IMPROVING THE MATHEMATICS PROGRAM

IN THE BRISTOW, OKLAHOMA,

HIGH SCHOOL

By

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PREFACE

Changes in college entrance requirements have caused many high schools to examine their mathematics courses and to try to improve them. The faculty of the Bristow, Oklahoma, High School was aware of this educational trend and was willing to make needed changes in the mathematics program. They believed that factual information should be the basis for change. The writer, therefore, undertook the present study.

The writer wishes to thank Mr. Harold H. Sims, Superintendent of Schools, and other faculty members of Bristow High School for the aid and encouragement they gave her to undertake the experiment and to complete it.

The work could not have been finished without the expert guidance of the writer's advisory committee which included: Dr. Ida T. Smith, Professor of Education; Dr. James E. Frasier, Associate Professor of Education; and Dr. James H. Zant, Professor of Mathematics. They have given so willingly of their time and reference material that it has indeed been a joy to work with each one.

The writer is also greatly indebted to her family who have been so interested in her work during the past years. She is especially grateful to her daughter, Luann Branch, for editing and typing the final copy.

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Location

Bristow, Oklahoma, is a town of approximately 6,000 persons located on United States Highway "66" between Tulsa and Oklahoma City. The town is served by one major railroad, two motor freight carriers, and one inter-state bus line. The Turner Turnpike, one of Oklahoma's major highways, has both an entrance and exit at Bristow. Two state highways enter the town and carry traffic to and from the turnpike. The building of the turnpike improved transportation so that Tulsa may now be reached with a driving time of forty-five minutes. Oklahoma City is now only an hour and a quarter away from Bristow by car. The improvement in transportation has been a factor in the changing economy of Bristow and the surrounding territory.

The Oil Industry

From 1920 to 1940 Bristow was an oil boom town with much drilling and much oil-field activity. Three refineries and numerous gasoline plants were built and operated during this period. Oil companies had many camps for their employees and there were almost as many people living in the surrounding area as lived within the city limits. This created a large and steady payroll in the trade territory. The oil industry contributed also to the economy through tax payments.

In 1949, when Oklahoma A & M College made an Agricultural and Development Survey of the community, eleven thousand people were living in the Bristow trade area. This population was almost equally divided between town and open country. Although the oil business was declining, there was one refinery still in operation and there were eight natural gasoline plants within the trade area.

But, by 1958, Bristow had no refineries and the nature of the oil business was changing rapidly. Production had declined and pipelines were carrying the oil to other places for refining. This means that fewer people were living on leases and oil camps were rapidly becoming a thing of the past. Most oil company employees were living in town and therefore the population of the surrounding territory was declining.

Agriculture

The 1949 survey also showed that more than half the farms in the trade area were listed as pasture lands. Moreover, most of the farms were owned by persons who did not live on the farms. Thus, there were many tenant farmers in the trade area.

Agriculture is not profitable in the Bristow trade territory, as problems of soil depletion and erosion are also of primary importance within this part of Creek County. Much of the land has been planted in cotton and peanuts year after year. The tenant farmers have harvested their crops but have not planted cover crops to prevent wind erosion. They have failed to rotate crops so the soil has been depleted and little fertilizer has been used to restore the minerals crops have removed from the soil.

The owners of the land, with the help of the Soil Conservation Service have returned much of the land to pasture. From the standpoint of topography and soil resources, the major portion of the Bristow trade area is adapted to the expansion of the production of all classes of livestock. Good grass and an abundance of water have caused the owners to buy more cattle, so the trend toward more pasture land has still further reduced the number of farmers and has resulted in many vacant farm homes. The cattle business also tends to enlarge farms, so the small, wornout farms have become part of larger cattle ranches. The raising of cattle does not require many people to care for them, so these people must find work elsewhere.

This, again, contributes to the loss of population in the trade area and to the changing economic pattern of the community.

Industry

There is little industrial development in Bristow. Bristow does have a garment factory, a boat manufacturing plant, a grain mill, a pecan processing plant, and a bleach manufacturing plant. These are all small plants.

The lack of local payrolls and crowded housing conditions in Tulsa have caused many people to obtain work in Tulsa and to continue living in Bristow. These people commute daily from Bristow and the surrounding trade area, to their jobs in Tulsa, Sapulpa, or Sand Springs. They can drive to Tulsa almost as quickly as they can drive across town in Tulsa. Many of them prefer to live in a small town as property, rent, and taxes are much lower and the children can attend school where the schools are not so crowded.

Results of the Changing Economy

Many children now in school in Bristow will not be able to go back to a farm or to find work locally. Most of them must look forward to employment in the professions, or in large industries located out of town.

Many large industries such as Firestone Tire and Rubber Company, J.C. Penny Company, Skelly Oil Company, and Goodyear Tire and Rubber Company, are now demanding college graduates for their employees, and since professional people need college preparation, the demand for higher education will increase and students now in high school must be prepared, through their school programs, to meet the demands of the changing economic pattern. Thus, Bristow High School must evaluate its current program and prepare to make any necessary modifications.

The Pupils and Their Parents

Although the City of Bristow has a population of only 5,400, the school enrollment is 1,500 pupils. The school district includes 136 square miles. About 33 per cent of the total school enrollment is composed of children who live in rural areas and who are brought to school by school buses or by private transportation. The per cent of rural enrollment in high school is greater than the per cent of rural enrollment in grade school, as many neighboring rural districts maintain elementary schools but do not maintain high schools.

Most of the school population is of white American stock. There are few Negro and Indian pupils and only a few students whose parents were born in European countries.

Most parents in this community try to send their children through high school, and many of the children go to college. Thirty-five per cent of the graduates of Bristow High School take some type of advanced training.[1] Of 130 students who started to school in Bristow twelve years ago, 102 or 78 per cent were graduated in the 1960 class.[2] This fact not only shows that parents in the community want their children to have at least a high school education, but also shows that transientness is not a major factor with respect to the high school population. This statement is also supported by the fact that

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[1]Official Records, Bristow High School, 1955-1960.
[2]Official Records, Bristow High School, June, 1960.

two-thirds of the families now living in the Bristow school district have lived in the area more than ten years.[3]

The occupations of the parents of the community have caused these parents to consider more educational advantages for their children, so they are demanding better educational programs. The parents of the Bristow High School students have the following classified occupations:[4]

Professional people	7%
Business people	19%
White collar positions	19%
Skilled labor	40%
Unskilled labor	15%

The Current Mathematics
Program in Bristow High School

Bristow High School is a four year high school, accredited by the North Central Association. The current high school enrollment is approximately 475-500.

The present program in Bristow High School offers four years of mathematics if there are enough registrants to justify the classes. But, since few students take algebra before the tenth grade, geometry and second year algebra are the only courses available for most students. If students enroll in algebra in the ninth grade, then they may take geometry in

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[3]Agricultural and Industrial Survey, A & M College, p.2.
[4]Official Records, Bristow High School, 1959-1960.

the tenth grade, second year algebra in the eleventh grade, and solid geometry and trigonometry in the twelfth grade. This would prepare them to enter college and to begin their college work with analytic geometry.

Although a four year program in mathematics is offered, the present high school program requires only one year of mathematics. That year may be either algebra or general mathematics.

The ninth grade student may enroll in algebra if he achieves a tenth grade score on the Science Research Associates Mathematics Test. This is supposed to put all the better students in algebra and all the weaker students in general mathematics. Usually from forty to fifty per cent of the ninth grade pupils have been enrolled in algebra. However, no child is required to go into algebra if he wishes to take general mathematics. Therefore, some bright students who know nothing about algebra, but do know that they can be successful in general mathematics, do not choose to enroll in algebra. Moreover, some lazy students prefer to take an easy course and therefore do not enroll in algebra. Thus, many good students satisfy the mathematics requirement for graduation with a course in general mathematics. This use of a course called general mathematics has been advocated by many authorities.

The general mathematics course in Bristow High School is a survey course of all high school mathematics and a continuation of eighth grade arithmetic. The survey course offers a little of each branch of high school mathematics, but the students get so little of each subject that many do not become interested in further mathematics education.

Unit I. Arithmetic - 6 weeks

Review of fundamentals:
1. Addition, whole numbers, fractions, decimals
2. Subtraction, whole numbers, fractions, decimals
3. Multiplication, whole numbers, fractions, decimals
4. Division, whole numbers, fractions, decimals

Unit II. Algebra - 6 weeks

1. Equations
2. Formulas
3. Signed numbers--addition, subtraction, multiplication, division
4. The powers
5. Parentheses
6. Graphs

Unit III. Geometry - 6 weeks

1. Use of compass, protractor and ruler
2. Construction of angles and triangles
3. Geometric designs
4. Postulates and axioms
5. Formal proof

Unit IV. Trigonometry - 6 weeks

1. Indirect measurements
2. Trigonometric functions
3. Indirect measurements by similar triangles
4. Problems in square root
5. Apply hypotenuse rule
6. Aviation problems

Unit V. Economic Problems - 6 weeks

Insurance
1. Accident
2. Annuties
3. Automobile
4. Bank deposits
5. Fire
6. Life
7. Property damage

8. Liability
9. Unemployment
10. Theft

Taxes
1. Amusement
2. Customs and duties
3. Estate
4. Gasoline
5. Local
6. Income
7. Sales
8. Social Security
9. Property
10. Internal revenue

Unit VI. Home Budgets or Business Arithmetic - 6 weeks

Graphs and Occupation Arithmetic

Graphs
1. Bar
2. Broken line
3. Circle
4. Pictograph
5. Line

Occupational Arithmetic
1. Clerk
2. Cement Worker
3. Carpenter
4. Welder
5. Farmer
6. Payroll Clerk

Recently, however, general mathematics courses are being questioned. Many authorities feel that while such courses may be adequate for students who do not finish high school, they are inadequate or even a waste of time for many students.

Professor Howard F. Fehr, Consultant, Teachers College, Columbia University, in a speech before the Oklahoma Curriculum Improvement Commission concerning the content of mathematics courses, said:

1. "All students should study the mathematics outlined for the seventh and eighth grades and they should study it until they have command of use of it at adult level; that is

sufficient for every day use throughout their life.

2. "The three years sequence, called Elementary and Intermediate Mathematics, should be studied by all students preparing for entering college. This is a minimum program in liberal or general education in mathematics to enable a person to interpret his culture as an educated person. It is a minimum program for future elementary and non-science secondary school teachers. It is the mathematics foundation for every college bound youth.

3. "I should like to add only one word concerning those in high school who are not capable of going or who are not planning to go to college. The present courses and textbooks for these students are a rehash and stew of everything under the sun. There is no organization, structure, or systematic development of mathematics in any of the books on proposed curricula. It is my hypothesis that the mathematics for these students will and must be the same as the elementary portions of the curriculum outlined for the college bound. It is merely longer time, with more concrete illustrations that are needed for the slow learner, and not a different type of curriculum."[5]

The Problem

In the school year of 1957-1958, the Bristow High School

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[5]Howard F. Fehr, The Changing Curriculum in Mathematics, p. 32. The Oklahoma Curriculum Improvement Commission Leadership Conference, February 1-2, 1957.

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[5]Howard F. Fehr, The Changing Curriculum in Mathematics, p. 32. The Oklahoma Curriculum Improvement Commission Leadership Conference, February 1-2, 1957.

faculty, recognizing a need for improvement in its mathematics program to meet changing educational needs of its students, undertook a study and evaluation of its offerings in mathematics. The current study evolved as a part of the general investigation. It is concerned, fundamentally, with the hypothesis stated by Mr. Fehr in the preceding paragraph.

The problem of the present study is, therefore, to determine whether or not beginning algebra can be taught successfully to all ninth grade students in Bristow High School.

The purposes of the study are to ascertain whether or not "slow" students can be successful in a beginning algebra class; whether their arithmetic skills will improve in an algebra class; and whether they will be interested in and enjoy an algebra class.

