth grade level.

The overall results of this study would suggest that remedial mathematics students will show as much improvement in mathematical skill development, regardless of whether they received instruction in a classroom remediation situation or in a clinical remediation situation.

Additional analysis of the data revealed the following:

1. The Pearson Product-Moment correlation coefficient (r) was used to describe the correlation of pretest and posttest scores for the sub-sets in each grade level of the study. A comparison of these values revealed that the sub-sets at each grade level showed a significant correlation between pretest and posttest on total composite mathematics at the .05 level of confidence.

2. A $\underline{t}$ test for correlated means was used to test for significance in change from pretest to posttest on the raw scores of total composite mathematics. Significance was shown at every grade level in the study at the .05 level of confidence.

3. At all grade levels it was found that the raw scores for total composite mathematics (Table IX) did show a significant gain from pretesting to posttesting. The range of the grade-equivalent gains was from 3.51 months for the classroom set of grade six to 9.68 months for the classroom set of grade seven (Table X). This suggests that remedial mathematics programs will aid students in the improvement of their mathematical skills when such programs are designed for the special needs of these students.

Recommendations

The following recommendations are presented as a result of the outcome of this study:

1. It is recommended that student attitude and its relationship to mathematical skill improvement in remedial mathematics programs be studied.

2. It is recommended that specific teaching aids and instructional materials used in remedial mathematics programs be evaluated.

3. It is recommended that a study be made concerning the relationship between self concept and problems associated with mathematical skills disability.

4. It is recommended that a similar study be made at grades three and four.

5. It is recommended that a follow-up study on the subjects included in this study be made at the senior high school level in order to determine if long range benefits were derived.

Appendix A

TABLE XI

GENERAL SCORES--GRADE FIVE--CLINICAL SET

Case	IQ	Raw Scores Computation Pre--	Post--	Raw Scores Concepts Pre--	Post--	Raw Scores Problem Solving Pre--	Post--	Raw Scores Composite Pre--	Post--	Grade Equivalency Composite Pre--	Post--
1	90	6	11	5	8	7	9	18	28	3.0	3.8
2	89	10	14	6	5	5	7	21	26	3.2	3.6
3	88	7	11	11	14	10	13	28	38	3.8	4.4
4	104	11	15	11	14	15	14	37	43	4.3	4.7
5	80	6	14	7	8	7	6	20	28	3.1	3.8
6	86	8	13	12	8	9	8	29	29	3.9	3.9
7	99	17	20	8	19	5	13	30	52	3.9	5.2
8	87	9	10	7	13	6	6	22	29	3.3	3.9
9	85	6	12	5	8	5	9	16	29	2.8	4.1
10	96	4	13	8	11	5	11	17	35	2.9	4.2
11	90	11	11	12	11	15	17	38	39	4.4	4.5
12	86	6	10	11	10	11	6	28	26	3.8	3.6
13	86	14	11	11	11	7	7	32	29	4.0	3.9

TABLE XI--Continued

Case	IQ	Raw Scores Computation Pre--	Post--	Raw Scores Concepts Pre--	Post--	Raw Scores Problem Solving Pre--	Post--	Raw Scores Composite Pre--	Post--	Grade Equivalency Composite Pre--	Post--
14	82	7	15	7	6	6	8	20	29	3.1	3.9
15	91	9	12	9	13	7	9	25	34	3.5	4.2
16	80	9	10	8	8	9	5	26	23	3.6	3.4
17	88	2	10	4	10	10	11	16	31	2.8	4.0
18	80	9	4	3	1	2	0	14	5	2.5	1.5
19	105	9	12	19	16	9	13	36	41	4.3	4.6
20	80	5	4	5	2	3	2	13	8	2.3	1.8
21	86	7	15	10	14	8	12	25	41	3.5	4.6
22	92	9	20	10	12	8	6	27	38	3.7	4.4
23	101	12	25	15	19	8	13	35	57	4.2	5.4
24	88	9	21	13	20	9	11	31	52	4.0	5.2
25	112	9	15	14	10	12	13	35	38	4.2	4.4
26	95	6	23	12	15	9	17	27	55	3.7	5.4

