AN ANALYSIS OF THE METHODS BEING USED TO MAKE PROVISIONS FOR OUTSTANDING HIGH SCHOOL MATHEMATICS STUDENTS IN NORTH CAROLINA

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TABLE OF CONTENTS

Chapter		Page

LIST OF TABLES

Table		Page

Table | Page

Table Page

CHAPTER I

INTRODUCTION

In the past generation, one problem in public education in this country has been the neglect of the superior student. It is a proper American boast that never before in history has any country educated such a large number of its youth to such high levels. But the appalling fact is that the egalitarian spirit has tended toward the average student.[1]

Teachers and administrators are just beginning to realize that equality of educational opportunity is not to be achieved by causing every individual to have identical educational experiences. As a result, considerable effort has been made to discover and apply educational methods that will enable adequate provisions to be made to meet the needs of slow learners. Unfortunately, the ability of superior students to overcome the deficiencies of their education has tended to obscure the necessity for exerting similar efforts on their behalf. Recent developments, however, have helped to reveal the very special needs of superior students.[2]

In many schools, provisions for outstanding students are limited to acceleration; that is, outstanding students are taught at an earlier chronological age the same subjects that regular students are taught. While this is better than doing nothing at all, it does not necessarily deal with the really significant problem of what is the best education that can be provided for the gifted child.[3]

Gifted children need both a qualitatively and a quantitatively different education from that offered to so-called average students. The bright youngster has a capacity to make generalizations and abstractions and thus can go deeper as well as faster. He can discover for himself what others have to be led to see.[4]

It has been long recognized that certain classes of children -- the physically handicapped and the mentally retarded -- require teachers with special training. The same consideration has not been extended to the teachers of gifted students. The special demands made on the teacher of gifted students should be recognized, and these teachers should be specially trained for the job. Adequate knowledge of subject matter is, of course, one of the important requirements; however, this knowledge alone is not sufficient. The importance of individual research, for example, requires that teachers of the gifted students should be familiar with research methods and procedures.[5]

The growing shortage of scientists, engineers, and technicians in this country indicates one area that perpetuates the need for study and improvement in the education of superior students. Even if all youths presumed to have the ability to complete training necessary for high level responsibilities were to do so, as pointed out by Getzel and Jackson,[6] manpower shortages in some areas would still exist. Estimates reached were based on a definition of "giftedness" which assumes that our highest potential is to be found in the upper three per cent of the general population, as measured by scores on standardized tests of intelligence.

The success of the United States in continuing its scientific, technological, and ideological leadership in world affairs is influenced by its success in developing and utilizing its resources of human talent. Conclusions of studies related to the subject have led to a re-evaluation of the high school program in light of the opportunities offered to gifted students.[7] Thus it is not surprising to find that the number of programs in mathematics for talented students has increased since the advent of Sputnik.

Because urbanization and the complexities of our society have created a need for well trained persons in diverse fields, it is not the intention of the public schools to make mathematicians of all students. However, the need for competently trained persons in mathematics exists in all walks of life, and the secondary schools have a responsibility in helping to meet the need. In order that the schools be as effective as possible in assuming and executing this responsibility, it is worthwhile to investigate current conditions. One purpose of this investigation, therefore, is to study the practices regarding the education of outstanding mathematics students. Such an investigation should prove useful both in the evaluation of present conditions and in suggesting ways to improve the education of outstanding students. While the investigation is limited to secondary schools in the state of North Carolina, it is expected that the findings can be used in similar situations in other states.

Statement of the Problem

Pressures being exerted on the United States to maintain its position in the technological and scientific race have focused much attention on high school mathematics students. One way of meeting the grave needs of science and technology is to encourage the development of each individual to his optimal creative potential. This observation has led to the realization that gifted students, like retarded students, have special needs. Their needs cannot be met by causing every student to move with the same speed and depth. Since mathematics is basic to science and technology, the education of mathematics students is one area in which serious attention is needed.[8]

Recent experiments have revealed that meeting the needs of different students in mathematics is a problem in all schools; however, this problem appears to be more acute in schools without multiple sections.[9] Even though in small schools (under 300) it is usually not feasible to have what is ordinarily thought of as a special class, grouping within the regular classes allows some provisions for a small number of outstanding students. Flexible programs for outstanding students may also be provided through special assignments and guidance.[10] The objective of this investigation, therefore, is to determine: What is the nature of the education for outstanding high school students in mathematics and what relationships exist between these and other measurable aspects of the high school?

