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A COMPARATIVE STUDY OF THE ACHIEVEMENT OF EIGHTH AND NINTH GRADE STUDENTS IN BEGINNING ALGEBRA

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A COMPARATIVE STUDY OF THE ACHIEVEMENT OF EIGHTH AND NINTH GRADE STUDENTS IN BEGINNING ALGEBRA

CHAPTER I

THE PROBLEM: ITS BACKGROUND AND DEFINITION

Introduction

Change in our American educational system is a slow process. A major reason for this according to many writers in the field is the problem of educating the public to the purposes and needs of the educational enterprise. Another reason is the slow process of educating the profession to the necessity for changes in the educational program. Many times changes are made on the basis of theories with little reliable evidence to substantiate them. At other times changes are made very slowly when reliable evidence is available to indicate a need for change.

In recent years much has been written concerning the need for additional or more effective mathematics and science instruction at the secondary level. Legislation has been enacted in an effort to encourage and improve the teaching of these and other subjects considered important to the welfare of the nation. The problem of how to enrich the curriculum of the public schools and to provide greater challenge for the more capable students is a problem that has provoked much thought and study by both professional educators and lay people.

The secondary school mathematics curriculum has been developed, through tradition, into an accepted sequence in which topics are to be studied. The study of algebra and geometry gradually moved from the college level into the secondary school where they have generally been accepted as basic secondary school courses. Early theories on the teaching of these courses were based in part on the mental discipline point of view. Professional organizations, educators, and the rise of the junior high school were influential in changing the philosophy of mathematics education. Other important influences have been research in the psychology of learning, trends toward teaching for meaning, and emphasis on the use of audio-visual aids.

The advance of technology in recent years has raised serious questions about the effectiveness of mathematics education. Deficiencies in mathematics achievement discovered during World War II directed attention to the need for special provisions for the less able mathematics student. In the following decade, concern was directed toward the shortage of scientists and engineers and thus toward providing for the education of the more academically talented students, particularly in the fields of mathematics and science.

Much research in recent years has been concerned primarily with method and content of the mathematics curriculum. Many societies, committees, and organizations have been organized for the purpose of studying the needs in mathematics education and proposing new methods of teaching and content of the mathematics curriculum.

The School Mathematics Study Group has produced materials now widely used in revising the mathematics curriculum. This group began its work in 1958 under the direction of Professor E. G. Begle of Yale University and has completed the writing of experimental textbooks, with the modern approach to mathematics, for grades seven through twelve. Their work has since been extended into the elementary school curriculum. Other groups engaged in producing materials for the secondary mathematics courses include The University of Illinois Committee on School Mathematics and The Ball State Experimental Program in Geometry and Algebra.

The above mentioned materials have embodied much of the content of traditional mathematics textbooks but have added new concepts, different approaches to the solution of problems, and some reorganization of sequence of topics and content. The method used in the presentation of the material is based on teaching for understanding basic concepts with which problems may be solved.

This is the first time in the history of education that so many competent mathematicians and educators have collaborated to improve the effectiveness of mathematics education. Continued cooperation of these groups should provide materials and methods that will provide appropriate and excellent instruction for the students at all levels of abilities.

Need for the Study

In 1955 Harding High School in Oklahoma City, Oklahoma began a program of accelerated mathematics instruction by selecting incoming seventh graders, on the basis of scholastic ability and arithmetic achievement, for a special class. The areas of instruction usually covered in both seventh and eighth grade arithmetic were taught to the special class in one year. Algebra I was then taught to these same students in the eighth grade. The author, as a member of the school guidance staff, assisted in the development of the program and from this activity developed an interest to study the implications and outcomes of this procedure.

Several schools, in recent years, have been selecting students from seventh grade arithmetic classes to begin algebra instruction in the eighth grade. One reason for this procedure is that boredom from repetitious presentations in arithmetic to junior high school students has caused discontent with the subject and often with the school in general.

"The academically talented student, as a rule, is not being sufficiently challenged, does not work hard enough, and his program of academic subjects is not of sufficient range."[1]

Hlavaty in discussing improved mathematics instruction for capable students in the seventh and eighth grades stated:

> It is the work of these two grades that has been most often criticized as being a waste of time for the talented. There is a great opportunity in these two grades to deepen the students' understanding of the number system, to introduce and develop new mathematical concepts, and to prepare more effectively for more advanced work in mathematics. The emphasis in these grades should be on these aspects of mathematics, rather than on repeated "application" of previously learned concepts and skills.[2]

Earlier, Hotelling expressed a similar point of view by stating that "the pettifogging insistance on small things, on drill, chewing away on elementary practice in place of rapid progress into higher mathematics is really the great obstacle to development in a great many people of a higher mathematical culture."[3]

Different methods have been used in the selection and the preparation of students for eighth grade algebra

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[1]James B. Conant, The American High School Today (New York: McGraw-Hill Book Co., 1959), p. 40.

[2]Julius H. Hlavaty (ed.), Mathematics for the Academically Talented Student in the Secondary School (National Education Association, 1959), p. 23.

[3]Harold Hotelling, "Some Little Known Applications of Mathematics," The Mathematics Teacher, XXIX (April, 1936), p. 169.

with each school apparently devising its own methods and procedures. "Undoubtedly new ideas about the organization of the school day and the allocation of time among various subjects should be tried out and tested as should the possibility of moving algebra as well as languages into the lower grades."[1]

Atwood reported from a study at the University of Wisconsin regarding achievement of superior college freshmen that there is a need for high schools to evaluate their present mathematics program with regards to the more capable students.[2]

Special provisions should be made for students with varying abilities in mathematics. Instruction in algebra for eighth grade students who are capable of understanding algebra concepts and thereby profiting from the experience is one means of providing for the needs of capable students in mathematics.