TABLE XI--**Continued**

Case	IQ	Raw Scores Computation Pre--	Post--	Raw Scores Concepts Pre--	Post--	Raw Scores Problem Solving Pre--	Post--	Raw Scores Composite Pre--	Post--	Grade Equivalency Composite Pre--	Post--
27	86	10	9	9	6	5	3	24	18	3.5	3.0
28	80	3	12	13	4	11	3	26	19	3.6	3.0
29	97	8	16	9	19	7	13	24	48	3.5	4.9
30	100	11	23	13	13	11	10	35	46	4.2	4.8
31	87	10	13	2	7	9	7	21	27	3.2	3.7
32	102	9	25	10	11	7	6	26	42	3.6	4.6
33	85	8	16	13	12	12	9	33	37	4.1	4.3
34	82	9	20	9	17	12	18	30	55	3.9	5.4
35	82	9	7	9	11	12	6	30	24	3.9	3.5
36	90	10	12	14	11	6	10	30	33	3.9	4.1
37	82	16	14	7	10	15	14	38	38	4.4	4.4
38	85	11	16	9	11	7	9	27	36	3.7	4.3
39	85	6	17	11	18	11	16	28	51	3.8	5.2

TABLE XI--**Continued**

Case	IQ	Raw Scores Computation Pre--	Raw Scores Computation Post--	Raw Scores Concepts Pre--	Raw Scores Concepts Post--	Raw Scores Problem Solving Pre--	Raw Scores Problem Solving Post--	Raw Scores Composite Pre--	Raw Scores Composite Post--	Grade Equivalency Composite Pre--	Grade Equivalency Composite Post--
40	94	12	10	8	7	11	6	31	23	4.0	3.4
41	86	9	14	15	12	8	13	32	39	4.0	4.5
42	102	6	17	9	13	15	15	30	45	3.9	4.8
43	88	10	14	7	11	5	16	22	41	3.3	4.6
44	92	9	18	11	13	10	14	30	45	3.9	4.8
45	98	12	17	8	15	11	13	31	45	4.0	4.8
46	81	12	9	8	11	6	5	26	25	3.6	3.5
47	104	7	19	11	7	10	13	28	39	3.8	4.5
48	95	10	16	8	9	11	9	29	34	3.9	4.2
49	82	9	11	8	11	7	9	24	31	3.5	4.0

TABLE XII

GENERAL SCORES--GRADE FIVE--CLASSROOM SET

Case	IQ	Raw Scores Computation Pre--	Post--	Raw Scores Concepts Pre--	Post--	Raw Scores Problem Solving Pre--	Post--	Raw Scores Composite Pre--	Post--	Grade Equivalency Composite Pre--	Post--
50	82	10	10	6	10	5	6	21	26	3.2	3.6
51	81	4	8	2	10	7	9	13	27	2.4	3.7
52	97	12	21	10	18	13	15	35	54	4.2	5.3
53	80	10	7	5	9	5	7	20	23	3.1	3.4
54	84	13	16	9	13	11	14	33	43	4.1	4.7
55	99	15	17	12	17	13	16	40	50	4.4	5.1
56	101	10	17	8	17	10	16	28	50	3.8	5.1
57	104	15	18	10	13	9	12	34	43	4.2	4.7
58	99	12	23	9	19	14	13	35	55	4.2	5.4
59	80	12	18	5	11	5	7	22	36	3.3	4.3
60	92	12	10	5	4	4	2	21	16	3.2	2.8
61	92	12	11	11	16	4	14	27	41	3.7	4.6
62	80	9	10	10	11	9	5	28	26	3.8	3.6

TABLE XII--**Continued**

Case	IQ	Raw Scores Computation Pre--	Post--	Raw Scores Concepts Pre--	Post--	Raw Scores Problem Solving Pre--	Post--	Raw Scores Composite Pre--	Post--	Grade Equivalency Composite Pre--	Post--
63	91	12	6	8	7	7	7	27	20	3.7	3.1
64	97	13	19	11	15	12	13	36	47	4.3	4.9
65	96	9	19	13	13	8	22	30	54	3.9	5.3
66	93	15	18	12	13	6	9	33	40	4.1	4.5
67	103	7	20	12	16	5	19	24	55	3.5	5.4
68	94	13	16	6	18	13	20	32	54	4.0	5.3
69	94	11	24	11	23	12	17	34	64	4.2	5.9
70	106	10	27	10	12	5	23	25	62	3.5	5.7
71	104	13	14	14	22	7	12	34	48	4.2	4.9
72	94	8	8	11	7	10	6	29	21	3.9	3.2
73	92	12	15	15	12	10	6	37	33	4.3	4.1
74	88	11	15	9	12	9	3	29	30	3.9	3.9
75	101	14	9	7	12	6	9	27	30	3.7	3.9