Need for the Study

The place of mathematics in the general high school program has become an issue in the national and local press, as well as in leading magazines. Colleges are demanding more mathematics in secondary schools so that students will be better prepared to begin college work.

The economic change of the community, the attitudes of the parents toward secondary education, the character and viewpoint of the students, and current trends in education have given impetus to an evaluation and modification of the present mathematics program in the Bristow schools.

"Education has also taken the parents into the educational planning. The secondary school program has always responded to the social forces and social problems of the times because the secondary school is thought of as an institution for helping youth to grow up and take their places in adult society.

Since World War II there has been a severe manpower shortage, especially of people with skills or knowledge requiring higher education, as in engineering or teaching. Consequently, the Educational Policies Commission of the National Education Association made a study of the problem, drawing on the large body of research in this area and published a report on Manpower and Education in 1956. One result has been to focus attention on the teaching of science and mathematics in the secondary schools, with a resulting improvement both in training of teachers and in curriculum in these areas."[6]

Research has been very limited in the field of mathematics education. "To assist in the collection and dissemination of research findings in the teaching of mathematics, the U.S. Office of Education with the aid of the Research Committee of the National Council of Teachers of Mathematics sent an inquiry to 817 colleges that offered graduate courses in mathematics or whose staffs had made previous contributions in this field. The committee received answers to the questionnaire from 399 colleges. Of the 399 colleges, 59 reported research in the teaching of mathematics. The Committee carefully studied the

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[6] Yearbook of Education (Yonkers-on-Hudson, New York: World Book Company, 1958), p. 492.

111 research studies reported by these 59 colleges and selected 73 of them for inclusion in this analysis. Those that were selected are 14 studies by college faculty members, 32 doctoral dissertations, and 27 master's theses."[7]

"Although there is considerable overlapping when the 73 studies are classified according to grade levels, the college level contains 23 studies; the high school level, 28."[8]

There are very few dissertations written on the subject, so it is difficult to have a very good proof that students will have any success in the field of algebra. Some companies have put out algebra aptitude tests that are rated as reliable.

Of course, the student's attitude and personal welfare can cause any good test to fail. This makes it difficult to get exact results in some cases.

"Some of the essential factors that must be considered in predicting achievement in mathematics are: comprehension of mathematical techniques, attentiveness in classroom, originality, study habits and certain phases of general intelligence. Studies in prognosis in mathematics seem to justify the conclusions that achievement in mathematics may be predicted with only a fair degree of accuracy and that it can be predicted best by the combined use of a good prognosis test,

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[7]Analysis of Research in the Teaching of Mathematics, 1957 and 1958, U.S. Department of Health, Education and Welfare (Washington, D.C.: Office of Education), p. 3.

[8]Ibid.

intelligence test and achievement test on previous work in mathematics."[9]

Definition of Terms

Control group. A regular algebra class of ninth grade students.

Experimental group. Ninth grade students who were enrolled in general mathematics by choice, or who were advised by teachers to enroll in general mathematics because of Science Research Associates Mathematics Test scores below grade ten.[10]

Gifted student. One who works mathematics assignments with very little assistance except class explanation; who works beyond class assignments; and who makes very few errors. James B. Conant states that gifted students compose about 15% of high school population.[11]

Mental age. The age for which a given score on an intelligence test is average or normal. If a score of 55 on an intelligence test corresponds to a mental age of 6 years, 10 months, then 55 is presumably the average score that would be made by an unselected group of children 6 years,

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[9] "Mathematics Secondary," Encyclopedia of Educational Research, 2nd Edition (1941), p. 722.

[10] Faculty Committee opinion.

[11] Address delivered before the National School Boards Association's 8th Annual Convention, April 17-19, 1958.

10 months of age.[12]

Aptitude tests. A test of a combination of abilities and other characteristics, whether native or acquired, known or believed to be indicative of an individual's ability to learn in some particular area.

Achievement test. A test that measures the extent to which a person has achieved something--acquired certain information or mastered certain skills, usually as a result of specific instruction.

Alternate form reliability. The closeness of correspondence or correlation between results on alternate (i.e. equivalent or parallel) forms of a test; thus, a measure of the extent to which the two forms are consistent or reliable in measuring whatever they do measure, assuming that the examinees themselves do not change in the abilities measured between the two testings.

Standardized test. A systematic sample of performance under prescribed conditions, scored according to definite rules and capable of evaluation by reference to normative information.

Plan of the Study

Educational goals determine educational programs. These programs must meet the needs of the students involved in them.

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[12] Test Service Notebook, No. 13 (New York: World Book Company), p. 3.

One of the major questions raised in the faculty study of the mathematics program was the place of algebra in the total school program. A study was therefore made of research and professional literature related to the teaching of algebra. This material will be discussed in Chapter II.

Following the study of research and related literature, an experiment was planned to determine whether or not all ninth grade students could be profitably enrolled in algebra, rather than in general mathematics.

The ninth grade students were divided into four groups based on teacher judgment and S.R.A. tests. There was one high group, one low group, and two intermediate groups.

The groups were then given tests for arithmetic skills, intelligence, and algebra aptitude. Part of this was a repeat of information that was obtained the year before, but the testing also took care of any new students. After studying the results of the testing, the upper intermediate group appeared to be a very good cross section of an average school class. The lowest group was a very poor group as to health and intellect, and students in it lacked ambition to do anything but the absolute minimum of work. This became the experimental group. A few good students were in each group and these were encouraged to move into other groups where the test scores were high. Nine students made the change.

The second high group now became the control group and the low group the experimental group as listed in Table I, page 54.

The next step in the study was to plan the course content for each group. The control group would be taught the regular course in algebra with all the more difficult problems. They would be expected to learn the manipulative skills as well as the basic concepts of the algebra course. The textbooks used list four different kinds of problems rated as easy, more difficult, hard, and "star" problems which are most difficult.

The control group would be expected to do the first three groups with only the better students able to work the "star" problems.

The program for the experimental group would be a slower moving program that would not rush the slow student. The explanations were to be more detailed and less hurried. The slow students were to be helped by working the first few problems together and then working independently as far as they could on the four groups of problems.

Next a testing program had to be planned for the entire year. Teacher-made achievement tests would be given to each group about every six to eight weeks. The Iowa Algebra Test would be given every six weeks. There would also be the mid-semester teacher-made test and the final teacher-made test given at the close of the year.

As a final check on the success of the program, the students would be given the S.R.A. Test again in March and the scores would be compared with scores made in the September testing.

The scores in all tests would be compared and, by using statistical treatment, results could be determined.

Summary

The current study is concerned with the mathematics program in Bristow High School. Bristow is a small town located between Tulsa and Oklahoma City. Improved transportation and a changing economic picture have focused attention on the educational program of the town.

The population is middle class, white, American stock, in general. Parents have always been interested in their school program. The population is relatively stable. About thirty-five per cent of the high school graduates take some type of advanced educational training.

The present mathematics program of the high school, which includes general mathematics, as well as algebra, geometry, advanced algebra, solid geometry, and trigonometry, is being examined critically as are similar programs in other high schools. The inclusion of general mathematics is being seriously questioned.

The current study is an attempt to determine, by a controlled experiment, whether or not those students enrolled in general mathematics could be enrolled in, and successfully complete, a beginning algebra course.

Chapter II will be devoted to a summary of pertinent literature.

Chapter III will contain a description of the experiment.

Chapter IV will be devoted to a discussion of the findings of the study.

CHAPTER II

RELATED LITERATURE

Introduction

Little research relative to teaching algebra to the slow learning and non-college bound student can be found. Most writings are the beliefs of persons who may be considered authorities or experts.

Since the beginning of the eighteenth century, mathematics has played an important role in secondary education. Yet among the unsolved problems of mathematics education are those of defining this importance and of determining the relative value of mathematics to other subjects as well as its value for students of greatly varying aptitude and interests. Perhaps more than for any other subject, there has been developed and maintained for mathematics a traditional and accepted sequence in which its topics are to be studied. However, there is little experimental evidence to support the superiority of this or any other particular sequence. Not until the middle of the twentieth century has this sequence been challenged. Nevertheless, there is still little, if any, basic research to determine a level of mental maturity appropriate for the study of particular mathematical concepts or effective means of motivating interest in the study of mathematics.[13]

At the present time in the United States a shortage of scientific, professional, and technical manpower exists. The problem of alleviating this shortage belongs to American society in general; and, in particular, it belongs to the educational agencies of society.

As a fundamental in the education of scientific, professional, and technical persons, mathematics education becomes an area of further focus for the problem created by this shortage.

What Bristow High School is doing to meet the changing needs of its students, in relation to mathematics, is the primary concern of this paper. Such a consideration requires an analysis of secondary school mathematics, past and present, since this history may be one of the factors contributing to the existence of the present shortage.

Mathematics in the Secondary Program

An Analysis of Secondary School Mathematics

A recent report on the subject of mathematics education considered three major factors: the student, the teacher, and the curriculum.[14] To these factors one more could be added:

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[13]"Mathematics Secondary," Encyclopedia of Educational Research, 3rd Ed., 1960, p. 796.

[14]Henry S. Dyer, Robert Kalin, and Fréderic M. Lord, Problems in Mathematical Education (Princeton, New Jersey: Educational Testing Service, 1956, cited by Clyde E. Parish, "Junior High School Mathematics and the Manpower Shortage," The Mathematics Teacher, December, 1956, p. 611.

our society. Of these four factors the society and the curriculum need the most extensive and critical consideration.

Society

In the final analysis, society, in terms of its economic, political, and technological factors, determines the necessary education of any individual preparing to play a role in society. This demand has been given extensive consideration in the professional education of mathematics teachers as evidenced by discussions found in textbooks designed for the prospective mathematics teacher.[15] The professionally trained mathematics teacher, therefore, is aware of the needs of specific roles played by individuals in society.[16]

However, this awareness on the part of mathematics teachers is apparently not accompanied by a like awareness on the part of the great bulk of the population. The old familiar refrain from parents, "I had algebra in high school and haven't used it since," is testimony to this lack of awareness. An engineer was heard to remark recently, that engineers may not recognize the significance of mathematics in their day-to-day

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[15]Charles H. Butler and F. Lynwood Wren, The Teaching of Secondary Mathematics (New York: McGraw Hill Book Co., 1951), cited by Clyde E. Parish, "Junior High School Mathematics and the Manpower Shortage," The Mathematics Teacher, December, 1956, p. 611.

[16]Lucien B. Kinney and Richard C. Purdy, Teaching Mathematics in Secondary School (New York: Rinehart, 1952), cited by Clyde E. Parish, "Junior High School Mathematics and the Manpower Shortage," The Mathematics Teacher, December, 1956, p. 611.

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work activities. For example: in answer to a query from a junior high school mathematics teacher, one engineer stated, "The only value mathematics has had for me was to provide mental discipline." Yet, a few minutes before this remark, he had pulled a slide rule from his breast pocket and had done a quick computation in relation to something he was thinking about. This engineer was so habituated in his use of mathematics that he was overlooking his rather obvious, probable daily, use of mathematics in many different ways.

This lack of awareness of the significance of mathematics on the part of the general public poses a real problem in the terms of selling the value and importance of mathematics to members of the American society. It also raises the possibility that there is a lack in the curricular organization of mathematics that is contributing to this low level of awareness.

As was pointed out previously, extensive consideration has been given to mathematical needs of individuals as created by the demands of modern society. These needs have been a strong governing factor in determining the advocated curriculum for secondary school mathematics. However, a stronger factor has been in operation and in opposition; it has a hold, through tradition, that is hard to break. This is the college preparatory character of high school mathematics courses. In some respects the preparation for a life in society and life in a college do coincide. Both call for computational skill and for development of understanding of concepts. The real disagreement created by the objectives of preparing for two types of life activity seems to lie in how the objectives shall be reached rather than in differences in the actual objectives. Considerable preoccupation with objectives is apparent in professional literature, possibly to the exclusion of other curricular considerations that may be more important.