Several studies have been made regarding the prediction of success in algebra by various methods but most of them were concerned with the ninth grade only. The results achieved from teaching algebra to ninth grade students for many years has apparently justified the practice to many

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[1]James B. Conant, op. cit., p. 42.

[2]Harry M. Atwood, An Analysis of Achievement by Selected Superior University of Wisconsin Freshmen with Implications for the Development of Enrichment Materials for High School Mathematics, (Ed. D. dissertation, University of Wisconsin, 1958).

educators. There was a need to evaluate the teaching of algebra to eighth grade students since some of the school systems of Oklahoma and elsewhere are beginning such a program and there is presently insufficient evidence to show that such a movement is profitable. If there is a difference in achievement, this difference needed to be analyzed to determine whether or not it justifies the practice when compared with the advantages of the present arrangement. The years difference in chronological age of eighth and ninth grade students does make some difference in their development. The problem was to determine what difference it makes with regard to learning algebra.

Statement of the Problem

The problem was to determine what differences in achievement would result from teaching algebra to the more academically able eighth grade students when compared to the teaching of algebra in the ninth grade to students of similar ability. The study was carried out in order to test the null hypothesis that there is no significant difference of achievement in algebra between the more academically able eighth and ninth grade students.

Additional hypotheses tested included: (1) there is no significant difference in algebra achievement between boys and girls, (2) there is no significant difference in algebra achievement between the students with I. Q. scores between 118.5 to 141 and those with I. Q. scores between 99 to 118.5, (3) there is no significant difference in the achievement of traditional concepts in algebra between the students in the class using traditional materials and those students in the classes using the School Mathematics Study Group materials.

Basic Assumptions

The following assumptions were made for this study:

1. The performance on the Seattle Algebra Test is a satisfactory measure of achievement in algebra.

2. The California Short-Form Test of Mental Maturity is a satisfactory measure of academic capability of junior high school students.

3. The arithmetic section of the Stanford Achievement Test is a satisfactory measure of achievement in arithmetic.

4. The population used in this study was a total population consisting of the sixty-six pupils enrolled in eighth grade algebra and the sixty-two pupils enrolled in algebra as ninth grade students in the Alice Robertson Junior High School of Muskogee, Oklahoma in 1959-60.

Definitions

For the purpose of this study, the following definitions were established:

1. Academically able included the students who were selected for inclusion in the classes used in this study on

the basis of (1) intelligence quotient, (2) achievement in arithmetic, and (3) teacher recommendation.

2. Gain is the difference in standard scores achieved on the pretest and posttest of the evaluative instrument.

3. Algebra achievement is the standard score on the Seattle Algebra Test.

4. Intelligence quotient of each student is his total score as measured by the California (S-F) Test of Mental Maturity.

5. Student is a member of the group of pupils selected for this study.

6. Arithmetic reasoning is represented by the raw score on the sub-test of the Stanford Achievement Test Battery.

7. Arithmetic computation is represented by the raw score on the sub-test of the Stanford Achievement Test Battery.

Delimitation of the Study

The study was limited to the students enrolled in the first hour eighth grade algebra class taught by Miss Leola Sharp, the second hour eighth grade class taught by Mr. Don Garvin, the second hour ninth grade algebra class and the fifth hour ninth grade algebra class also taught by Miss Sharp in the Alice Robertson Junior High School of Muskogee, Oklahoma, for the first semester of the 1959-60 school year. The study was further limited to those students in the selected classes who were available for the complete study.

Review of Selected Related Literature

Some leading educators have advocated for many years, that special provisions should be made for the academically capable students. Research related to instruction in algebra to eighth grade students is very limited. The earlier writings were generally concerned with the capable student and his possibilities regarding academic endeavors in general. Only recently, and especially since Russia was successful in orbiting the first man-made satellite, has the literature on curricular adjustments for the academically capable student increased to any great proportion.

In 1927, Spraberry reported the results of a study to determine the intelligence necessary for a person to study algebra with a fair insurance from failure. The study was based on data obtained by testing 375 nonselected pupils from four different schools. The evaluative instruments included a standardized intelligence test and two algebra achievement tests constructed by the author. The failing score on the test was determined by the instructors.

From this investigation, the following conclusions were drawn:

1. A pupil above I. Q. of 100 who enrolls in algebra has only a small chance for failure, while one below an I. Q. of 100 has a correspondingly greater chance for failure.
2. There is a greater correlation between I. Q. and abilities in algebraic problems than between I. Q. and algebraic computation.
3. The relation between intelligence (as measured by present intelligence tests) and algebraic abilities is not very close at any particular level of ability.

He observed that eighty percent of those who failed the achievement test had an intelligence quotient of 100 or less.[1]

Earlier recognition of the need for revising the mathematics curriculum in high school is noted by a statement made by Hotelling in 1936: "It is going to be necessary to introduce the calculus into the high school if men and women are to be equipped on the higher level to meet many of the problems in the complex civilization in which we now find ourselves."[2]

Lankton reported a study of evaluation and comparison of achievement in first year algebra of public high school students grouped according to their mathematical background. The study included students in grades nine through twelve, grouped into eight different categories of mathematical backgrounds.

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[1]George E. Spraberry, The Relation of Intelligence to Abilities in Algebra, (Masters Thesis, University of Oklahoma, 1927).

[2]Harold Hotelling, "Some Little Known Applications of Mathematics," The Mathematics Teacher, XXIX (April, 1936), p. 169.