TABLE XII--**Continued**

Case	IQ	Raw Scores Computation Pre--	Post--	Raw Scores Concepts Pre--	Post--	Raw Scores Problem Solving Pre--	Post--	Raw Scores Composite Pre--	Post--	Grade Equivalency Composite Pre--	Post--
76	86	14	19	15	15	9	13	38	47	4.4	4.9
77	80	9	10	5	13	4	10	18	33	3.0	4.1
78	84	13	15	12	11	7	7	32	33	4.0	4.1
79	88	11	9	9	5	8	8	28	22	3.8	3.3
80	100	14	12	11	11	12	6	37	29	4.3	3.9
81	89	7	12	12	15	11	10	30	37	3.9	4.3
82	87	13	11	11	6	8	14	32	31	4.0	4.0
83	96	11	18	7	15	9	12	27	45	3.7	4.8
84	98	15	18	5	13	14	10	34	41	4.2	4.6
85	104	2	13	7	10	5	17	14	40	2.5	4.5
86	87	10	16	6	13	10	15	26	44	3.6	4.7
87	97	11	10	4	16	14	17	29	43	3.9	4.7
88	88	5	4	8	5	9	7	22	16	3.3	2.8

TABLE XII--<u>Continued</u>

Case	IQ	Raw Scores Computation Pre--	Raw Scores Computation Post--	Raw Scores Concepts Pre--	Raw Scores Concepts Post--	Raw Scores Problem Solving Pre--	Raw Scores Problem Solving Post--	Raw Scores Composite Pre--	Raw Scores Composite Post--	Grade Equivalency Composite Pre--	Grade Equivalency Composite Post--
89	80	6	11	15	16	9	14	30	41	3.9	4.6
90	100	13	21	14	15	11	23	38	59	4.4	5.6

Appendix B

TABLE XIII

GENERAL SCORES--GRADE SIX--CLINICAL SET

Case	IQ	Raw Scores Computation Pre--	Raw Scores Computation Post--	Raw Scores Concepts Pre--	Raw Scores Concepts Post--	Raw Scores Problem Solving Pre--	Raw Scores Problem Solving Post--	Raw Scores Composite Pre--	Raw Scores Composite Post--	Grade Equivalency Composite Pre--	Grade Equivalency Composite Post--
91	108	16	16	14	20	15	16	45	52	4.8	5.2
92	83	17	17	23	22	11	16	57	55	5.2	5.4
93	99	13	18	18	16	18	16	49	50	5.1	5.1
94	96	16	18	14	18	17	15	47	51	4.9	5.2
95	105	18	30	13	20	12	17	43	67	4.7	6.0
96	91	19	16	16	20	10	17	45	53	4.8	5.3
97	90	20	25	14	12	11	18	45	55	4.8	5.4
98	85	11	17	4	10	3	10	18	37	3.0	4.3
99	106	20	22	21	26	15	15	56	63	5.4	5.9
100	104	12	18	13	19	13	14	38	51	4.4	5.2
101	94	20	21	14	14	13	10	47	45	4.9	4.8
102	80	10	17	10	15	5	7	25	39	3.5	4.5
103	88	11	20	12	11	13	12	36	43	4.3	4.7

TABLE XIII--Continued

Case	IQ	Raw Scores Computation Pre--	Post--	Raw Scores Concepts Pre--	Post--	Raw Scores Problem Solving Pre--	Post--	Raw Scores Composite Pre--	Post--	Grade Equivalency Composite Pre--	Post--
104	84	7	20	11	11	11	9	29	40	3.9	4.5
105	83	10	18	14	13	11	15	35	46	4.2	4.8
106	103	19	21	14	16	17	15	50	52	5.1	5.2
107	83	19	25	11	12	11	18	41	55	4.6	5.4
108	98	18	24	10	18	18	22	46	64	4.8	5.9
109	83	15	15	21	16	13	20	49	51	5.1	5.2
110	92	6	13	10	12	16	19	32	44	4.0	4.7
111	87	8	15	8	15	14	12	30	42	3.9	4.6
112	82	15	18	15	8	8	9	38	35	4.4	4.2
113	96	15	20	14	21	17	16	46	57	4.8	5.4
114	85	5	21	13	19	8	20	26	60	3.6	5.7
115	90	15	24	19	23	20	22	54	69	5.3	6.2
116	95	17	23	25	27	12	25	54	75	5.3	6.7