Because of the broadness of the basic problem, it is necessary to determine specific questions that need to be answered in carrying out the proposed study of the basic problem. The specific questions are as follows:

1. To what extent are provisions being made for outstanding mathematics students?

2. What are the methods of making provisions for outstanding high school students?

3. What factors limit or prevent the use of these methods?

4. What is the relationship between the programs provided for outstanding students and the academic preparation of teachers?

5. What is the relationship between the programs provided for outstanding students and the recency of formal training of mathematics teachers?

6. Are the uses of these methods related to the geographical region, school size, socio-economic status, and administrative policy?

Definitions of Concepts

Even though the terms used in this report are all found in general literature, it is necessary to explain the meanings of certain terms as used in this report. The critical terms used throughout the paper are:

Outstanding student. This term will be used to refer to the topmost level of brightness as selected by teachers on the basis of provided guidelines. These guidelines include the selection of students in each school who fall within the top 15 per cent of the student body, or who possess both highly rated intellect, as determined by I. Q., and intrinsic motivation toward mathematics, or who have indicated by such criteria as achievement tests scores, course grades, and high interest, that they are capable of performing at a high level if the proper provisions are made. The use of the term "outstanding student" is not limited to the "gifted" as defined by Getzel and Jackson,[11] but the gifted fall within this group.

Method. Those procedures, techniques, devices, or practices used in the school environment to provide a unique program for the outstanding student are designated as method.

Geographical region. This term refers to the three distinct divisions of North Carolina -- Piedmont, Mountain, and Coastal Plain -- as described by Hobbs and Bond.[12]

School size. This term is used to refer to the number of students attending the schools within specified size ranges.

Administrative policy. The school's stated or implied procedure for the identification of outstanding students and the providing of programs for them will be referred to as administrative policy.

Socio-economic status. This term will be used to refer to the five-class structure that Havighurst and Neugarten[13] have identified as being characteristic of American population.

Assumptions

Aside from the normal assumptions of any investigation, such as honesty of response, there are certain specific assumptions underlying this investigation. They are:

1. The sample will include schools that are making provisions for the education of outstanding students of mathematics.
2. Schools differ in the extent to which they make provisions for outstanding students of mathematics.
3. There are educational methods of providing for outstanding mathematics students being used by some teachers in some schools that can produce desired results when used by teachers in other schools.

Importance of the Study

The significance of this study lies in the need for some comprehensive study of methods being used in high schools to make provisions for outstanding mathematics students. This report should provide North Carolina school personnel, and hopefully school personnel of other states, with information regarding the existing conditions and should suggest ways in which improvements may be made.

Since a search of related literature reveals an absence of a previous study in this area, such an investigation is needed to arouse the consciousness of the citizens of North Carolina of the increasing need for teachers and for schools capable of meeting the needs of these outstanding students. A study of this type is also needed to provide base line data for further study.

Organization of the Study

The main concern of this chapter has been the nature and background of the problem of providing for outstanding students of mathematics. There was also an endeavor to establish a rationale for the necessity of a study in this area. Then, there was a statement of certain assumptions necessary to carry out the study.

An investigation of the literature is presented in Chapter II. This investigation was prompted by the need to determine what national practices are utilized in providing for outstanding students. Moreover, it grew out of the conviction that an extensive review of the literature would reveal certain problems encountered in trying to provide for outstanding students.

A discussion of the design of the study constitutes Chapter III. Construction and validation of the instrument, selection of schools and teachers, and validities of the study will be the major topics discussed. A discussion of the extent of responses will also be presented.