Several interesting results were observed in this comparison of achievement:

1. Interest in mathematics was found to be very closely associated with achievement. Those in the higher interest classification were superior in their mean achievement to those who were in the lower interest classification.

2. Sex differences offered no basis for differentiation except among seniors whose mathematical background was very limited.

3. The mean achievement level of the ninth grade students was significantly greater than the mean achievement level of all other groups except those groups whose background included the second year of algebra.[1]

From Lankton's evaluation of achievement in first year algebra, he concluded, "The fact remains that the mathematics curriculum is not very well suited to the needs of all the high school population."[2] He further stated that, "The most crucial area in the mathematics program of instruction is the field of first year algebra."[3]

Hartung studied a class of superior students who

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[1]Robert S. Lankton, Evaluation of Achievement and Comparison of Achievement in First Year Algebra of Public High School Students Grouped According to Their Mathematical Backgrounds and Interests, (Ph. D. dissertation, University of Michigan, 1951).

[2]Ibid., p. 185.

[3]Ibid., p. 186.

started the study of algebra at mid-term of the eighth grade and continued through the ninth grade with emphasis on the functional concept and its application in scientific work. After three weeks in grade nine the pupils achieved a mean scaled score of 64.2 on the Cooperative Elementary Algebra Test which was the 88th percentile of the published norms. The organization of the school prohibited the students advancing to intermediate algebra during the ninth grade but algebra instruction with the functional concept was continued throughout the year. Although much of the usual content of intermediate algebra had been omitted, the median scaled score of the group on the Cooperative Intermediate Algebra Test, administered during the last week of the ninth grade was at the 62nd percentile. "The conclusion that seems warranted on the basis of this experience is that bright students can, at an early age, learn much more mathematics than they are usually given an opportunity to study."[1]

Duncan studied twenty-two selected variables and their relationship to algebra achievement in developing a procedure which could be used to identify youngsters to whom algebra might be taught successfully at the eighth grade level. Seventy pupils enrolled in two eighth grade algebra classes were the subjects.

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[1]Maurice L. Hartung, "High School Algebra for Bright Students," The Mathematics Teacher, XLVI (May, 1953), p. 321.

Coefficients of correlation for each pair of variables were computed and from these a multiple regression equation was developed. The tests selected in order of isolation included intelligence quotient, interest in literature and science, Orleans Algebra Prognosis Test score, and arithmetic computation. The coefficient of correlation between the predicted score and the achieved score was .76.[1]

McWilliams and Brown surveyed 140 selected junior high schools that provided special programs for the superior mathematics students. These schools were distributed throughout the United States from Maine to California. The data was collected by means of a visit to the school and classroom observation.

The purpose of their study was to determine what provisions were being made for the superior mathematics student in junior high school and what methods were being used that were considered successful. No attempt was made to randomize the sampling nor to submit these schools as examples of outstanding programs. Rather, it was an attempt to determine what was being done and by what methods.

The findings were reported in three major categories with various methods being used in meeting the needs of the

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[1]Roger Lee Duncan, The Prediction of Success in Eighth Grade Algebra, (Ed. D. dissertation, University of Oklahoma, 1960).

superior mathematics students.

1. Provisions made within the organization of the regular class included enrichment, sub-grouping within a class, individualized instruction, and use of supplementary material.

2. Out-of class activities that provided additional mathematics experiences were mathematics clubs, contests, scholarships, fairs and conferences, and field trips.

3. Some schools provided for the superior students through organizational arrangements for special schools, special classes, and individual acceleration.[1]

The U. S. Office of Education recently published a monograph that contained a survey of the psychological and educational literature of the years 1948 to 1958, with special reference to research in the field of mathematics education. Included was a discussion of problems proposed for further research in mathematics education with suggested designs for initiating certain studies.[2]

Research in this area is not extensive nor conclusive. Although programs of instruction in eighth grade algebra were

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[1]Earl M. McWilliams and Kenneth E. Brown, <u>The Superior Pupil in Junior High School Mathematics</u>, U. S. Office of Education Bulletin 1955, No. 4, (Washington: U. S. Government Printing Office, 1955).

[2]Phillip H. DuBois and Rosalind L. Feierabend (eds.), <u>Research Problems in Mathematics Education</u>, U. S. Office of Education Cooperative Research Monograph No. 3, (Washington: U. S. Government Printing Office, 1960).

reported in the literature, no study comparing objective data on algebra achievement between eighth and ninth grade students was found.

CHAPTER II

DESIGN OF THE STUDY

This study was designed to determine what differences in achievement would result from teaching algebra to the more academically able eighth grade students when compared to the teaching of algebra in the ninth grade to students of similar ability. The primary objective of this study was to test the null hypothesis that there is no significant difference in achievement in algebra between the more academically able eighth and ninth grade students.

Other hypotheses tested included: (1) there is no difference in algebra achievement between boys and girls, (2) there is no difference in algebra achievement between students with I. Q. scores between 118.5 to 141 and those with I. Q. scores between 99 to 118.5, (3) there is no difference in the achievement of traditional concepts in algebra between the students in the class using traditional materials and those students in the classes using the School Mathematics Study Group materials.

Selection of Subjects and Formation of Classes

The subjects were 66 eighth grade students (32 boys and 34 girls) and 62 ninth grade students (28 boys and 34 girls) selected in the spring of 1959 for enrollment in beginning algebra during the fall semester of the 1959-60 school year at Alice Robertson Junior High School, Muskogee, Oklahoma.