TABLE XIII--Continued

Case	IQ	Raw Scores Computation Pre--	Raw Scores Computation Post--	Raw Scores Concepts Pre--	Raw Scores Concepts Post--	Raw Scores Problem Solving Pre--	Raw Scores Problem Solving Post--	Raw Scores Composite Pre--	Raw Scores Composite Post--	Grade Equivalency Composite Pre--	Grade Equivalency Composite Post--
117	80	8	19	25	26	17	28	50	73	5.1	6.6
118	102	12	18	15	13	11	15	38	46	4.4	4.8
119	82	10	18	6	10	9	5	25	33	3.5	4.1
120	105	21	15	9	18	10	13	40	46	4.5	4.8
121	85	17	8	16	17	14	18	47	43	4.9	4.7

TABLE XIV

GENERAL SCORES--GRADE SIX--CLASSROOM SET

Case	IQ	Raw Scores Computation Pre--	Post--	Raw Scores Concepts Pre--	Post--	Raw Scores Problem Solving Pre--	Post--	Raw Scores Composite Pre--	Post--	Grade Equivalency Composite Pre--	Post--
122	88	10	9	7	18	6	8	23	35	3.4	4.2
123	80	17	24	12	16	8	8	37	48	4.3	4.9
124	96	20	25	19	10	17	14	56	49	5.4	5.1
125	96	23	23	23	25	10	19	56	67	5.4	6.0
126	92	20	16	19	23	15	12	54	51	5.3	5.2
127	83	22	16	15	19	19	15	56	50	5.4	5.1
128	80	0	6	2	5	1	6	3	17	1.2	2.9
129	91	7	9	6	5	3	8	16	22	2.8	3.3
130	80	3	6	9	14	5	6	17	26	2.9	3.6
131	81	15	17	8	7	10	7	33	31	4.1	4.0
132	105	19	15	19	26	19	16	57	57	5.4	5.4
133	86	22	14	18	23	16	14	56	51	5.4	5.2
134	86	7	13	15	10	11	5	33	28	4.1	3.8

TABLE XIV--**Continued**

Case	IQ	Raw Scores Computation Pre--	Raw Scores Computation Post--	Raw Scores Concepts Pre--	Raw Scores Concepts Post--	Raw Scores Problem Solving Pre--	Raw Scores Problem Solving Post--	Raw Scores Composite Pre--	Raw Scores Composite Post--	Grade Equivalency Composite Pre--	Grade Equivalency Composite Post--
135	89	22	22	16	14	14	17	52	53	5.2	5.3
136	90	6	9	9	6	4	3	19	18	3.1	3.0
137	80	5	7	8	7	7	6	20	20	3.1	3.1
138	99	15	19	10	14	7	9	32	42	4.0	4.6
139	90	11	16	12	12	11	10	34	38	4.2	4.4
140	100	12	15	13	16	13	8	38	39	4.4	4.5
141	107	18	24	14	23	11	19	43	66	4.7	6.0
142	101	21	22	11	19	13	17	45	58	4.8	5.6
143	93	14	15	18	18	13	19	45	52	4.8	5.2
144	97	17	18	18	20	12	13	47	51	4.9	5.2
145	136	13	14	22	24	15	12	50	50	5.1	5.1
146	80	19	15	16	13	15	6	50	34	5.1	4.2
147	82	15	21	19	18	16	18	50	57	5.1	5.4

TABLE XIV--Continued

Case	IQ	Raw Scores Computation Pre--	Raw Scores Computation Post--	Raw Scores Concepts Pre--	Raw Scores Concepts Post--	Raw Scores Problem Solving Pre--	Raw Scores Problem Solving Post--	Raw Scores Composite Pre--	Raw Scores Composite Post--	Grade Equivalency Composite Pre--	Grade Equivalency Composite Post--
148	89	17	17	21	15	12	16	50	48	5.1	4.9
149	86	23	25	17	22	13	24	53	71	5.3	6.4
150	86	16	14	21	18	16	10	53	42	5.3	4.6
151	111	23	17	15	26	15	23	53	66	5.3	6.0
152	95	20	22	20	20	17	17	57	59	5.4	5.6
153	91	21	14	20	18	16	15	57	47	5.4	4.9
154	96	6	19	13	18	11	13	30	50	3.9	5.1
155	80	12	17	9	7	13	17	34	41	4.2	4.6
156	82	14	23	13	15	7	16	34	54	4.2	5.3
157	93	16	23	17	13	10	17	43	53	4.7	5.3
158	101	15	25	17	22	15	24	47	71	6.0	6.4
159	102	18	26	17	23	14	18	49	67	5.1	6.0
160	93	19	20	15	20	16	16	50	56	5.1	5.4