Objectives of the Mathematics Program

Butler and Wren summarize objectives of the high school mathematics program as follows:[17]

1. Proficiency in fundamental skills.
2. Comprehension of basic concepts.
3. Appreciation of significant meanings.
4. Development of desirable attitudes.
5. Efficiency in making sound applications.
6. Confidence in making intelligent and independent interpretations.

Other writers have made similar expressions of the objectives of secondary mathematics teaching.

Examination of published material and collection of data from experience reveals an emphasis upon basic skills associated with computation as related to practical considerations of life so narrowly focused that it has made some of the objectives inoperative. An evidence of this is the emphasis represented by the Guidance Pamphlet in Mathematics for High School Students.[18] Its primary emphasis is upon mathematical competencies necessary for effective citizenship and for

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[17]Butler and Wren, op. cit., p. 16.

[18]"By Commission on Post War Plans of the National Council of Teachers of Mathematics," The Mathematics Teacher, 1947, cited by Clyde E. Parish, "Junior High School Mathematics and the Manpower Shortage," The Mathematics Teacher, December, 1956, p. 612.

satisfactory performance in certain vocational and professional roles.

Personal experience reinforces this evidence. Several years ago a particular school system asked each secondary school teacher to prepare a statement of objectives for each subject he was currently teaching. Without exception, the teachers of mathematics, who taught only mathematics, turned in a series of objectives that were purely subject matter in orientation. The statements were a copy of the textbook table of contents. No mention was made of development of attitudes, of the encouragement of interest, or of an appreciation of mathematics as teaching objectives. The teaching may have an implied subscription to these objectives, but it is not a conscious subscription. It is probable that the above condition is not confined to this school alone.

If this is true, the present day mathematics curriculum in secondary schools is too narrow. The following is an indication that this is the real condition:

An increased and more accurate understanding of the learning process, which has resulted from the scientific study of pupils, explains the ineffectiveness of much of the past and present day teaching of mathematics. It calls attention to the importance of attitudes, understandings, and interests as well as manipulative skills.[19]

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[19]Lucien B. Kinney, _op_. _cit_., p. 38.

Change in Objectives

Where formerly the aim of the mathematics program was to develop scholars, the aim now is to develop well-educated citizens.[20]

At this point it seems that an hypothesis needs formulation and testing. This part of the manpower shortage can be corrected by teaching mathematics to induce an attitude of appreciation, a stimulation of interest, and an understanding of the part played by mathematics in the culture.

The Mathematics Curriculum

The importance of algebra in the secondary school mathematics program has rarely been questioned in the past century. Nearly all high schools offer one year of algebra and some as many as five semesters of algebra in sequence.[21]

The traditional college preparatory subjects--plane and solid geometry, algebra together with vocational mathematics, such as business and shop mathematics, remain as the fundamental courses in the senior high school. More recently, general mathematics in the first or last year has become important as an elective. The factors which compelled a reorganization in the junior high school and in the senior high school have

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[20] William David Reeve, Mathematics for the Secondary School (New York: Henry Holt, 1954), p. 247.

[21] "Mathematics Secondary," Encyclopedia of Educational Research, 3rd ed. (1960), p. 800.

not been effective as yet in redistributing emphasis among topics.[22]

If a college preparatory sequence is begun in the ninth grade, the problem of recognizing the needs of the non-college group is solved in one of three ways:[23]

1. No further courses are available outside the specialized college preparatory program.
2. Ninth grade algebra is made available to all pupils, in an endeavor at the same time to adapt the applications to the purpose of general education and maintain standards suitable for college preparatory.
3. Algebra is provided for the college preparatory group, and general mathematics for the non-college group.

The "Post-ponement Movement"--gaining ground slowly over a period of years has been the idea that mathematics as taught in the elementary and junior high school should be enriched to meet the requirements of the times and extended through the ninth grade as a required subject postponing the beginning of formal courses in algebra until the tenth grade and geometry until the eleventh grade.

The plan, which would make it impossible to have a four year sequence in the traditional courses in secondary mathematics, has not been widely adopted. Even in those schools in which it is employed, it is a common practice to permit the abler students to enter the course in algebra in their ninth year.[24]

The Commission on Mathematics has made detailed recom-

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[22]Harl R. Douglas, <u>The High School Curriculum</u> (New York: Ronald Press Co., 1947), p. 504.

[23]<u>Ibid</u>.

[24]<u>Ibid</u>.

mendations recently on the mathematics of grade nine for college capable students. These recommendations should have a profound influence on the traditional first-year algebra course. The work of the University of Illinois Committee on School Mathematics has received wide recognition. The recommended course for grade nine has been tried out in a number of schools and has served as a basis of in-service study for many teachers.

General Mathematics Courses

Much curriculum improvement work which is productive and helpful to the classroom teacher consists in beginning on actual specific problems or needs of teachers, applying sound techniques of study, and utilizing in the classrooms the positive results of the investigation.[25]

Until recent decades, only a select few continued mathematics beyond the eighth grade. For these few more difficult and relatively abstract courses in algebra, geometry, and trigonometry were appropriate. However, in recent years the high school pupil population has approached universality, giving rise to the problems inherent in the great hetrogeneity of ability, interest, and future need.

As a result, there has emerged a new type of course in mathematics for the ninth grade. The course includes consider-

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[25]American Association School Administrators, American School Curriculum, Thirty-first Yearbook (1953), p. 138.

able arithmetic and centers upon application to life problems. This course is intended primarily for students of lesser capacity for, and/or interest in, abstract mathematics, and less likely to go on to college and to take further courses in mathematics.

This trend seems in harmony with other trends in secondary education. It is called for by the alarming decrease in proportion of high school students enrolling for the more difficult and less applied courses. It is obvious that the quantative aspects of life problems today are too vigorous for the citizen who has only an eighth grade literacy in mathematics.

World War II brought nationwide publicity to the fact that the great majority of youths who quit or are graduated from high school are quite deficient in their ability in elementary computations and problem solving. The general mathematics course in senior high school is directed to correcting this deficiency and its occurence in high school curriculums is increasingly common.[26]

The impetus for a re-study of the secondary mathematics program in Florida arose when a belief became prevalent that an earlier attempt to do the same thing had not been productive. As a result of a study made twenty-five years earlier, general mathematics had been introduced into the schools as a substitute for algebra. The hope had been that such a course

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[26]Lucien B. Kinney, The High School Curriculum, ed. by Harl R. Douglas (New York: Ronald Press Co., 1947), p. 504.

would reduce the number of failures in mathematics, that it would provide materials within the interest and understanding of the less mature students, and that it would provide a course of special value to those students who did not take mathematics after the ninth grade. However, after the prolonged efforts of many capable teachers over the years, educators, in general, believe that "general mathematics" in the ninth grade is an overloaded, unproductive, dead-end course; and that constructive work aiming toward this weak spot should be started at once.[27]

The Mathematics Teacher

Effective teaching demands that teachers know their pupils. In many cases, the teacher must work out an arrangement by which he can teach college preparatory and non-college preparatory mathematics at the same time. He must always be alert to principles of psychology and know how to apply them in his teaching. The teacher must also be willing to accept children as they are and to help extend their knowledge from that point. He must understand the process of moving from concrete experiences to abstract thinking. These are matters which involve the idea of readiness.

The achievement of functional competence is aided when teachers in all grades:[28]

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[27] American Association School Administrators, _op_. _cit_., pp. 138, 160.

[28] New York State Education Department, "The Readjustment of High School Education," _Mathematics for All High School Youth_ (Albany, 1953), pp. 28-29.

1. Teach so that the spirit of discovery and adventure is kept alive.
2. Use many concrete experiences in the learning of abstractions.
3. Make problem-solving ability in their pupils a primary goal, thus producing one of the most valuable outcomes of mathematics education.

There are at least three kinds of mathematics teachers in the public secondary schools:

1. Persons who want to teach mathematics because of interest in mathematics.
2. Persons who have interest in young people, but who are teaching mathematics because of school programming.
3. Those who have mathematic competence and who are also interested in young people.

One common factor in the first two types of teachers is their own student experience with mathematics. Both took, and are now probably teaching, computationally oriented courses; and if any of their students become teachers, they will also teach computationally oriented courses, unless something is done to break the cycle, because of their own experiences in mathematics courses.

The first type of teacher finds intrinsic motivation in the subject material of mathematics. Because of this feeling, he is annoyed that not all his students see the subject matter as he does. He may concentrate on the students who share his feeling, while the others struggle along as best they can with minimum attention.

This circumstance of the dubious influence of the teacher, according to the evidence,[29] is occuring all too often and, it

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[29]Dyer, Kalin and Lord, op, cit., p. 15.

must be concluded, to the detriment of a general appreciation for mathematics and interest in it.

The second type of teacher may have a sympathetic feeling for students who are having difficulties. This would be true if he had had similar troubles during his student days. He is more likely to teach the greater bulk of his students than is the teacher who is motivated by his own interest in mathematics. Sometimes, however, he is less mathematically competent than is desirable.

Both these types of teachers need to expand their perception of both mathematics and mathematics teaching. Each should have a broader set of teaching objectives. The curriculum cannot expand without this expanded perception on the part of the teacher.

The third type teacher probably represents the ideal mathematics teacher.

The Student in the Mathematics Class

At the very center of this consideration of mathematics stands the student who is to learn, the one who is subject to the teaching of the teacher. Modern educational psychology labels the student as the most important consideration in the educative process. The mathematics teachers and makers of the mathematics curriculum have not yet accepted this point of view. They have been exposed to it, but as yet have not worked out how to use it in mathematics teaching.

One of the basic rules of learning is that learning occurs only when motivation is present. Some teachers have tried to follow this principle to a certain degree. It has led to the previously mentioned wide consideration of the individual's mathematical needs as dictated by social needs. But this has only established what the student needs and not "why" he needs it, or how to incorporate it into the student's educational pattern.

The student is told that he needs to know how to compute his income tax when he becomes an earner. He may accept this fact and agree with the teacher, but he is not aroused emotionally by this fact of a hypothetical income.

This raises a question, "Can we appeal to the emotional system of the student and get him to internalize these apparent future needs through a curriculum based and organized directly around fundamental concepts and understanding of subject matter involved?" (This is intended to include college preparatory needs). Evidence existing at the present time seems to indicate a negative answer.

While the search for a more satisfactory means of motivation goes on, the teacher exercises authority which forces students to go through the motions of learning. Students may absorb something through this practice, but it is doubtful if they will appreciate what they have absorbed. Until a satisfactory means of motivation can be found, the program can only mark time. In other words, the problem of arousing a genuine interest in mathematics is just as important as the educational psychologist says it is. In the present high school mathematics curriculum, there is little possibility of achieving the needed motivation.[30]

Guidance in the Mathematics Program

The junior high school has functioned as a level of education that places considerable emphasis on guidance in relation to the student's present and future. Some educators have identified the junior high school years as a crossroads period. What the student does in these years has great import as far as career choices are concerned. Patterns of behavior will be formed that will either permit an unrestricted or a restricted career choice when the student feels moved to make that choice.

There is, therefore, probably no better place to start a guidance program in mathematics than when a child enters the seventh grade. Here is a point in the child's education where the broad general offering of the elementary school is beginning to narrow down to the place where children will have to make decisions and choices.

At the end of grade eight, most children will be confronted with the important question, "Should I take algebra or general mathematics?" It is then that a student may suddenly become aware of these facts: that his arithmetic foundation is not strong enough to give him unlimited choices in higher mathematics; that he should have developed better work habits

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[30]Clyde E. Parish, "Junior High School Mathematics and the Manpower Shortage," The Mathematics Teacher, December, 1956, pp. 611-616.

in order to be recommended by a teacher for a particular course; and that he should have built up his arithmetic skills in grades seven and eight because success in the new course he desires depends on a good foundation. He may also realize that certain types of careers require certain programs of study, and that although he liked the introduction to algebra, general mathematics might be more useful to him in his future plans.