The eighth grade students were selected at the end of the seventh grade on the basis of their seventh grade arithmetic teacher's recommendation, their intelligence quotient as measured by the _California Short-Form Test of Mental Maturity_, and their arithmetic achievement as measured by the arithmetic section of the _Stanford Achievement Test_ administered in March of 1959. The ninth grade students were selected at the end of the eighth grade on the basis of their eighth grade arithmetic teacher's recommendation, their intelligence quotient as measured by the _California Short-Form Test of Mental Maturity_, and their arithmetic achievement as measured by the arithmetic section of the _Stanford Achievement Test_ administered in March of 1959.

The students were divided into four groups for this study comprising four separate classes in beginning algebra. Two classes were composed of eighth grade students and two classes were composed of ninth grade students. The classes were designated by numbers for convenience in making reference to them throughout the study. Class 8-1 is class number one of the eighth grade and class 8-2 is class number two of the eighth grade. Similarily, 9-1 is class number one of the ninth grade and 9-2 is class number two of the ninth grade.

Table I presents the data used in the selection of students by classes. Teacher recommendations are not presented nor was there any attempt to submit these for analysis since all received equal ratings by the fact that they were recommended.

The three objective instruments measured factors that are generally considered basic to the effective study of algebra. First a student must have some general scholastic aptitude as well as some ability to comprehend abstractions. In addition he must have acquired the mechanical skills of arithmetic computation and some skill in reading and understanding the terminology of mathematics. The subjective evaluation consisted of teachers recommendations based on what they knew of the abilities of the individual students.

For analysis of differences in achievement according to sex, each class was divided into two groups. The gains achieved by the girls were compared with the gains achieved by the boys within each class. The boys and girls in each class were not equally divided, but the variation was considered small enough so that the statistical analysis was not seriously affected.

Each class was divided into two groups according to I. Q. for analysis of the gains made by the group with the

TABLE I

MEAN, STANDARD DEVIATION, AND STANDARD ERROR OF THE MEAN OF OBJECTIVE MEASURES CONSIDERED IN SELECTION OF STUDENTS

		I. Q. C(S-F)TMM			Stanford Achievement					
					Arith. Reas.			Arith. Comp.		
Class	N	Mean	S. D.	SE_m	Mean	S. D.	SE_m	Mean	S. D.	SE_m
8-1	33	118.8	10.1	1.79	38.2	3.1	.55	32.6	5.7	1.01
8-2	33	113.5	9.0	1.59	37.5	3.95	.69	34.3	2.2	.39
9-1	29	117.3	9.1	1.72	41.2	2.32	.44	36.1	3.05	.57
9-2	33	115.6	8.2	1.45	38.3	3.8	.67	35.0	2.88	.51

lower I. Q. score when compared to the gains made by the group with the higher I. Q. score. An arbitrary point of 118.5 was chosen for this division. This division placed the high group approximately in the upper 10% of the normal population while the lower group range was from about the 50th percentile to about the 90th percentile in a normal population. The boys and girls were almost equally divided within each I. Q. group.

Instruction

Classes 8-1, 9-1, and 9-2 were taught by Miss Leola Sharp. Class 8-2 was taught by Mr. Don Garvin. Both teachers were regular members of the Alice Robertson Junior High School Staff of Muskogee, Oklahoma and were certified by the Oklahoma State Board of Education to teach mathematics. Classes 8-1, 9-1, and 9-2, taught by the same teacher, used the School Mathematics Study Group's Mathematics for High School First Course in Algebra as their text and class 8-2, taught by another teacher, used a traditional text in first year algebra.

This was the first year that the School Mathematics Study Group materials had been used in the Alice Robertson School and the first time that this teacher had used these materials in teaching. The teacher had attended a conference conducted by the School Mathematics Study Group for teachers preparing to use this material.

The initial use of the new materials suggested the inclusion of the hypothesis of no difference in achievement of traditional algebra concepts between students using the traditional text and students using the School Mathematics Study Group material.

Although this study was not primarily concerned with the evaluation of teaching methods or materials, interesting implications were observed.

The instructional period for which gain scores in algebra achievement were obtained was from the end of the second week of the school term to the end of the first semester.

The Evaluation Instrument

The Seattle Algebra Test was selected as the instrument for measuring the success of the students in algebra achievement. This test was designed to measure achievement of the more important objectives of the first half year of beginning algebra. Application of acquired skills and methods as well as knowledge and understanding of facts is included in this instrument. In a review of this test, Meder criticized its weakness and summarized the review by stating,

> It must be noted that these criticisms apply at most to a half dozen items. It is doubtful that a student's score would be seriously affected by these defects.
>
> The reviewer is pleased to note that the items in part D, which measures what he considers to be the most important aspect both of the test and of instruction in elementary algebra, are unusually good.

> On the whole, the strengths of this test far outweigh its weaknesses, and its use is recommended.[1]

Form Am of the Seattle Algebra Test was administered to all subjects at the end of the second week of school as a pretest for the purpose of establishing differences existing from previous experiences. Form Bm of the Seattle Algebra Test was administered to all subjects at the end of the first semester for the purpose of determining the achievement level of the students after one semester of instruction.

The tests were administered separately to each class by following the formal "Directions for Administration" carefully.

The gain score for each individual was obtained by subtracting his standard score on the pretest from his standard score on the posttest.

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[1]Oscar K. Buros, (ed.). The Fifth Mental Measurement Yearbook (Highland Park: The Gryphon Press, 1959), p. 582.

CHAPTER III

PRESENTATION AND ANALYSIS OF DATA

This study was designed to determine what differences in achievement would result from teaching algebra to the more academically able eighth grade students when compared to the teaching of algebra in the ninth grade to students of similar ability.

The first consideration was given to an analysis of the similarities of the four classes. This was accomplished through an analysis of the academic potentiality of the students as measured by the <u>California Short-Form Test of Mental Maturity</u> and arithmetic achievement as measured by the arithmetic section of the <u>Stanford Achievement Test</u>. Separate analysis was made of the two subscores provided by this instrument.