TABLE XIV--**Continued**

Case	IQ	Raw Scores Computation Pre--	Raw Scores Computation Post--	Raw Scores Concepts Pre--	Raw Scores Concepts Post--	Raw Scores Problem Solving Pre--	Raw Scores Problem Solving Post--	Raw Scores Composite Pre--	Raw Scores Composite Post--	Grade Equivalency Composite Pre--	Grade Equivalency Composite Post--
161	96	21	21	17	18	14	13	52	52	5.2	5.2
162	103	17	26	18	27	17	22	52	75	5.2	6.7
163	105	15	22	25	20	12	19	52	61	5.2	5.7
164	107	17	29	20	17	17	17	54	63	5.3	5.9

Appendix C

TABLE XV

GENERAL SCORES--GRADE SEVEN--CLINICAL SET

Case	IQ	Raw Scores Computation Pre--	Post--	Raw Scores Concepts Pre--	Post--	Raw Scores Problem Solving Pre--	Post--	Raw Scores Composite Pre--	Post--	Grade Equivalency Composite Pre--	Post--
165	97	14	22	9	13	10	8	33	43	4.7	6.0
166	85	15	23	11	19	13	15	39	57	5.4	7.1
167	100	18	17	15	18	17	17	50	52	6.4	6.7
168	88	11	13	11	15	12	11	34	39	4.8	5.7
169	89	18	22	10	18	10	13	38	53	5.3	6.8
170	88	12	21	16	15	9	11	37	47	5.2	6.4
171	80	8	7	5	7	10	5	23	19	3.9	3.5
172	87	11	21	9	12	13	12	33	45	4.7	6.2
173	82	14	11	11	10	7	8	32	29	4.6	4.5
174	86	10	19	14	13	10	12	34	44	4.8	6.0
175	90	8	9	12	7	6	6	26	22	4.1	3.8
176	83	12	13	8	14	15	22	35	49	4.9	6.6
177	94	17	21	19	20	14	17	50	58	6.4	7.1

TABLE XV--Continued

Case	IQ	Raw Scores Computation Pre--	Post--	Raw Scores Concepts Pre--	Post--	Raw Scores Problem Solving Pre--	Post--	Raw Scores Composite Pre--	Post--	Grade Equivalency Composite Pre--	Post--
178	119	16	24	13	21	16	17	45	62	5.9	7.5
179	80	11	11	7	11	9	11	27	33	4.2	4.9
180	81	6	8	3	7	2	5	11	20	2.4	3.7
181	97	7	21	11	21	13	21	31	63	4.5	7.6
182	82	14	18	14	19	14	12	42	49	5.7	6.6
183	97	11	16	8	12	7	14	26	42	4.1	5.9
184	101	11	10	5	9	7	13	23	32	3.9	4.8
185	83	18	12	11	13	10	18	39	43	5.4	6.0
186	81	9	10	9	12	13	14	31	36	4.5	5.3
187	101	12	15	11	13	9	9	32	37	4.6	5.4
188	101	14	13	7	14	9	16	30	43	4.4	6.0
189	99	16	23	17	18	10	15	43	56	5.7	6.9
190	85	14	5	11	10	12	12	37	27	5.2	4.3

TABLE XV--Continued

Case	IQ	Raw Scores Computation Pre--	Raw Scores Computation Post--	Raw Scores Concepts Pre--	Raw Scores Concepts Post--	Raw Scores Problem Solving Pre--	Raw Scores Problem Solving Post--	Raw Scores Composite Pre--	Raw Scores Composite Post--	Grade Equivalency Composite Pre--	Grade Equivalency Composite Post--
191	84	15	19	12	15	12	12	39	46	5.4	6.2
192	107	6	11	15	15	14	13	35	39	4.9	5.7
193	103	6	10	7	12	7	10	20	32	3.6	4.8
194	84	16	16	10	16	8	6	34	38	4.8	5.6
195	92	13	18	13	20	11	11	37	59	5.2	7.3
196	92	18	13	9	13	11	14	38	40	5.3	5.7
197	80	5	8	7	0	3	0	15	8	3.0	1.9

TABLE XVI

GENERAL SCORES--GRADE SEVEN--CLASSROOM SET

Case	IQ	Raw Scores Computation		Raw Scores Concepts		Raw Scores Problem Solving		Raw Scores Composite		Grade Equivalency Composite	
		Pre--	Post--	Pre--	Post--	Pre--	Post--	Pre--	Post--	Pre--	Post--
198	93	15	16	3	12	0	10	18	38	3.3	5.6
199	92	7	11	7	8	7	7	21	26	3.7	4.2
200	92	10	10	10	14	6	11	26	35	4.1	5.2
201	88	6	2	12	16	9	15	27	33	4.2	4.9
202	103	9	9	9	8	10	11	28	28	4.3	4.4
203	94	11	11	10	8	7	9	28	28	4.3	4.4
204	86	10	12	9	11	10	18	29	41	4.3	5.9
205	89	15	12	9	17	6	13	30	42	4.4	5.9
206	90	10	10	11	12	9	14	30	36	4.4	5.3
207	94	11	12	14	17	7	14	32	43	4.6	6.0
208	95	14	14	13	11	7	10	34	35	4.8	5.2
209	91	13	12	10	16	12	8	35	36	4.9	5.3
210	91	15	8	11	7	9	11	35	26	4.9	4.2