Chapter IV will be limited to a presentation of objective findings. All interpretations, suggestions, and conclusions will be reserved for the fifth and final chapter.

FOOTNOTES

[1]Robert D. Clark, "Universal Problems in Honors," The Superior Student, VII (November, 1964), 5.

[2]Paul C. Rosenbloom, Talent and Education (Minneapolis, 1960), pp. 181-182.

[3]Ibid., p. 182.

[4]Ibid.

[5]Louis A. Fleegler, Curriculum Planning for the Gifted (Englewood Cliffs, N.J., 1961), p. 179.

[6]J. W. Getzel and P. W. Jackson, "The Highly Intelligent and Highly Creative Adolescent: A Summary of Some Research Findings," Third Research Conference on the Identification of Creative Scientific Talent (Salt Lake City, 1959), pp. 46-57.

[7]Abraham J. Tannenbaum, "History of Interest in the Gifted," Education for the Gifted, Fifty-seventh Yearbook of the National Society for the Study of Education, Part II (Chicago, 1958), p. 34.

[8]Ibid., p. 34.

[9]Bryan Calloway, "A Small School Meets the Needs of Superior Students in Mathematics," Peabody Journal, XLIII (November, 1965), 233-237.

[10]Julius H. Hlavaty, ed., Mathematics for the Academically Talented Student (Washington, D. C., 1959), p. 17.

[11]Getzel and Jackson, pp. 45-47.

[12]Marjorie Bond and S. H. Hobbs, North Carolina Today (Chapel Hill, 1947), p. 9.

[13]R. Havighurst and Bernice Neugarten, Society and Education (Boston, 1962), p. 21.

CHAPTER II

REVIEW OF RELATED LITERATURE

While Chapter I has been essentially a general introduction to the study, this chapter will focus on the related literature. Literature on methods of providing for outstanding students of mathematics will be reviewed, and latest research on the training of secondary mathematics teachers will be presented.

Before 1950, very few research findings appeared in the literature on the educational provisions for outstanding students in mathematics. Since 1960, however, as pointed out in the first chapter, the many studies on the nature of the outstanding student and the numerous experimental programs to provide for the outstanding student have resulted from the realization that outstanding students need an education that is distinctly different from that of the average student.

Nature of the Outstanding Student

Over the years, varying attributes have been settled on the "gifted" student. Once they were considered physically and socially below the average student, but this notion has now been repudiated. Terman,[1] for example, found that students who are superior in mental ability are likely to be superior in other things as well. Terman's studies point out the following abilities often exhibited by gifted children:

1. They use a large number of words accurately and easily.
2. They learn easily and rapidly.
3. They have a longer attention span on challenging material.
4. They ask meaningful questions.
5. They have active interest in a wide number of topics.
6. They comprehend meanings, recognize relationships, and reason clearly.
7. They grasp abstract concepts readily.
8. They use original methods and ideas.
9. They are alert and observant.
10. They have great powers of retention.
11. Their questioning attitudes make them interested in finding out the reasons for observed phenomena. They are constantly asking, "Why?"

Behavioral scientists are making significant efforts to distinguish other behavioral attributes worthy of special educational attention. Creativity, productive thinking (as distinct from reproductive and divergent thinking (as opposed to convergent) are concepts representing attempts to isolate, define, and measure additional significant qualities of mind which relate to giftedness. The development of creativity is now being seen as an increasingly worthy educational objective.[2]

The future mathematicians, whether in pure or applied mathematics, will be drawn from the groups of outstanding students for which we are now providing. Generally, the mathematician is most creative during his twenties and thirties. If a student is to reach his creative potential, he must move surely and swiftly up the mathematical ladder.[3]

Too often the mathematically talented student is discouraged from pursuing mathematics because he finds the pace too slow, too tedious, or even boring. He is asked to do work that provides him with little or no challenge. He is forced to move at a much slower rate and with much less depth than his capacity permits. Why should he not have educational programs which enable him to perform at his maximum potential?[4]