The second major consideration was given to an analysis of the scores achieved by each class on the <u>Seattle Algebra Test</u>. Analysis was made of the scores on the pretest, posttest, and gains for each class. Additional analysis was made between gain scores in achievement between boys and girls within each class as well as an analysis of the gain scores of a low and high ability group within each class.

Analysis of variance and the 't' ratio were the statistical treatments applied to the data for this comparison.

Analysis of Selection Data

Analysis of variance of the intelligence quotient of the four classes provided an F of 1.98 which was not significant. For a more detailed analysis of these scores, 't' ratios presented in Table 2, were computed comparing each class with every other class. Only one 't' ratio was significant, that between classes 8-1 and 8-2. This obtained 't' was 2.22 which was significant at the .05 level of confidence.

TABLE 2

MEAN INTELLIGENCE QUOTIENT AND COMPUTED 't' SCORES COMPARING EACH CLASS WITH EVERY OTHER CLASS

Class		9-2	8-1	8-2
	Mean	115.6	118.8	113.5
8-1	118.8	1.39		
8-2	113.5	1.0	2.22	
9-1	117.3	.75	.61	1.62

The arithmetic achievement test used in this study provides two scores, arithmetic reasoning and arithmetic computation. The raw scores achieved on each division of this test were used for further analysis of the similarity of the four classes. Analysis of variance was computed for each of these two groups of scores presented earlier in Table 1. The obtained F's on both the arithmetic reasoning scores and the arithmetic computation scores were significant, therefore the data were submitted to a more detailed analysis by means of the 't' test.

An examination of the computed 't' ratios for the arithmetic reasoning scores presented in Table 3 indicated that class 9-1 achieved significantly higher scores than did the other three classes with a 't' ratio between 9-1 and 9-2 of 3.62, a 't' ratio between 9-1 and 8-1 of 4.3, and a 't' ratio between 9-1 and 8-2 of 4.46. All of these were significant at the .01 level of confidence. None of the 't' ratios comparing the other three classes with each other proved to be significant even at the .05 level.

An examination of the computed 't' ratios for the arithmetic computation scores presented in Table 4 indicated that these scores were less varied. The only score significant at the .01 level of confidence was the 't' ratio of 3.04 comparing the means of class 9-1 and class 8-1. An obtained 't' ratio of 2.18 comparing means of classes 8-1 and 9-2 and a 't' ratio of 2.6 comparing means of classes 9-1 and 8-2 were significant at the .05 level of confidence.

TABLE 3

MEAN ARITHMETIC REASONING SCORES AND COMPUTED 't' SCORES COMPARING EACH CLASS WITH EVERY OTHER CLASS

Class		9-2	8-1	8-2
	Mean	38.3	38.2	37.5
8-1	38.2	.11		
8-2	37.5	.82	.79	
9-1	41.2	3.62*	4.3*	4.46*

*Significant at the .01 level of confidence.

TABLE 4

MEAN ARITHMETIC COMPUTATION SCORES AND COMPUTED 't' SCORES COMPARING EACH CLASS WITH EVERY OTHER CLASS

Class		9-2	8-1	8-2
	Mean	35.0	32.6	34.3
8-1	32.6	2.18#		
8-2	34.3	1.1	1.59	
9-1	36.1	1.44	3.04*	2.6#

*Significant at the .01 level of confidence.

#Significant at the .05 level of confidence.

This indicated that the ninth grade classes achieved slightly higher scores on arithmetic computation than did the eighth grade classes.

The academic capability of the four classes seemed to be quite similar according to the intelligence quotients as measured by The California Short-Form Test of Mental Maturity. The arithmetic achievement of the four classes was somewhat dissimilar in favor of the ninth grade students as evidenced by these scores. The additional year of training in mathematics could explain the higher achievement scores obtained by the ninth grade students.

Analysis of Algebra Achievement Scores

Results of the algebra achievement test for each class are presented in Table 5. Analysis of variance computed from the scores achieved on form Am, the pretest, of the Seattle Algebra Test produced an F of 9.2 which was very significant. This indicated that the classes were not matched according to algebra achievement. Further analysis of these scores provided 't' ratios of 2.84, 4.4, and 4.1 when the mean of class 8-1 was compared with the mean of each of the other three groups. Consideration of these scores presented in Table 6 indicated that the only real difference existing between the mean achievement scores of the four classes was that class 8-1 achieved a mean score, significant at the .01 level of confidence, below the other

TABLE 5

MEAN, STANDARD DEVIATION, AND STANDARD ERROR OF THE MEAN OF STANDARD SCORES ON THE SEATTLE ALGEBRA TEST FOR EACH CLASS

		Pretest (Form Am)			Posttest (Form Bm)			Gain (Difference)		
Class	N	Mean	S. D.	SE_m	Mean	S. D.	SE_m	Mean	S. D.	SE_m
8-1	33	85.7	9.8	1.73	108.8	7.3	1.29	23.1	9.95	1.76
8-2	33	95.3	7.3	1.29	118.3	7.2	1.27	23.0	9.0	1.59
9-1	29	95.6	8.8	1.66	112.8	8.7	1.64	17.2	8.1	1.53
9-2	33	92.0	7.9	1.39	106.3	9.3	1.64	14.3	9.3	1.64

TABLE 6

MEAN STANDARD SCORES ACHIEVED ON THE PRETEST (FORM Am OF THE SEATTLE ALGEBRA TEST) AND COMPUTED 't' SCORES COMPARING EACH CLASS WITH EVERY OTHER CLASS

Class		9-2	8-1	8-2
	Mean	92.0	85.7	95.3
8-1	85.7	2.84*		
8-2	95.3	1.7	4.4*	
9-1	95.6	1.67	4.1*	.14

*Significant at the .01 level of confidence.

three classes. The remaining three classes did not vary significantly from each other.