TABLE XVI--Continued

Case	IQ	Raw Scores Computation		Raw Scores Concepts		Raw Scores Problem Solving		Raw Scores Composite		Grade Equivalency Composite	
		Pre--	Post--	Pre--	Post--	Pre--	Post--	Pre--	Post--	Pre--	Post--
211	97	10	15	15	23	10	17	35	55	4.9	6.9
212	87	12	12	11	20	12	10	35	42	4.9	5.9
213	94	12	13	10	21	14	17	36	51	5.1	6.7
2.4	89	12	11	10	11	14	11	36	33	5.1	4.9
215	88	10	16	17	17	9	8	36	41	5.1	5.9
216	85	13	18	9	14	17	10	39	42	5.4	5.9
217	100	17	10	16	23	8	13	41	46	5.6	6.2
218	86	12	11	17	15	13	14	42	40	5.7	5.7
219	101	14	21	16	21	12	24	42	66	5.7	7.8
220	96	15	11	13	13	14	11	42	35	5.7	5.2
221	96	14	17	17	18	15	20	43	55	5.7	6.9
222	92	15	15	17	17	12	10	44	42	5.9	5.9
223	93	12	28	18	18	17	21	47	67	6.0	8.0

TABLE XVI--Continued

Case	IQ	Raw Scores Computation Pre--	Raw Scores Computation Post--	Raw Scores Concepts Pre--	Raw Scores Concepts Post--	Raw Scores Problem Solving Pre--	Raw Scores Problem Solving Post--	Raw Scores Composite Pre--	Raw Scores Composite Post--	Grade Equivalency Composite Pre--	Grade Equivalency Composite Post--
224	81	8	9	2	14	8	6	18	29	3.3	4.5
225	80	7	11	9	8	2	7	18	26	3.3	4.2
226	85	9	11	5	12	7	10	21	33	3.7	4.9
227	94	6	11	6	15	10	14	22	40	3.8	5.7
228	82	7	11	9	9	6	10	22	30	3.8	4.6
229	93	9	8	6	14	9	8	24	30	3.9	4.6
230	95	7	11	12	22	5	17	24	50	3.9	6.6
231	86	10	14	9	12	9	16	28	42	4.3	5.9
232	91	9	12	10	11	11	10	30	33	4.4	4.9
233	91	15	11	7	14	9	15	31	40	4.5	5.7
234	94	12	19	12	19	7	19	31	57	4.5	7.1
235	90	9	14	13	16	11	15	33	45	4.7	6.2
236	84	11	13	17	16	7	17	35	46	4.9	6.2

TABLE XVI--Continued

Case	IQ	Raw Scores Computation		Raw Scores Concepts		Raw Scores Problem Solving		Raw Scores Composite		Grade Equivalency Composite	
		Pre--	Post--	Pre--	Post--	Pre--	Post--	Pre--	Post--	Pre--	Post--
237	99	13	13	13	14	11	11	37	38	5.2	5.6
238	94	12	15	16	16	9	8	37	39	5.2	5.7
239	99	12	15	13	18	12	15	37	48	5.2	6.4
240	92	13	11	13	13	12	13	38	37	5.3	5.4
241	98	17	16	12	15	11	18	40	49	5.4	6.6
242	88	12	17	15	14	15	8	42	39	5.7	5.7
243	93	13	13	18	27	14	18	45	58	5.9	7.1
244	89	23	20	15	23	11	20	49	63	6.2	7.6