The child may show his bewilderment by such remarks as: "What is algebra, anyway?" "What is geometry?" "I know I can get it if I work, but I just didn't work in the seventh and eighth grades." "Do I need these courses to get into college?" "Can't I take algebra even if I don't want to take remedial arithmetic?" "Will general mathematics give me the same credit as algebra?"

Added to the bewilderment of the child is the concern of the parents. They, too, may suddenly become aware that the child is not qualified to make a choice of the courses offered. It is at this time that they realize the importance to the child of good grades in mathematics, even in lower mathematics.

What can be done to ease the tension, the disappointment, the bewilderment for the child at an age when there is already considerable nervous tension? What can be done to help the parents?

First one must look at the facts about the mathematics program in junior high school:

1. Most children will have only two more years of a single track program in mathematics. This will be in grades seven and eight.

2. In these two years of junior high school he will have the opportunity to develop skills and understanding in arithmetic.

3. Arithmetic in junior high school becomes a mathematics course. Arithmetic is no longer the only objective, but intuitive geometry and introduction to algebra are part of the course.

Whether or not a child recognizes these facts depends on the guidance his teacher or counsellor may give him in developing this perspective.[31]

The student in junior high school should get an introduction to the general range of high school mathematics. The algebra should have the formula, the equation, the graph and directed numbers. These four concepts are so important in elementary science, in simple mensuration, and in ordinary business that everyone should know something about them.

The fact that we do not obtain the degree of mastery that we might naturally anticipate does not mean that we need to confine the work in mathematics of the junior high school to arithmetic alone.[32]

Guidance of Students to Enroll in Algebra I

The procedures employed most frequently in determining which students were to enroll in Algebra I were the same ones employed for other mathematics courses, namely, counseling and

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[31] Alice M. Hach, "The Importance of Early Guidance at the Junior High School Level," National Council Mathematics Year-Book, 22nd ed., pp. 81-84.

[32] William David Reeve, Mathematics for the Secondary School (New York: Henry Holt & Co., 1954), p. 29.

prior record. All the techniques reported as employed for this purpose and as they ranked in order of the frequency with which they were reported are listed as follows:[33]

1. Counseling
2. Prior records
3. Placement tests
4. Prognostic tests
5. Diagnostic tests
6. Teachers' opinions

V.S. Mallory studied the problem of adapting mathematical instruction to ninth grade pupils who had an IQ of 109 or below and whose unusual difficulties with mathematics were reflected through tests, teachers' marks, or both. Such pupils, called "slow moving" or "slow learning" pupils were placed in separate classes for which the subject matter was very carefully selected and the methods of teaching especially designed. There were several simple items in the construction and evaluation of the formulas, the use of signed numbers, the fundamental operations with literal numbers, and the solutions of equations, which a large majority of the group were able to handle successfully. Signed numbers and simple equations were taught with the best results. The course proved to have a definite value for and to be of real interest to the slow-learning pupil in the ninth grade level.[34]

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[33] Mathematics in California Public Schools, prepared by the Bureau of Secondary Education (1958), p. 51.

[34] "Mathematics Secondary," Encyclopedia of Educational Research, 2nd ed., (1941), p. 709.

Methods of Teaching

Mathematics should be taught for the sake of the pupil and not for the sake of mathematics.

The recognition of variations in academic ability and differences in future educational or vocational aspirations in the individuals in any school group is inherent in sound planning.

Provision for the Below-average Student

The problem of educating the slow learner arose when high school education became available to all youth instead of to the select few. Today in the secondary school there are large groups of pupils who have low intellectual ability, who show little interest, whose aptitude or preparation is meager.

These pupils are not able to do successfully the mathematics of the traditional high school courses because such courses are college preparatory courses or technical courses. The problem is how to plan mathematical situations that will give the slow learner functional experiences on his level of ability and interest so that he can succeed in developing mathematical competence of value in practical situations. Many of these youth become the most successful citizens and employ skilled mathematicians to do their work.

Learning can be improved by giving more class time to individual work under the direction of the teacher. Many teachers have found that improved learning comes from the following pattern: Spend only ten or fifteen minutes of the group's time in discussing the work to be done for the day. The remainder of the period should be given over to individual work. The teacher moves freely about the room and plans to see each pupil at least once during the period. "Whenever a common difficulty is noted, the teacher stops the class (if most are having difficulty) or takes the small group to one side and goes over the explanation with them."[35]

There are some who recommend that the current, rather wide-spread, practice of offering both general mathematics and algebra in grade nine should be discouraged in favor of teaching the regular first year algebra more slowly for the slower group and providing an opportunity for individual excursions into deeper understanding for the gifted. These facts lend support to the statement that, at this level of instruction, the adjustment of subject matter and teaching techniques to varying levels of pupil ability is a problem which demands careful study and experimentation.[36]

Evaluation in Mathematics

Four major functions of evaluation are (1) Measuring the achievement of objectives (2) Comparing relative merits of different educational programs (3) Providing a basis for pupil

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[35] A Course Study in Mathematics. Commonwealth of Pennsylvania, Department of Public Instruction (1958), p. 30.

[36] Report of the Secondary School Curriculum Committee. Reprinted from The Mathematics Teacher (May, 1959), p. 404.

guidance (4) Diagnosing student strengths and weaknesses. These attributes which characterize a satisfactory evaluation program are balance, comprehensiveness, continuity, teacher and pupil participation, freedom from the stringent curricular restriction, validity, reliability, and intelligent interpretation.

There have been many efforts exerted to detect whether there is any relation between mathematical ability and general intelligence or between mathematical ability and ability in other subjects. Available evidence leads to the conclusion that achievement in mathematics is not closely related to the above factors. Efforts to measure the comparative values of the traditional type and the generalized type of organization of subject matter in secondary mathematics have not been very conclusive in their results. Specialists in the teaching of mathematics seem to favor the newer methods of organization and presentation while high schools and college teachers have been somewhat divided in their opinions as to the relative effectiveness of the newer and older procedures.

While some form of general mathematics has gradually replaced the traditional organization in the junior high school, the more individual nature of the mathematical material for the senior high school has seemed to discourage much effort toward fusion in the senior high school. Experiments have not shown any very significant results as to advantages or disadvantages of one plan of organization over the other.

Purpose of Evaluation Program

While various objectives help to point out purposes of a testing program, there are specific values to keep in mind. Chief among these are the following:[37]

1. Guidance. Testing program should locate sources of difficulty. Involves elements of corrective teaching and placement.

2. Maintaining standards. It is necessary that our cultural values not be lowered but rather be raised.

3. Motivate learning. A test, whether diagnostic, prognostic, or of achievement, when studied with the pupil, displays his learning as well as his non-learning or mis-learning.

4. As guide to teaching. Good evaluation programs furnish criterion for needed changes in curriculum.

5. As an appraisal of teaching. Low outcomes on a test may signify poor achievement on the part of the class, but they can also mean that a poor job of teaching has been done.

Means of Determining the Effectiveness of Mathematics Courses

The means of evaluation used in determining the effectiveness of the algebra course were tabulated and arranged in the order of the frequency with which they were reported. The list of techniques thus developed follows:

1. Teacher-made tests
2. Standardized tests
3. Students' written work
4. Textbook tests
5. Oral quizzes
6. Recitation
7. Homework

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[37] Mathematics for All High School Youth, New York State Department (1953), p. 73.

8. Student's success in subsequent courses
9. Central office tests
10. Reviews
11. Workbooks
12. Class comparison

In determining students' progress in mathematics courses, heavy reliance is placed upon the use of tests. No one would question the value of tests, but there is some question as to whether test results provide an adequate basis for evaluating students' progress and achievement. Probably test results should be supplemented with teacher-student and teacher-student-parent conferences and reported observations of students' work. The course may also be evaluated by using the results thus obtained and by making follow-up studies of students who have been graduated.

It was noted that counseling and students' prior records were the principal means for determining whether students needed to, or were qualified to, enroll in mathematics courses. Only slight use was being made of placement, diagnostic, and prognostic tests for this purpose. The adequacy of the methods used is questionable. There is certainly need for improved means of determining who will likely succeed in college preparatory mathematics courses. These improved means should be employed as a basis for determining which students will be encouraged to take such courses.[38]

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[38] Mathematics in California Public Schools, Bureau of Secondary Education (1953), p. 51.

Standard Tests

If maximum growth and development of each individual are to be achieved, frequent measures of his abilities, readiness levels and rates of progress must be available. It is in this connection that standardized tests have a contribution to make. They provide a measure of the potentiality of each person, or his capacity for learning. They provide a standard of comparison by means of which the performance of a pupil can be compared with the performance of other pupils of the same age and the same grade. They afford a basis for regular measurement or growth over an extended period of time. They help to identify strength or weakness in some areas.

Most standardized tests enjoy the characteristics of reliability and validity that no teacher-made test can hope to achieve.[39]

Summary

From the foregoing summary of related literature, the following conclusions may be drawn:

1. Little research is available concerning an accepted sequence of mathematics courses for secondary schools.

2. More guidance is needed at the junior high school level if students are to make decisions concerning enrollment in high school mathematics.

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[39] New York Education Dept., op. cit., pp. 73-74.

3. Algebra courses should be open to any ninth grade student with grouping and instructional changes in the course of study to fit each class.

4. The student must be able to achieve at his own level of learning.

5. The methods of teaching must provide interest, attention, participation, and some degree of success.

6. Any change in the ninth grade mathematics program should tend toward the goal of mathematics for all high school youth. The results of any program can be evaluated by a good testing program. Any change in the content and instruction should be justified by the use of standardized tests.

CHAPTER III

THE EXPERIMENT

Introduction

Harold Alberty, in his book Reorganizing the High School Curriculum, says: In general, procedures that are proposed for curriculum development presuppose that an entire school, or system of schools, is embarked upon a curriculum revision program. Very frequently this situation does not prevail. What then of the individual teacher who wishes to improve his work? What can he learn from the studies of curriculum procedures? Within certain limits, fixed by the organization of the curriculum of the school, he may utilize either the social-functions approach or the adolescent-needs approach to improve his teaching. He may, for example, select and organize the learning activities in his field in such a way as to touch upon the crucial problems in all aspects of living. This would serve to broaden his work and to bring it more directly into relationship with present day living at the same time. He may study his students in the light of general trends in adolescent development; discover their needs, interests, and problems; and organize his learning activities in such a way as to help the adolescent to meet his problems, satisfy his needs, and extend and enrich his interests. And he may well find that the two procedures supplement each other.[40]

Research has been used in many professions and there has been much progress on the basis of the findings. Educators have been very lax in their efforts to prove that their educational practices are grounded on research.

While certain kinds of problems can be solved, only by highly trained research specialists, other problems of equal importance can be solved only as teachers, supervisors, and principals become researchers. This represents a highly important extension of the role of research in education, and it requires some important developments in research procedures.[41] This type of research is often known as action research, rather than "pure" research.

The current study is in accord with this point of view.

The faculty of the Bristow High School realized there was a problem in the ninth grade mathematics teaching-learning situation. Before making changes in the program, the staff decided to undertake some action research in a classroom situation. Each class, freshmen, sophomores, juniors, and seniors is divided into four sections, multiple sections of algebra could be taught by the same teacher. The classes

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[40]Harold Alberty, Reorganizing the High School Curriculum, (New York: The Macmillan Co., 1947), p. 215.

[41]Stephen M. Corey, Action Research to Improve School Practices, (New York: Bureau of Publications, Teachers College, Columbia University, 1953), p. v.

could be compared and the findings concerning their progress could be recorded to see whether or not the students would show improvement in their mathematics concepts, understandings, and generalizing of information as well as in the mechanical skills of algebra and arithmetic. The writer was assigned to teach four freshman mathematics classes.