Analysis of variance computed from the scores achieved on form Bm of the algebra achievement test, the posttest, produced an F of 2.04 which was not significant and indicated that these scores did not vary significantly as a group. Through further analysis by comparing each class with every other class, it was determined that some classes were significantly different from other classes. Class 8-2 scored significantly higher than each of the three other classes with 't' ratios of 5.8, 6.2, and 2.66 and class 9-1 scored significantly higher than did class 9-2 with a 't' ratio of 2.8. Table 7 presents the 't' scores for comparison of class means on form Bm of the algebra achievement test.

TABLE 7

MEAN STANDARD SCORES ACHIEVED ON THE POSTTEST (FORM Bm OF THE SEATTLE ALGEBRA TEST) AND COMPUTED 't' SCORES COMPARING EACH CLASS WITH EVERY OTHER CLASS

Class		9-2	8-1	8-2
	Mean	106.3	108.8	118.3
8-1	108.8	1.2		
8-2	118.3	5.8*	6.2*	
9-1	112.8	2.8*	1.9	2.66*

*Significant at the .01 level of confidence.

A comparison of the 't' ratios presented in Table 6 with those presented in Table 7 suggested variations in gains made by the two eighth grade classes in comparison to the two ninth grade classes as presented in Table 8. Class 8-1 achieved standard scores significantly lower on the pretest than did the other three classes which were not significantly different. Class 8-1 on the posttest did not differ significantly from the two ninth grade classes but class 8-2 scored significantly higher than did the other three classes.

Comparison of Gains by Grade Levels and Classes

This study was carried out in order to test the null hypothesis that there is no significant difference of achievement in algebra between the more academically able eighth and ninth grade students. Gains in achievement in algebra were determined by gains made in standard scores during the instruction period as measured by different forms of the same standardized algebra test. Form Am of the Seattle Algebra Test was administered to all students early in September of 1959 and form Bm of the Seattle Algebra Test was administered to all students in January of 1960. Gain scores were obtained by subtracting the standard score achieved by each student on form Am from his standard score on form Bm.

TABLE 8

MEAN GAINS IN STANDARD SCORES ACHIEVED ON THE SEATTLE ALGEBRA TESTS AND COMPUTED 't' SCORES COMPARING EACH CLASS WITH EVERY OTHER CLASS

Class		9-2	8-1	8-2
	Mean	14.3	23.1	23.0
8-1	23.1	3.7*		
8-2	23.0	3.8*	.04	
9-1	17.2	1.3	2.59#	2.68*

*Significant at the .01 level of confidence.

#Significant at the .05 level of confidence.

The ninth grade students achieved a mean gain of 15.7 standard scores. The eighth grade students achieved a mean gain of 23.07 standard scores. The computed 't' ratio of 4.44 comparing the two grade levels was significant at the .01 level of confidence.

The ninth grade students achieved a mean standard score of 109.55 on the posttest and the eighth grade students achieved a mean standard score of 113.55 on the posttest. The computed 't' ratio comparing the mean scores on the posttest of 2.85 was significant at the .01 level of confidence.

The eighth grade achieved a mean standard score significantly higher than did the ninth grade on the posttest and achieved a mean gain in standard scores significantly greater than did the ninth grade. <u>The null hypothesis was considered untenable and therefore rejected</u>.

Analysis of the gains in standard scores achieved by each class is presented in Table 8. The gain made by class 8-1 was significant at the .05 level over class 9-1 with a 't' ratio of 2.59 and at the .01 level over class 9-2 with a 't' ratio of 3.7. The gain made by class 8-2 was significantly higher than the gains made by classes 9-1 and 9-2 at the .01 level with 't' scores of 2.68 and 3.8 respectively. Gains made by classes 8-1 and 8-2 were not significantly different.

Examination of the three tables concerning the algebra achievement scores indicated that achievement by eighth grade students as measured by the Seattle Algebra Test was greater than that of the ninth grade students. An examination of Tables 3 and 4 presented earlier in this chapter showed that where real differences in arithmetic achievement existed between classes the ninth grade classes achieved the higher score. The lack of higher achievement scores in arithmetic apparently did not retard progress in algebra for the two eighth grade classes. It should be noted however, that the eighth grade arithmetic achievement scores were well above the norm for that grade.

Sells, in a survey of research literature in the general area of prediction of success in college level mathematics had concluded that number facility is relatively unimportant beyond elementary arithmetic.[1] In developing a procedure to predict success in algebra by eighth grade students Duncan found that there was a greater correlation between intelligence quotient and algebra achievement than there was between mental age and algebra achievement. He stated, "This seemed to indicate that brightness, not maturity, is the more important factor in handling

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[1]S. B. Sells, "Mental Abilities and Personality Variables in Relation to Proficiency in Mathematics," Research Problems in Mathematics Education, Cooperative Research Monograph No. 3, U. S. Dept. of Health, Education, and Welfare, (Washington: U. S. Government Printing Office, 1960).

abstractions."[1] Hensley, in a comparative study of bright and dull children had found that there was no appreciable difference in the problem solving ability of students with varying chronological ages but with the same mental age.[2]

Comparison of Gains by Sex

Consideration was given to the possible variation in algebra achievement when girls were compared to boys. The hypothesis tested was that there is no significant difference in algebra achievement between boys and girls.