Appendix D

TABLE XVII

GENERAL SCORES--GRADE EIGHT--CLINICAL SET

Case	IQ	Raw Scores Computation		Raw Scores Concepts		Raw Scores Problem Solving		Raw Scores Composite		Grade Equivalency Composite	
		Pre--	Post--	Pre--	Post--	Pre--	Post--	Pre--	Post--	Pre--	Post--
245	80	9	12	13	16	6	12	28	40	4.3	5.7
246	105	8	8	7	11	4	9	19	28	3.5	4.4
247	95	19	22	20	19	23	18	62	59	7.3	7.3
248	94	15	22	8	20	14	14	37	56	5.2	6.9
249	87	14	16	15	16	10	15	39	47	5.4	6.4
250	85	15	17	15	18	12	14	42	49	5.7	6.6
251	99	17	21	15	19	12	12	44	52	5.9	6.7
252	89	12	18	12	20	9	11	33	59	4.7	7.3
253	91	8	12	13	12	8	12	29	36	4.3	5.3
254	83	11	11	9	10	8	4	28	25	4.3	4.1
255	86	22	20	14	14	14	12	50	46	6.4	6.2
256	82	15	15	7	18	10	15	32	48	4.6	6.4
257	96	8	12	13	14	11	15	32	41	4.6	5.9

TABLE XVII--Continued

Case	IQ	Raw Scores Computation Pre--	Raw Scores Computation Post--	Raw Scores Concepts Pre--	Raw Scores Concepts Post--	Raw Scores Problem Solving Pre--	Raw Scores Problem Solving Post--	Raw Scores Composite Pre--	Raw Scores Composite Post--	Grade Equivalency Composite Pre--	Grade Equivalency Composite Post--
258	106	14	10	17	18	19	13	50	41	6.4	5.9
259	98	18	21	14	15	14	6	46	42	6.0	5.9
260	102	13	13	12	14	11	4	36	31	5.1	4.7
261	96	15	21	19	20	12	15	46	56	6.0	6.9
262	86	11	16	15	19	8	16	34	51	4.8	6.8
263	95	14	14	11	16	10	9	35	39	4.9	5.7
264	98	15	17	17	23	13	23	45	63	5.9	7.6
265	107	9	19	14	18	11	15	34	52	5.2	6.7
266	90	10	11	11	13	8	11	29	35	4.3	5.2
267	80	15	17	15	17	13	9	43	43	5.7	6.0
268	86	14	16	14	16	11	14	39	46	5.4	6.2
269	81	14	5	10	16	12	9	36	30	5.1	4.6
270	107	18	19	18	23	14	16	50	58	6.4	7.1

TABLE XVII--Continued

Case	IQ	Raw Scores Computation Pre--	Raw Scores Computation Post--	Raw Scores Concepts Pre--	Raw Scores Concepts Post--	Raw Scores Problem Solving Pre--	Raw Scores Problem Solving Post--	Raw Scores Composite Pre--	Raw Scores Composite Post--	Grade Equivalency Composite Pre--	Grade Equivalency Composite Post--
271	85	6	8	13	9	7	6	26	23	4.1	3.9
272	84	12	5	9	14	7	11	28	30	4.4	4.7
273	98	19	23	21	19	14	19	54	61	6.7	7.5
274	80	16	9	11	15	10	7	37	41	5.2	5.9
275	89	22	20	21	20	9	18	52	58	6.6	7.1
276	80	12	14	11	10	10	9	33	33	4.7	4.9
277	87	11	16	16	23	14	13	41	52	5.6	6.7
278	83	18	16	13	20	11	11	42	47	5.7	6.4
279	88	14	19	10	12	13	16	37	47	5.2	6.4
280	102	15	24	9	20	19	22	43	66	5.7	7.8
281	83	13	12	13	10	10	11	36	33	5.1	4.9
282	89	3	6	8	8	9	6	20	20	3.7	3.7
283	80	17	20	13	14	8	10	38	44	5.3	6.0

TABLE XVII--Continued

Case	IQ	Raw Scores Computation Pre--	Post--	Raw Scores Concepts Pre--	Post--	Raw Scores Problem Solving Pre--	Post--	Raw Scores Composite Pre--	Post--	Grade Equivalency Composite Pre--	Post--
284	90	9	10	9	10	7	10	25	30	4.0	4.6
285	85	13	16	8	20	10	22	31	58	4.7	7.1
286	97	10	18	6	13	8	14	24	45	4.0	6.2
287	85	18	22	16	19	13	12	47	53	6.0	6.7
288	95	11	16	12	16	11	13	34	45	4.8	6.2
289	88	16	24	12	13	9	15	37	52	5.2	6.7
290	88	15	14	20	19	10	14	45	47	5.9	6.4
291	87	19	20	17	21	10	19	46	60	6.0	7.3
292	90	6	12	9	13	6	14	21	39	3.7	5.7