Design

The eighth grade students of Bristow High School were given the Science Research Associates Achievement Test in February, before they entered the ninth grade in September. When each student enrolled for the ninth grade, a committee of the faculty checked his placement on the mathematics section of the test. Most of the students who were enrolled in algebra by this committee scored tenth grade or above on the S.R.A. test. When the enrollment had been completed there were four sections of ninth grade mathematics. Two were algebra; and two were general mathematics.

The first algebra section had thirty-four members, while the second algebra section had twenty-nine members. The first general mathematics class had thirty-two members and the second general mathematics class had thirty-seven members.

When the classes met in the fall, rolls of all classes were studied in respect to the results of the S.R.A. test. Twelve students enrolled in general mathematics rated tenth, eleventh, or twelfth grades in arithmetic skills. This enrollment in general mathematics may have been the result of deliberate choice or lack of information and guidance, or a line of least resistence. The writer believed that general mathematics would be a waste of time for these students. The algebra program was explained to them and the better students were given a chance to change to an algebra class. Nine students took advantage of the opportunity to change and entered the algebra class, leaving three students with high scores in arithmetic in the general mathematics class. The rearranged groups then contained thirty-eight students in one algebra group and thirty-five students in a second algebra group. There were twenty-four students in one general mathematics group, and there were thirty-five students in the other general mathematics group.

The classes were again checked for ability. One algebra class had more of the higher or faster group and the other had more of the average students and only a few very good ones. These good students were moved to the faster group so that one group would be very high and the other a very average class of students. This latter class of thirty-five students became the control group.

The two general mathematics classes were checked to ascertain test results and were observed for general alertness in the classroom. One class had a few very alert and willing people, but they lacked experience and practice in mathematics procedures. The other class was a very diversified group. Some were average and willing to try; others were very timid and followed the line of least resistance. This was an average low class so it became the experimental group and contained twenty-four students.

The control group and the experimental group were given the Iowa State Algebra Aptitude Test and the Otis Mental Maturity Test. These test results, together with the mental age, chronological age, and achievement scores for each student, were tabulated.

Each group was to be taught algebra. The content of the courses was to be similar, but the methods used in conducting the classes were to be different.

<u>Problems of Instruction</u>

After the groups had been established, the problem of instruction was considered. An effective program in algebraic instruction must strive to help the student do the following: gain an appreciative understanding of significant algebraic concepts; develop skill in using fundamental algebraic techniques; acquire a significant comprehension of the fundamental characteristics of functional thinking and of the importance of seeing things in relation to each other; attain moderate proficiency in the use of algebraic symbolism; and comprehend its effectiveness as an aid in organizing, analyzing, and generalizing information and experience. To be effective, any program of algebraic instruction must give as much emphasis to the development of associative skills as to manipulative skills.

Many plans have been devised to provide efficient instruction for students of different abilities. Ability grouping, honors' courses, supervised study, differentiated curriculums and assignments, and individual attention have been most prominent among provisions suggested for taking care of both the inferior and superior student.

Fehr's hypothesis "that the mathematics for these students will and must be the same as the elementary portions of the curriculum for the college bound. It is merely a longer time, with more concrete illustrations that are needed for the slow learner, and not a different type of curriculum," applies here.

The classroom procedures to be used with the experimental group were quite different from those used with the control group. The textbooks used for the regular algebra course include sample problems, easy problems, more difficult problems and "star" problems for better students. According to the publishers, the average algebra student should be able to work all the easy problems and most of the more difficult ones.

In the regular algebra class, daily assignments were made at the beginning of the class. The new work was discussed, the previous work was reviewed, and sample problems were worked on the board. The student followed the problems in the books. The student then worked on the assignment for the remainder of the class period in a supervised study period. Questions were answered and difficulties were explained at this time.

The better students could finish most of the problems during class time and could work on the "star" problems. The average student could get part of the difficult problems and could do the rest for homework on in study hall.

The students in the experimental group in this study were given more time for a review of groundwork and explanations were given in the simplest words. More sample problems, from other sources, were presented and the students were helped with the first few problems. These students, as a rule, were slow in motion as well as slow mentally. They could work about ten problems whereas the other group would work twenty. The slow group did what they could and tried to be accurate.

The development and understanding of algebraic concepts was stressed in each class, so that each student would understand what he was doing as well as develop mechanical skills in working the problems. The help given them by the teacher during class period prevented these students from seeking outside assistance and caused them to do their own work.

Testing

The testing program during the year, consisted of teacher-made tests, given every six weeks in the first semester and then the semester test over all the material.

The results of the first six weeks teacher-made tests are given in Table II. The second six weeks results are shown in Table III. The data for the first semester test are given in Table IV.

During the second semester teacher-made tests were given each nine weeks. The results of the first nine weeks are listed in Table VI. The second nine weeks test data are listed in Table VII.

The Larson-Greene Unit Tests in first-year algebra were used during the year as each unit was completed. The scores were tabulated at the end of the first semester and again at the end of the second semester. The first semester results for both the experimental and control groups are given in Table V. The second semester results for this test are listed in Table VIII.

Summary

Curriculum change should be based on research and factual information. The problem of improving the mathematics program of the Bristow High School included questions concerning the place of a general mathematics course in the high school and whether or not all high school students could be profitably enrolled in algebra. To answer these questions, the faculty proposed "action research" in a freshman class.

The writer proposed an experiment in which one group of students regularly enrolled in algebra, and a second group of students enrolled in general mathematics would both be taught algebra and the results of the instruction compared. The same course outline would be followed in each group; the same texts would be given; but instructional procedures would be varied. Progress in algebra would be compared. Progress in arithmetic could also be measured.

The findings of the study will be found in Chapter IV.

CHAPTER IV

FINDINGS, CONCLUSIONS, RECOMMENDATIONS

Findings

When the experiment described in Chapter III was initiated, there were twenty-four pupils in the experimental group and thirty-five pupils in the control group. Because of schedule changes, transfers, and drop-outs, complete data could be secured for only eighteen students in the experimental group and for only twenty-one students in the control group.

Data concerning the I.Q., Algebra Aptitude, and Mathematics Achievement Test scores of these thirty-nine students are shown in Table I.

The I.Q. range for the control group was twenty-two points, from 100 to 122, with a median I.Q. of 114. The I.Q. range for the experimental group was thirty-five points, from 84 to 119, with a median I.Q. of 101. Only one student in the control group had an I.Q. score higher than any student in the experimental group. Nine students in the experimental group had I.Q. scores below those of any students in the control group.

The Algebra Aptitude scores for the control group were from 38 to 84, a difference of 46 points. The Algebra Aptitude scores for the experimental group were from 30 to 56, a difference of 26 points. Twelve of the eighteen students in the

TABLE I

Initial Test Series for Students Included

in the Experiment

Control Group				Experimental Group		
I.Q.	Algebra Aptitude	Mathematics Achievement		I.Q.	Algebra Aptitude	Mathematics Achievement
1. 122	64	11-9		1. 119	50	8-9
2. 118	76	11-6		2. 118	44	10-5
3. 118	84	11-9		3. 110	50	8-5
4. 117	83	11-9		4. 110	46	9-4
5. 117	53	9-9		5. 109	56	7-6
6. 117	70	10-8		6. 108	48	7-8
7. 116	65	11-2		7. 105	43	6-2
8. 116	66	10-4		8. 105	35	9-3
9. 116	61	11-9		9. 104	45	7-9
10. 116	66	10-8		10. 98	30	8-4
11. 114	62	9-2		11. 94	38	6-4
12. 112	68	10-8		12. 93	49	7-7
13. 110	58	10-5		13. 93	34	7-6
14. 110	38	10-3		14. 91	41	7-2
15. 108	60	10-2		15. 91	35	7-4
16. 107	51	9-8		16. 84	46	8-4
17. 106	50	10-5		17. 84	30	6-5
18. 103	78	11-2		18. 84	36	5-0
19. 103	59	11-1				
20. 102	60	9-4				
21. 100	57	9-6				

Median I.Q.--114
Median Algebra Aptitude--63
Median Mathematics Achievement--
10-6

Range

I.Q.--22 points
Algebra Aptitude--46 points
Mathematics Achievement--
2 years, 7 months

Median I.Q.--101
Median Algebra Aptitude--42
Median Mathematics Achievement--
7-8

Range

I.Q.--35 points
Algebra Aptitude--26 points
Mathematics Achievement--
5 years, 5 months

experimental group had Algebra Aptitude test scores equal to or better than the lowest Algebra Aptitude test score in the control group. Seventeen of the twenty-one students in the control group had Algebra Aptitude scores higher than the highest aptitude test score made by any student in the experimental group.

The Achievement Test scores for the control group ranged from grade 9-2 to grade 11-9, a range of two years and two months. The Achievement Test scores for the experimental group ranged from grade 5-0 to grade 10-5, a range of five years and five months. Only three students in the experimental group had Achievement Test grade scores equal to or above the lowest achievement Test score of any student in the control group. Eight students in the control group had higher Achievement Test scores than did any student in the experimental group.

From these data, the conclusion may be drawn that the greatest differences between the groups were at the upper and lower extremes of the test scores. In general, the control group was superior in intelligence, algebra aptitude, and achievement. The least difference between the groups was in algebra aptitude.

Tables II, III, IV, and V are composed of data for the first semester testing.

Tables II and III contain data relative to scores made by each group on the six weeks examinations given during the first semester. These were teacher-made tests. The range of

TABLE II

Comparison of Scores on Teacher-made Test #1

(First Semester)

Scores Made	Control Group	Experimental Group
	Frequency	Frequency
40-41	2	2
35-39	3	
30-34	7	
25-29	4	6
20-24	2	
15-19	3	3
10-14		3
5-9		3
1-4		1
	Median 31.5	Median 18
	Mean 28	Mean 22.5
	Range 25 points	Range 40 points

scores on the first test (Table II) was much greater in the experimental group than was the range of scores for the control group. The ranges were 25 and 40 points respectively. The median score for the control group was 31.5; the median score for the experimental group was 18, a difference of 13.5 points between the groups. A study of the table reveals however, that eleven students in the experimental group had scores equal to or above the lowest score made by any student in the control group. Two students in the experimental group had scores equal to the two highest student scores in the control group. On this test, the greatest difference between the groups was at the lower end of the test scores.

The range of scores on the second teacher-made test are given in Table III. The range of scores for the control group was 40 points; the range of scores for the experimental group was 30 points. Thus, the range of scores for the control group is increasing; the range of scores for the experimental group is decreasing. On this test, seven students in the control group scored higher than any student in the experimental group. Only two students in the experimental group scored lower than any student in the control group. The median score for the control group was 30; the median score for the experimental group was 23.5. This is a difference of only 6.5 points as contrasted with a difference of 13.5 in the medians in the first tests.

Again, this test indicates a greater difference at the extremes. The most difference is apparent at the upper end of distribution.

TABLE III

Comparison of Scores on Teacher-made Test #2

(First Semester)

Scores Made	Control Group	Experimental Group
	Frequency	Frequency
40-49	1	
35-39	7	
30-34	4	1
25-29	3	2
20-24	2	10
15-19	3	3
10-14	1	
5-9		2
	Median 30	Median 23.5
	Mean 27	Mean 21
	Range 40 points	Range 30 points

Data relative to the final first semester examination are given in Table IV. This again was a teacher-made test. The range of scores for the control group was 60 points; the range of scores for the experimental group was 55 points. Two students in the control group had scores higher than any student in the experimental group; one student in the experimental group scored lower than did any student in the control group. The difference in the medians was 20 points. Two-thirds of the students in the control group scored above the median of the experimental group.

These data show that the greatest difference between the groups was at the upper and lower extremes of the range.

The Larson-Greene Algebra Test (Standard Test) was given at the end of the first semester. Data for this test are shown in Table V. A study of the table shows that the range of scores for both groups was identical, 19 points. There was a difference of 2.8 points in the medians. One student in the experimental group had a test score equivalent to the score made by the seven highest students in the control group. Two students in the control group had test scores in the same low group as did three students in the experimental group. The results of this examination show a marked similarity between the groups.