The number of boys and girls was approximately equal within each class. Table 9 presents 't' scores comparing gains made by boys with gains made by girls within each class. No 't' score was significant at the .05 level which indicated that these boys and girls gained equally well in algebra achievement. The hypothesis was therefore accepted on the basis of these data.

Comparison of Gains by Intelligence Quotient

The relationship between measured scholastic aptitude and achievement in algebra was considered by testing the hypothesis that there is no significant difference in algebra

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[1]Roger Lee Duncan, The Prediction of Success in Eighth Grade Algebra, (Ed. D. dissertation, University of Oklahoma, 1960), p. 35.

[2]H. G. Hensley, A Comparative Study in Problem Solving of Bright and Dull Children, (Ph. D. dissertation, University of Oklahoma, 1957), p. 38.

TABLE 9

MEAN GAIN IN STANDARD SCORES ACHIEVED ON THE *SEATTLE ALGEBRA TEST* AND COMPUTED 't' SCORES COMPARING BOYS WITH GIRLS IN EACH CLASS

Class	Boys		Girls		
	N	Mean	N	Mean	't' Scores
9-2	14	11.3	19	16.6	.85
9-1	14	19.9	15	14.7	1.7
8-2	14	20.5	19	24.7	1.27
8-1	18	22.4	15	23.9	.38

achievement between the students with I. Q. scores between 118.5 to 141 and those with I. Q. scores between 99 and 118.5. Within each class the upper group was compared with the lower group with regard to the gains made in algebra achievement. Table 10 presents the results of this comparison.

It is appropriate to note that, although the differences in gains were not significant, in each class the lower intelligence quotient group achieved greater gains than did the higher intelligence quotient group. Although each class was not divided equally by choosing a single dividing point, there was no significant variation observed in the groups that were not equally divided. The hypothesis was therefore accepted.

TABLE 10

MEAN GAIN IN STANDARD SCORES ACHIEVED ON THE SEATTLE ALGEBRA TEST AND COMPUTED 't' SCORES COMPARING UPPER ABILITY GROUPS WITH LOWER ABILITY GROUPS

Class	I. Q. 118.5 and Below		I. Q. 118.5 and Above		
	N	Mean	N	Mean	't' Scores
9-2	20	16.1	13	11.6	1.74
9-1	16	17.9	13	16.4	.52
8-2	25	23.7	8	20.75	.85
8-1	17	25.7	16	20.21	1.36

This study did not attempt to ascertain reasons for achieving or non-achieving but a review of the literature was made for similar findings and possible explanations for the difference.

Lankton concluded from a study of evaluation and comparison of achievement in first year algebra of public high school students in grades nine through twelve that the mean achievement level of the ninth grade students was greater than the mean achievement level of all the other groups except those groups which had a course in advanced algebra as well as beginning algebra.[1] This suggested the possibility

[1]R. S. Lankton, Evaluation of Achievement and Comparisons of Achievement in First Year Algebra of Public High School Students Grouped According to Their Mathematical Backgrounds and Interests, (Ph. D. dissertation, University of Michigan, 1951).

of a readiness factor operating that deteriorates when the study of algebra is postponed. This point of readiness could have been passed for the upper group to the extent that it affected their achievement. The lack of challenge for brighter students in a regular school program is often attributed to their development of poor study habits.

Getzels and Jackson in a study of giftedness compared the achievement of high intelligence students with the achievement of highly creative students. The high intelligence group included students in the top twenty per cent of the school in I. Q. but not in the top twenty per cent in creativity. The mean I. Q. for this group was 150. The high creativity group included students in the top twenty per cent in creativity but not in the top twenty per cent in I. Q. The mean I. Q. for this group was 127. The high creativity group and the high intelligence group achieved equally superior to the total school population on standardized achievement tests. The high intelligence group was preferred by teachers significantly above the average group but the high creativity group was not.[1]

Comparison of Gains by Mathematics Materials Used

Comparison of gains achieved by each class was

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[1]J. W. Getzels and P. W. Jackson, "The Study of Giftedness: A Multidimensional Approach," The Gifted Student, Cooperative Research Monograph No. 2, U. S. Department of Health, Education, and Welfare, (Washington: U. S. Government Printing Office, 1960).

investigated with reference to the basic textbooks used. The hypothesis tested was that there is no significant difference in the achievement of traditional concepts in algebra between the students in the class using traditional materials and those students in the classes using the School Mathematics Study Group materials. Table 8, presented earlier in this chapter, presents the mean gains and corresponding 't' ratios comparing each class with every other class.

Classes 8-1 and 9-1 were taught by the same teacher using the School Mathematics Study Group text for beginning algebra. The computed 't' score comparing the mean gains of the two classes was 2.59 which was significant at the .05 level of confidence. The eighth grade class gained in algebra achievement significantly more than did the ninth grade class. A computed 't' score of 3.7 comparing the mean gains of classes 8-1 and 9-2 which were taught by the same teacher using the School Mathematics Study Group text was significant at the .01 level of confidence.

Class 8-2 used a traditional text book in beginning algebra whereas classes 9-1 and 9-2 used the School Mathematics Study Group text in beginning algebra. Computed 't' scores comparing the mean gain achieved by class 8-2 with the mean gains achieved by classes 9-1 and 9-2 were 2.68 and 3.8 respectively. Both were significant at the .01 level of confidence.

The mean gains achieved by classes 8-1 and 8-2 were approximately equally superior to the mean gains achieved by classes 9-1 and 9-2. Class 8-1 used the same text as did classes 9-1 and 9-2 while class 8-2 used a different text, the traditional material.