TABLE XVIII

GENERAL SCORES--GRADE EIGHT--CLASSROOM SET

Case	IQ	Raw Scores Computation Pre--	Post--	Raw Scores Concepts Pre--	Post--	Raw Scores Problem Solving Pre--	Post--	Raw Scores Composite Pre--	Post--	Grade Equivalency Composite Pre--	Post--
293	94	7	21	7	8	5	4	19	33	3.5	4.9
294	80	5	8	8	12	7	10	20	30	3.6	4.6
295	94	10	16	7	18	6	12	23	46	3.9	6.2
296	84	13	12	6	11	10	14	29	37	4.3	5.4
297	96	13	12	10	6	8	6	31	24	4.5	4.0
298	83	17	16	7	13	8	6	32	35	4.6	5.2
299	87	15	8	12	12	5	9	32	29	4.6	4.5
300	106	8	19	11	14	13	12	32	45	4.6	6.2
301	83	9	13	13	8	11	5	33	26	4.7	4.2
302	87	11	18	12	14	11	14	34	46	4.8	6.2
303	101	15	13	10	16	11	10	36	39	5.1	5.7
304	86	16	13	13	10	8	10	37	33	5.2	4.9
305	93	12	9	14	11	12	10	38	30	5.3	4.6

TABLE XVIII--**Continued**

Case	IQ	Raw Scores Computation Pre--	Post--	Raw Scores Concepts Pre--	Post--	Raw Scores Problem Solving Pre--	Post--	Raw Scores Composite Pre--	Post--	Grade Equivalency Composite Pre--	Post--
306	87	15	23	14	15	10	10	39	48	5.4	6.4
307	115	19	15	11	15	10	10	40	40	5.4	5.7
308	103	13	19	20	19	10	8	43	46	5.7	6.2
309	84	23	19	12	18	14	8	49	45	6.2	6.2
310	98	15	14	21	18	13	6	49	38	6.2	5.6
311	109	14	22	24	27	12	19	50	68	6.4	8.0
312	101	24	23	16	19	14	19	54	61	6.7	7.5
313	108	21	28	20	25	14	23	55	76	6.7	8.8
314	105	24	31	21	22	13	23	58	76	6.9	8.8
315	83	10	14	5	11	5	8	20	33	3.6	4.9
316	93	8	15	11	14	5	14	24	43	3.9	6.0
317	88	13	9	9	17	4	10	26	36	4.1	5.3
318	94	18	12	15	10	10	23	43	45	5.7	6.2

TABLE XVIII--Continued

Case	IQ	Raw Scores Computation Pre--	Raw Scores Computation Post--	Raw Scores Concepts Pre--	Raw Scores Concepts Post--	Raw Scores Problem Solving Pre--	Raw Scores Problem Solving Post--	Raw Scores Composite Pre--	Raw Scores Composite Post--	Grade Equivalency Composite Pre--	Grade Equivalency Composite Post--
319	80	13	12	12	10	9	10	34	32	4.8	4.8
320	89	14	17	8	12	12	11	34	40	4.8	5.7
321	100	14	11	13	8	7	9	34	28	4.8	4.4
322	86	15	21	10	14	10	11	35	46	4.9	6.2
323	95	14	19	9	12	13	21	36	62	5.1	6.7
324	88	14	13	13	14	9	12	36	39	5.1	5.7
325	90	15	19	9	10	13	9	37	38	5.2	5.6
326	90	16	14	14	19	10	14	40	47	5.4	6.4
327	91	18	12	12	16	14	17	44	45	5.9	6.2
328	110	9	22	21	22	15	24	45	68	5.9	8.0
329	87	17	20	16	14	11	19	44	53	5.9	6.8
330	89	16	26	16	21	14	14	46	61	6.0	7.5
331	83	14	14	18	22	14	13	46	49	6.0	6.6

TABLE XVIII--Continued

Case	IQ	Raw Scores Computation Pre--	Raw Scores Computation Post--	Raw Scores Concepts Pre--	Raw Scores Concepts Post--	Raw Scores Problem Solving Pre--	Raw Scores Problem Solving Post--	Raw Scores Composite Pre--	Raw Scores Composite Post--	Grade Equivalency Composite Pre--	Grade Equivalency Composite Post--
332	90	18	21	15	20	15	15	48	56	6.2	6.9
333	99	12	26	19	24	17	28	48	78	6.2	9.0
334	80	19	18	19	19	13	17	51	54	6.4	6.8
335	88	16	22	19	23	18	28	53	73	6.6	8.4
336	90	16	20	15	20	23	12	54	52	6.7	6.7
337	93	18	28	23	27	15	21	56	76	6.8	8.8
338	101	21	25	20	28	18	28	59	81	6.9	9.2

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