Tables VI, VII, VIII, and IX contain a summary of the second semester testing.

Tables VI and VII contain summaries of the teacher-made tests given during the second semester.

TABLE IV

Comparisons of Scores on

Teacher-made Semester Examination

Scores Made	Control Group	Experimental Group
	Frequency	Frequency
60-65	1	
55-59	1	
50-54	1	1
45-49	1	
40-44	7	
35-39	4	
30-34	1	1
25-29	1	5
20-24		3
15-19	1	4
10-14	2	3
5-9	1	
0-4		1
	Median 40	Median 20
	Mean 35.5	Mean 17
	Range 60 points	Range 55 points

TABLE V

Comparison of Scores on Larson-Greene Algebra Test

(First Semester)

Scores Made	Control Group	Experimental Group
	Frequency	Frequency
15-19	7	1
10-14	9	4
5-9	3	10
0-4	2	3
	Median 12	Median 9.2
	Mean 12	Mean 19
	Range 19	Range 19

A study of Table VI reveals that the range of scores for the control group was 30; the range of scores for the experimental group was 25 points. The difference is five points. The median for the control group was 23; the median for the experimental group was 20. The difference is three points. Six students in the control group scored higher than did any student in the experimental group. Two students in the experimental group scored lower than did any student in the control group.

A study of Table VII reveals that the range of scores for the control group was 19 points; the range of scores for the experimental group was 14 points. Twelve students in the control group had higher scores than did any student in the experimental group. Seven students in the experimental group had scores lower than did any student in the control group. The medians for the groups show a difference of 10 points. This test shows an increasing difference between the groups at both the upper and lower extremes of the scale.

A study of Table VIII, which contains results of the second testing with the Larson-Greene test, shows a range of 45 points within the control group and a range of 30 points within the experimental group. The medians for the groups show a difference of 22.5 points. Nineteen students in the control group scored higher than did any student in the experimental group. Twelve students in the experimental group scored lower than did any student in the control group.

TABLE VI

Comparison of Scores on Teacher-made Test #3

(Second Semester)

Scores Made	Control Group	Experimental Group
	Frequency	Frequency
35-39	5	
30-34	1	
25-29	1	1
20-24	9	8
15-19	3	4
10-14	1	1
5-9	1	2
0-4		2
	Median 23	Median 20
	Mean 24	Mean 17
	Range 30 points	Range 25 points

TABLE VII

Comparison of Scores on Teacher-made Test #4

(Second Semester)

Scores made	Control Group	Experimental Group
	Frequency	Frequency
20-24	3	
15-19	9	
10-14	4	2
5-9	4	9
0-4		7
	Median 15.5	Median 5.5
	Mean 14.5	Mean 5
	Range 19	Range 14

TABLE VIII

Comparison of Scores on Larson-Greene Algebra Test

(Second Semester)

Scores Made	Control Group	Experimental Group
	Frequency	Frequency
65-69	1	
60-64		
55-59	1	
50-54	1	
45-49	7	
40-44	4	
35-39	5	
30-34	1	2
25-29	1	4
20-24		2
15-19		4
10-14		4
5-9		2
0-4		
	Median 41	Median 18.5
	Mean 39	Mean 19.5
	Range 45	Range 30

Table IX contains a comparison of the Arithmetic Achievement Test scores for each group as indicated by pre-test scores, made in 1957 and final test scores made in 1958. A study of this table shows that twelve students in the control group showed arithmetic gains while nine showed losses. Fourteen of the students in the experimental group showed arithmetic gains while four showed losses. Thus, 57 per cent of the control group and 77 per cent of the experimental group showed gains in arithmetical skills. This is a difference of 20 per cent in favor of the experimental group.

A summary of the data given in Tables II through IX shows:

1. The range in achievement scores became increasingly greater for the control group.
2. The range in achievement scores became increasingly less for the experimental group.
3. The difference between the groups in median scores became increasingly greater.
4. As the year progressed, more and more students in the control group exceeded the median score of the experimental group. On the final test, the scores of the entire control group exceeded the median score of the experimental group.
5. The difference between high scores became increasingly greater. On the final test 19 students in the control group made higher scores than did any student in the experimental group.
6. The differences in low scores became increasingly

TABLE IX

Progress Report

Arithmetic Skills

S.R.A. Test 1957 and 1958

Control Group			Experimental Group		
1957	1958		1957	1958	
1. 11-9	12-8	+	1. 8-9	9-0	+
2. 11-6	13-8	+	2. 10-5	15-9	+
3. 11-9	14-5	+	3. 8-5	9-0	+
4. 11-9	10-5	−	4. 9-4	12-7	+
5. 9-9	13-3	+	5. 7-6	8-7	+
6. 10-8	10-7	−	6. 7-8	10-7	+
7. 11-2	13-6	+	7. 6-2	8-8	+
8. 10-4	10-3	−	8. 9-3	8-3	−
9. 11-9	12-8	+	9. 7-9	7-7	−
10. 10-8	10-5	−	10. 8-4	10-0	+
11. 9-2	10-5	+	11. 6-4	7-8	+
12. 10-8	9-8	−	12. 7-7	6-7	−
13. 10-5	10-8	+	13. 7-6	9-6	+
14. 10-3	11-0	+	14. 7-2	7-2	−
15. 10-2	10-1	−	15. 7-4	8-9	+
16. 9-8	9-1	−	16. 8-3	9-0	+
17. 10-5	12-2	+	17. 6-5	7-6	+
18. 11-2	12-5	+	18. 5-0	7-2	+
19. 11-1	10-1	−			
20. 9-4	9-4	−			
21. 9-6	10-5	+			
12 gains	9 losses		14 gains	4 losses	

greater between the groups. On the final tests twelve students in the experimental group made lower scores than did any student in the control group.

7. The experimental group showed a greater gain in arithmetical skills than did the control group.

Additional data concerning the progress of the students in algebra are found in Graphs 1 through 7. These graphs indicate that each group made progress. The growth curve is a normal curve for each group. Curves on both teacher-made and standard tests follow similar patterns. These graphs further substantiate the findings on page 69.

Summary

The problem of the study was to determine whether or not beginning algebra can be taught successfully to all ninth grade students in Bristow High School.

In Chapter I, the community, the pupils and their parents, and the current mathematics program of Bristow High School are discussed. The need of the study is demonstrated and the plan for the experiment is presented.

In Chapter II, a review of pertinent literature is given.

In Chapter III, the design for the study is presented. Ninth grade students in Bristow High School are enrolled either in algebra or in general mathematics. Two of the four ninth grade groups were chosen for the experiment. The control group consisted of 21 pupils with I.Q.'s from 100 to 122, who scored tenth grade or better on the S.R.A. Arithmetic Achievement test. The experimental group was composed of 18 students with I.Q.'s from 84 to 119, all but three of whom scored below tenth grade in the S.R.A. Arithmetic Achievement Tests. Each group was taught by the same teacher. Similar course content was presented and similar materials were used. The methods of teaching were different for each group.

The same teacher-made and standard achievement tests were given to each group. Scores were tabulated and results of the testing were compared. The findings of the study are shown in Tables II through VII in Chapter IV, and in Graphs 1 through 7.

From these findings, the following conclusions are drawn:

1. Students in Bristow High School, ordinarily assigned to general mathematics courses can learn algebra.
2. Grades in previous mathematics courses did not correlate highly with grades in the Algebra I course. Hence, such grades should not be used for predictive purposes.
3. More time should be given for slow learning students to cover the content of the usual algebra course, since progress of the slower group was less during the second semester than during the first semester.
4. The arithmetic skills of the slow group showed greater gains than did the arithmetic skills of the better group, showing perhaps that lack of interest in arithmetic had been a factor in poor grades rather than a lack of ability.

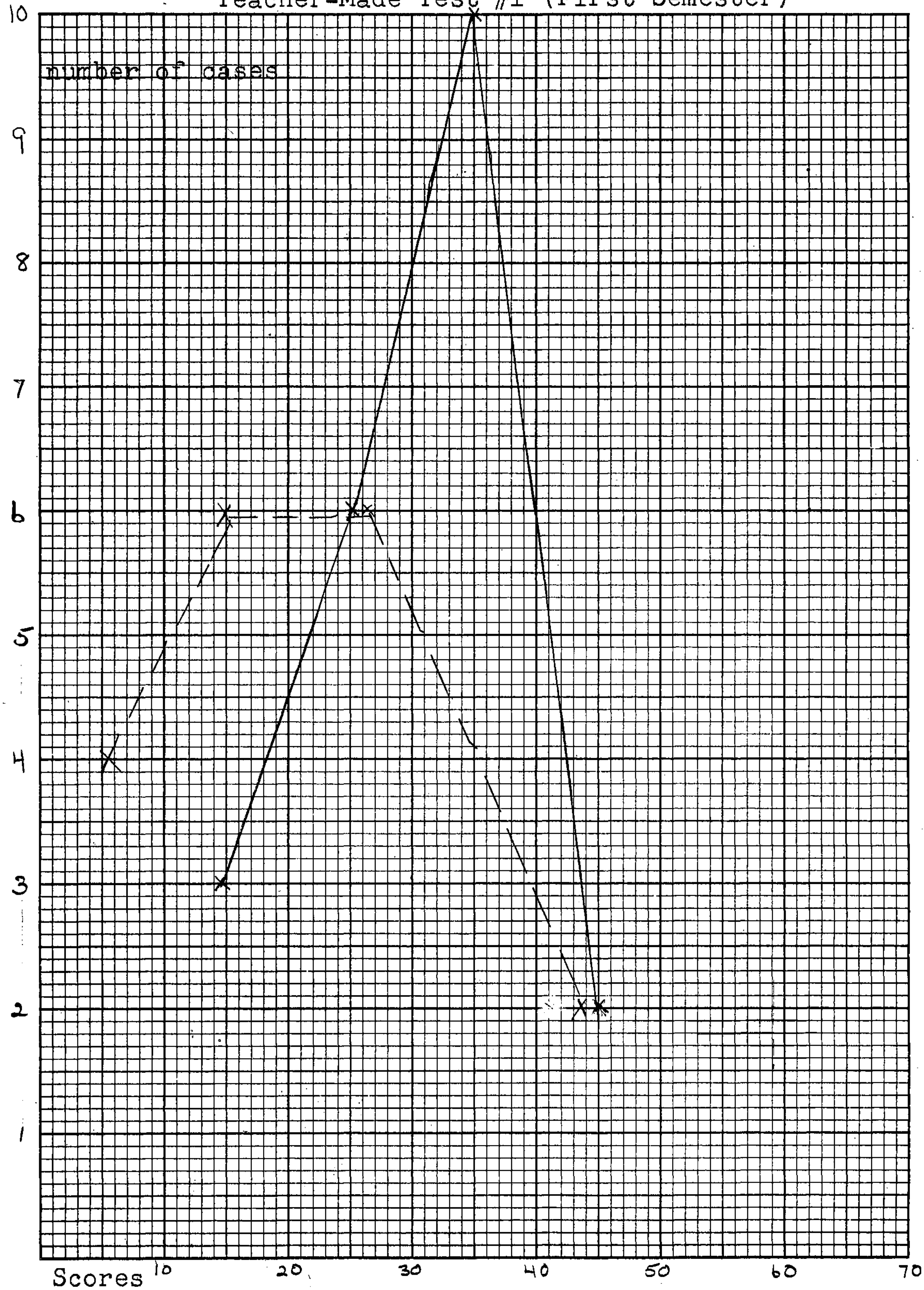
Recommendations:

The writer recommends that:

1. all students entering Bristow High School be afforded an opportunity to enroll in algebra.
2. slow learning students be allowed a longer period to cover the content covered by regular students in one year.
3. arithmetic scores should not be used as predictive measures for success in algebra.
4. this experiment, or a similar one, be repeated several times with other groups to validate and extend the findings of the study.