A computed 't' score comparing class 9-1 with 9-2 of 1.3 was not significant. The two classes were using the School Mathematics Study Group text. A computed 't' score comparing class 8-1 with 8-2 of .04 was very insignificant. Class 8-1 used the School Mathematics Study Group text while class 8-2 used a traditional text.

Real differences in gains achieved by the individual classes were not evident in relation to the different materials that were used. Where real differences existed, they were related to the grade level of the class. The eighth grade classes achieved significantly greater gains than did the ninth grade classes. The gains achieved by the ninth grade classes using the same materials were not different. The gains achieved by the eighth grade classes using different materials were not different. <u>The hypothesis was therefore accepted</u>.

CHAPTER IV

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

This study was designed to determine what differences in achievement would result from teaching algebra to the more academically able eighth grade students when compared to the teaching of algebra in the ninth grade to students of similar ability. The primary objective was to test the null hypothesis that there is no significant difference in achievement in algebra between the more academically able eighth and ninth grade students.

Other hypotheses tested included: (1) there is no difference in algebra achievement between boys and girls, (2) there is no difference in algebra achievement between students with I. Q. scores between 118.5 to 141 and those with I. Q. scores between 99 to 118.5, (3) there is no difference in the achievement of traditional concepts in algebra between the students in the class using traditional materials and those students in the classes using the school Mathematics Study Group materials.

Analysis of the intelligence quotients revealed no real difference in the measured scholastic ability of the four classes with a computed F of 1.98. A 't' ratio of 2.2 in comparing the mean intelligence quotients of the two eighth grade classes did show significance at the .05 level. This was not considered to be of concern for this study since 't' scores did not prove significant when comparing scores of either eighth grade class with the scores of either ninth grade class.

Prior to the algebra instruction, the arithmetic section of the Stanford Achievement Test was administered to all subjects. This test provides two scores, arithmetic reasoning and arithmetic computation. Resulting 't' ratios from the analysis of these raw scores indicated that there were significant differences in arithmetic achievement. The differences that did exist were in favor of the ninth grade classes. Some of these differences were significant while others were not. This was to be expected, perhaps, because of the additional year of mathematics experience of the ninth grade students. The possibility of the effect that this might have on algebra achievement was recognized at the beginning of the study.

Examination of the results of the pretest scores on the Seattle Algebra Test indicated that the only real difference in these scores was that class 8-1 scored significantly lower than did the other three classes. Examination of the results of the posttest scores which was another form of the same test indicated that class 8-2 scored significantly higher than did the other three classes. Class 9-1 also scored significantly higher than did 9-2. This suggested the possibility that the eighth grade classes gained significantly more than did the ninth grade classes. An analysis of the mean gains achieved by each class confirmed this suggestion. The gains in achievement made by the eighth grade classes were significantly greater at the .05 level or .01 level than were the gains in achievement made by the ninth grade classes.

Analysis of the scores achieved on form Bm of the Seattle Algebra Test, the posttest, was made between the two grade levels. A computed 't' ratio of 2.85 was obtained by comparing the mean standard score of the eighth grade group with the mean standard score of the ninth grade group which is significant at the .01 level of confidence. Comparison of the mean gains in standard scores achieved by each group provided a 't' ratio of 4.44 which is also significant at the .01 level of confidence. The eighth grade achieved significantly greater scores in algebra than did the ninth grade. The gains in algebra achievement scores were also significantly greater for the eighth grade than for the ninth grade. Reasons or explanations for these results was not a part of the design of this study and therefore could not be determined.

Comparison of gains in standard scores achieved by the two eighth grade classes indicated that the difference was very insignificant. Class 8-1 used the School Mathematics Study Group materials while class 8-2 used a traditional textbook. The gains achieved by each eighth grade class using different materials, were equally superior to the gains achieved by each of the ninth grade classes using the same material.

A comparison of gains made by girls with those made by boys within each class did not reveal significant differences existing in any of the classes.

The classes were divided into a high intelligence quotient group and a low intelligence quotient group within each class and their gains compared. Analysis of the mean gains by these groups produced 't' scores that were not significant in each of the classes. In each class the lower group mean gain was greater than the higher group mean gain although it was not significantly greater.

Conclusions

Under the conditions of this study and through an analysis of the results obtained therefrom, the following conclusions seem warranted:

1. The eighth grade students achieved significantly greater scores in algebra than did the ninth grade students.

2. The eighth grade students made significantly greater gains in algebra achievement than did the ninth grade students.

3. The superiority of the ninth grade students in arithmetic achievement did not contribute significantly to their achievement in algebra above that of the eighth grade.

4. There were no significant differences in gains in algebra achievement between the upper ability groups and the lower ability groups of this selected population.

5. Eighth grade students achieved traditional algebra concepts through study of the School Mathematics Study Group materials as well as through study of traditional materials. No instrument was available to measure other outcomes.

6. No significant variations in algebra achievement can be attributed to sex differences.

7. Chronological age differences between eighth and ninth grade students was not significant for achievement in algebra.

Recommendations

The learning process is very complicated and has many facets. Some of the aspects of learning algebra have been investigated in this study while others have not. As a result of this study the following recommendations are submitted:

1. School officials should give serious consideration to the possibilities of offering beginning algebra to the more capable eighth grade students.

2. School officials should not be reluctant to institute the newer mathematics programs such as that of the School Mathematics Study Group. Fear that understanding of traditional algebra concepts will be lessened appears groundless.

3. Further investigation and research is needed relative to the secondary school mathematics curriculum.

4. Further experimentation is needed in the comparison of desired achievement in the teaching of traditional algebra and the newer mathematics concepts.

5. Other courses in the secondary school curriculum should be investigated for the purpose of improving the program of studies for academically talented students.

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