Colleges and universities across the country have taken the leadership in determining the nature of learning and the extent of learning in outstanding high school mathematics students. At Hamline University in St. Paul, Minnesota, classes were held on Saturday to determine if high school students could complete college mathematics and science courses while maintaining their other high school activities and courses.[5] The mathematics courses offered such topics as college algebra, trigonometry, and analytic geometry and calculus. Of the fifty high school students starting the program, 43 per cent received a final grade of B or better, 80 per cent received C or better, and only 20 per cent received D or less. All students continued to do well in their high school courses.[6]

This program was judged generally successful by the director. Two significant revelations resulted from the experiment. First, superior students can do substantially more advanced work, with acceleration and with more depth. Second, outstanding students are receiving top grades in high school with little work, and they expect to continue this level of work in college.[7]

Administrative Provisions for Outstanding Students of Mathematics

Whether the school administration makes provisions for outstanding students depends, in many instances, on the size of the school. In larger schools, ability grouping is one of the major means of providing for the outstanding student. However, more and more schools are grouping pupils by ability as early as the seventh grade.[8]

Identifying the gifted student calls for the best available measure in order to arrive at as accurate an assessment of pupil potential as possible. Screening can be used in initial identification. The process entails the employment of several criteria, such as group measured intelligence, tested achievement, and teacher judgment. An essential consideration in determining the criteria for assessment of pupil potential is that the measure permit students to perform at their optimal level, not a level which has a ceiling imposed on it.[9] In the final analysis, each school individually establishes the criteria for selection of students.[10]

One factor which might influence the establishment of criteria for selecting or judging the gifted student is the socio-economic distribution of the population. For example, a school in a culturally favored suburban community may have an I. Q. cut-off score of 130 in the identification of the gifted. A school located in a culturally deprived community, on the other hand, might have a cut-off score of 120. Thus the inclusion of a certain percentage of the enrollment in the group of gifted students may not be realistic.[11]

Much of the important research on the identification of superior students and on grouping according to ability was done in the early part of the century.[12] Recent research by Conant,[13] Miller,[14] Wrightstone,[15] and Vredevoe[16] tends to support special grouping as a favorable way of meeting the needs of outstanding students. When students are placed in such groups, they can better receive the stimulation, encouragement, and challenge to perform more nearly to their potential.

More can be said in favor of grouping students according to ability. Hlavaty[17] suggest three advantages of ability grouping. First, since talented students do not need as much drill and review as other students, it is possible for them to cover the standard curricular offerings in less time. Thus it is possible to expand the content which these students cover and to provide them with more intense instruction than the average student can manage.

The second advantage of ability grouping is that gifted students are stimulated by working with others of similar ability. The challenge of stiff competition causes them to perform more nearly at optimal level. In such a situation students are helped to develop worthy attitudes of self-respect as well as humility and respect for others.

Third, a curriculum can be developed more easily for a group with similar interests and abilities than for undifferentiated groups. The interests of both the average students and the talented students are more practically served in this case. Moreover, teachers are able to experiment with methods of instruction without failing to meet requirements of the curriculum.

Schools which practice ability grouping should, on the other hand, be cautious in the separation of students into groups. The outstanding students should not be withdrawn from the mainstream of school life. They should be encouraged to participate in social functions, homeroom activities, and athletic events. The assignment of students to special classes should be looked upon as an honor and a privilege. Special care should be taken to instill attitudes of humility and service in students taking part in special classes.[18]

The organization of mathematics clubs is another means of making administrative provisions for outstanding students. These clubs may be organized by grades, by schools, or by school systems, depending upon interests, talent, and resources. Such provisions may be used in addition to, or as an alternative to, grouping according to ability. In schools where it is difficult to provide day-to-day contact between outstanding students of similar interests and abilities, mathematics clubs would be especially beneficial. They would provide opportunities for the students to hear authorities in the fields of mathematics and science and opportunities to hear students from clubs in other schools.[19]