GRAPH 1

Teacher-Made Test #1 (First Semester)

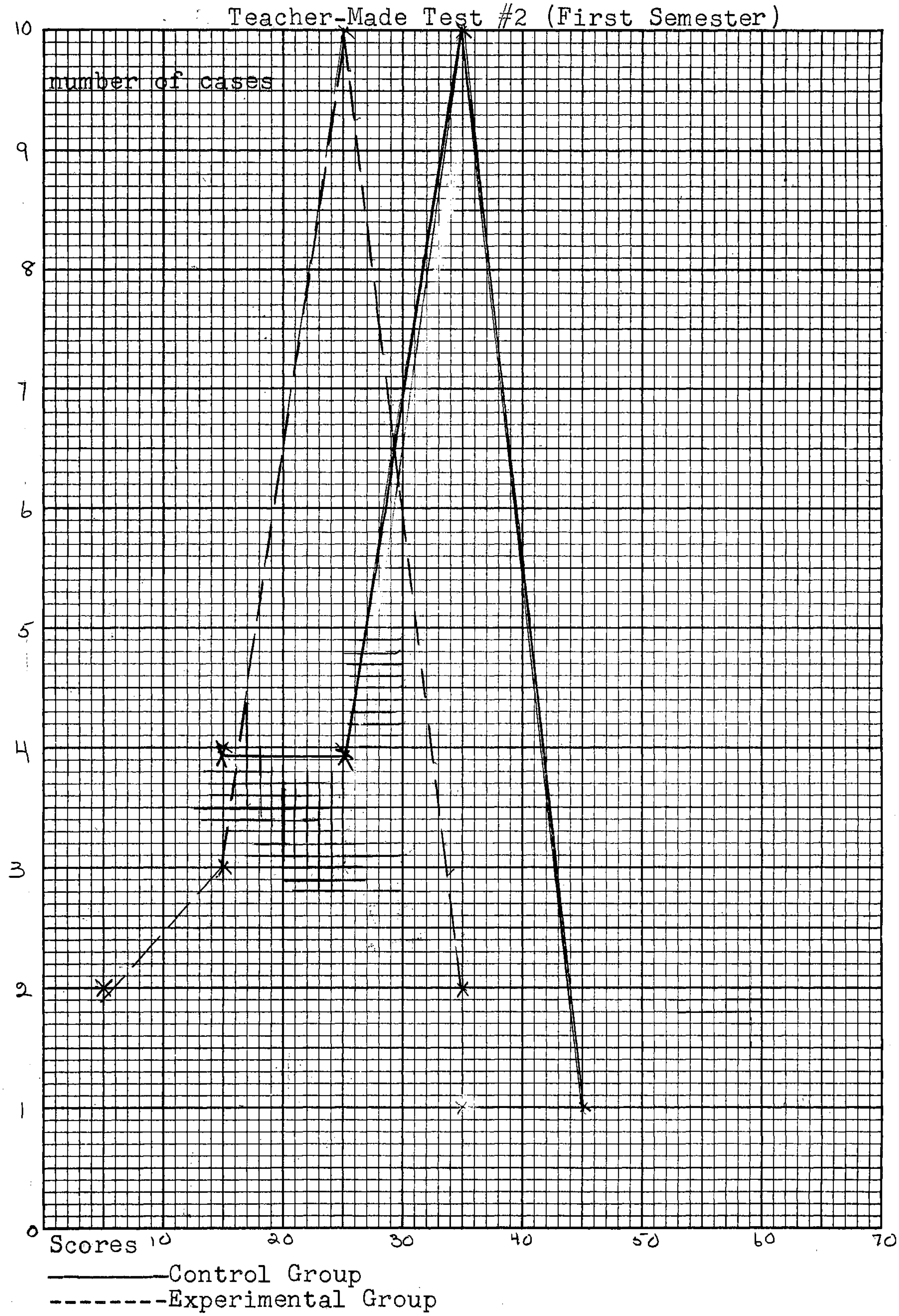


_______Control Group

--------Experimental Group

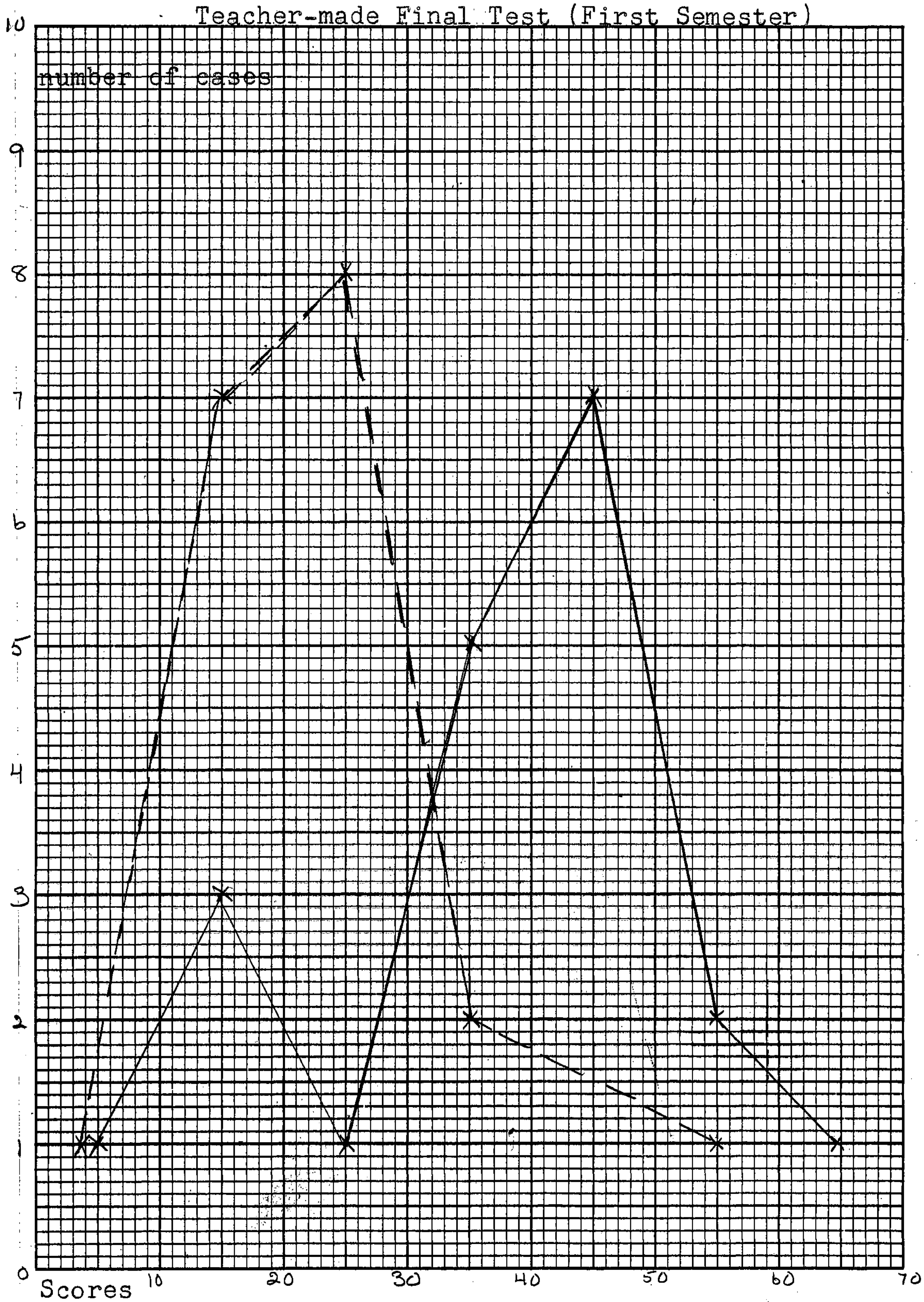
GRAPH 2

Teacher-Made Test #2 (First Semester)



GRAPH #3

Teacher-made Final Test (First Semester)

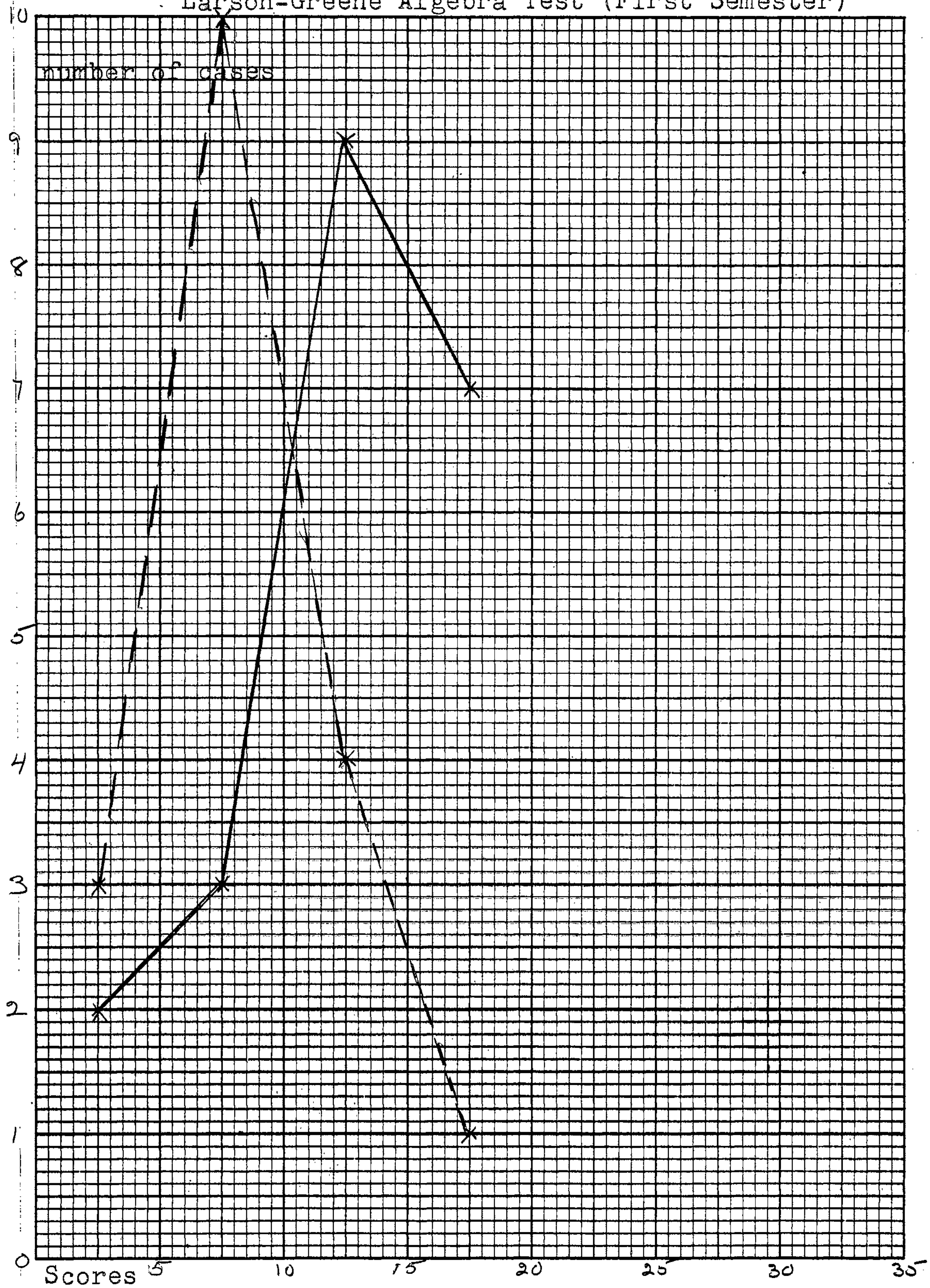


——————Control Group

--------Experimental Group

GRAPH #4

Larson-Greene Algebra Test (First Semester)

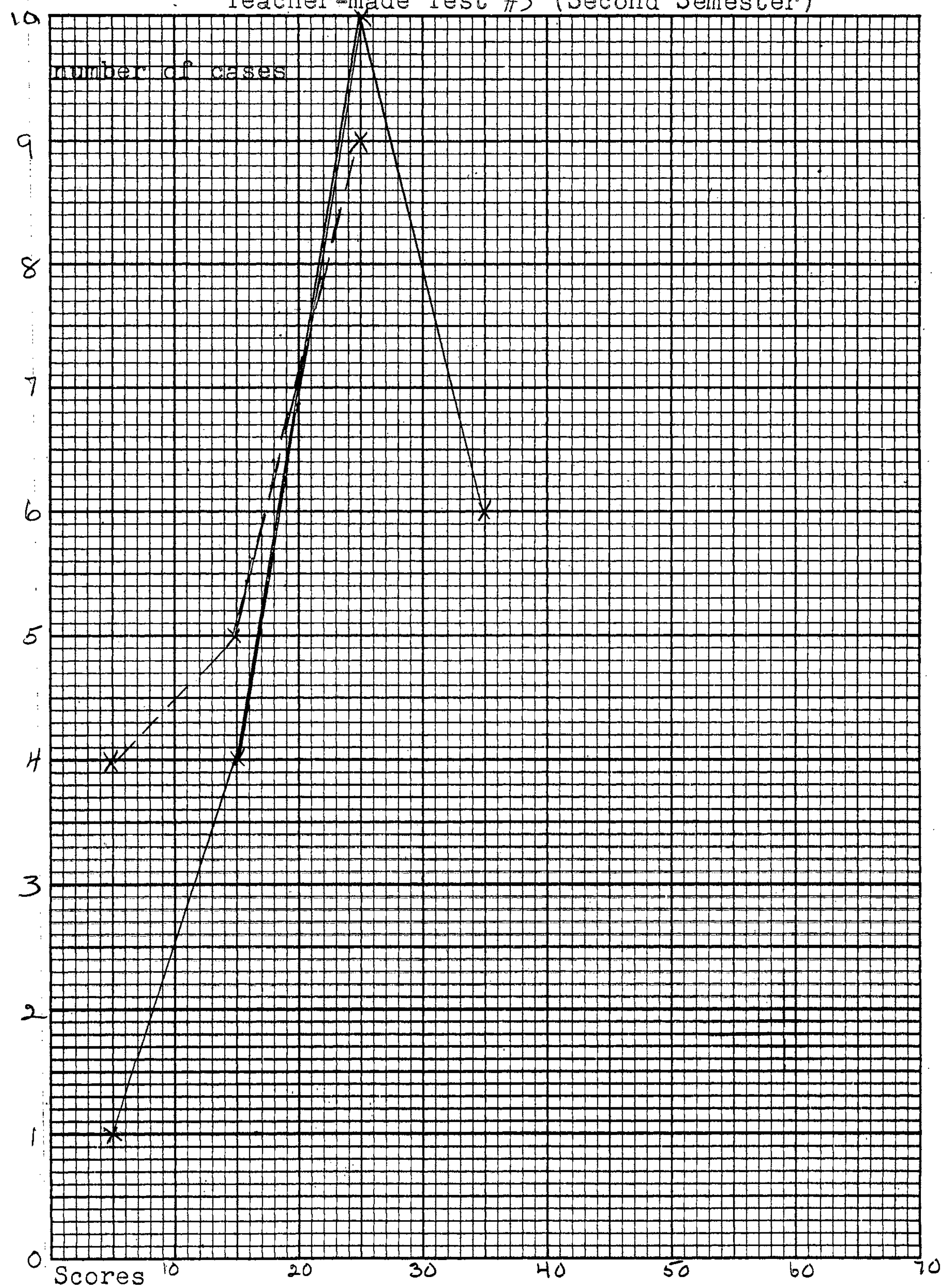


———— Control Group

- - - - - - - Experimental Group

GRAPH #5

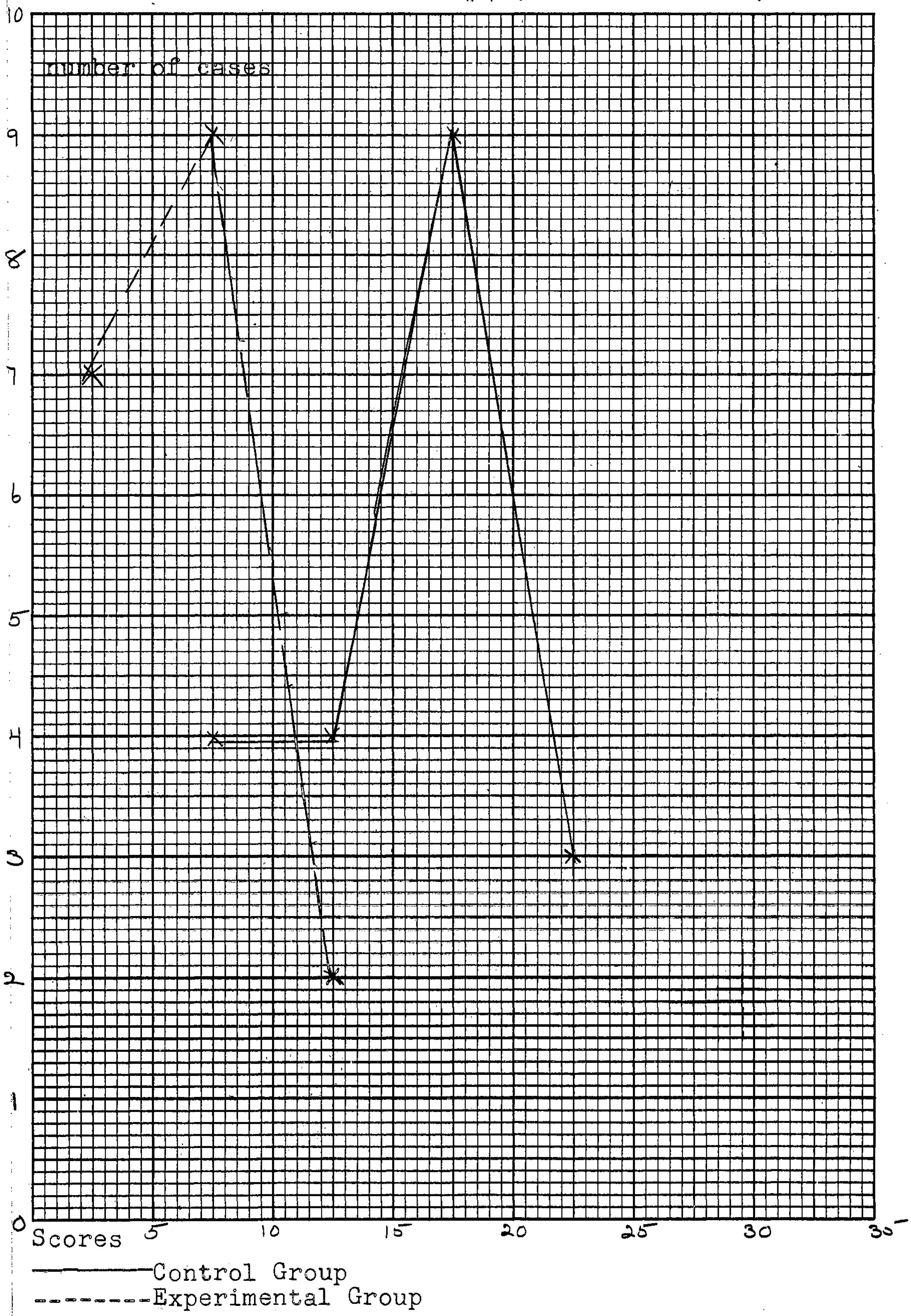
Teacher-made Test #3 (Second Semester)



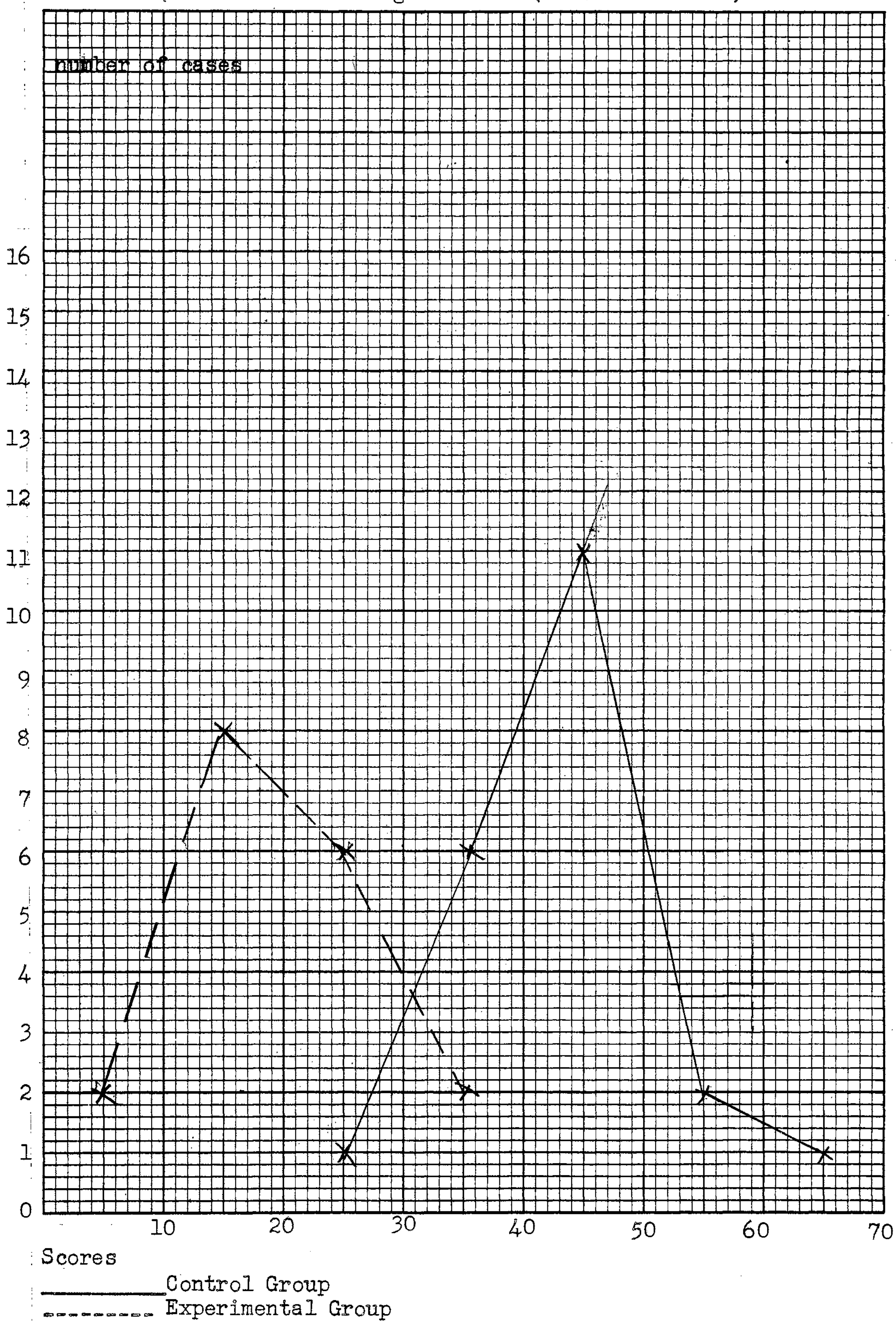
——————Control Group

--------Experimental Group

GRAPH #6
Teacher-made Test #4 (Second Semester)



GRAPH #7
Larson-Greene Algebra Test (Second Semester)



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