In addition to ability grouping and mathematics clubs, administrative provisions for outstanding students can be made by permitting and encouraging correspondence courses, enrollment in courses offered at nearby colleges, and seminar studies. In cases where small groups of students are interested in topics not included in the curriculum, these provisions are useful. In the past, the most popular method has been to provide correspondence courses or to permit enrollment in courses at nearby colleges. More recently the trend is to provide seminar studies for such groups.[20]

Seminar courses can prove to be practical in schools where there is a limited curriculum or where there is a limited number of students interested in a particular topic or area. Personnel for such courses might come from several sources. When no one on the school staff is competent or is interested in conducting the seminar, an outsider may be called in. He may be an adult from the community, a professor from the community college, or some other resource person.[21]

One of the most important ways for the school administration to provide for outstanding students is to provide a strong curriculum. The 1959 report by Conant[22] on the American high school charged that the curriculum did not present a sufficient challenge for the able student. Conant felt that algebra could be offered as early as the eighth grade. Because eighth grade and seventh grade arithmetic were so similar, outstanding students often felt no challenge, became bored, and lost interest in mathematics as well as in other subjects. Although the Conant report met early opposition, parents and teachers have since come to agree with many of its recommendations.

The secondary school curriculum has been undergoing notable changes in the last ten years. Most significant and most progressive have been the changes in mathematics, mainly because it is one of the fastest growing and most useful subject matter areas. Many of the revisions taking place are aimed at enriching and extending programs to challenge the outstanding students.[23]

In an effort to gather evidence to provide school personnel with insight on the readiness of eighth grade students for courses in algebra, and Dade County school system in Miami, Florida, experimented with two groups of students: one group consisted of thirty-four eighth grade students and the other consisted of thirty-four ninth grade students. Mean average age of the younger group was 13.1 years while that of the older group was 14.2. Students were selected for placement in these groups on the basis of I. Q., achievement in arithmetic, academic ability in all subjects, and opinions of teachers and counselors on such factors as emotional stability, interest, work habits, and regularity of attendance.[24]

Test score results of students involved in the study indicated that age was not a significant factor in the students' achievement in elementary algebra. A more important factor was the extra incentive for studying mathematics. Parents and students alike felt that the challenge of the algebra classes helped stimulate thinking in all areas. Perhaps the most important aspect of such a program was that the total mathematics program was accelerated one full year, thus enabling these students to complete a year of mathematics in high school equivalent to a first year college course.[25]

A pilot program in Charleston, West Virginia, initiated by Pauley was designed to provide for the needs of outstanding students in mathematics. Pauley and his committee developed a sequence of courses and topics to be taught in each grade: accelerated modern arithmetic, elementary algebra, combined plane and solid geometry, trigonometry and college algebra, and mathematical analysis, to be taught in seventh through twelfth grades, respectively. This program was designed to adequately prepare students for more rigorous college mathematics courses.[26]

In an evaluation of the program by principals, teachers, and students, there was general agreement that special classes in mathematics more adequately provide for the needs of the students.

Students involved had improved in their general attitude toward mathematics and standardized tests revealed that they had accelerated as much as three grades.[27]

An inclusion of calculus in the high school mathematics program is a question that has both negative and positive sides. W. Eugene Ferguson[28] taught calculus at Newton (Massachusetts) High School for fourteen years. He outlines, on the basis of his experience, definite conditions that must be met by the school, the teachers, and the students before a school should attempt to offer a course in calculus:

1. The school must offer the prerequisite courses.
2. The school must have at least one teacher on the staff who is qualified to teach bona fide college calculus.
3. The students must be adequately prepared mathematically.

Many feel that the high schools are embarking upon an impossible task in accelerating to place calculus in the curriculum. On the contrary, according to many college professors at top rank universities, students who took calculus in high school are more successful in their college mathematics classes. This is not to say that there are not some failures. Ferguson points out that much of the "failure in high school comes as a result of ill-prepared calculus courses, taught by ill-prepared teachers, taken by ill-prepared students."[29]

At Emerson (Arkansas) High School, considerable experimentation has been going on since 1960 in an effort to find ways that the small high school can meet the needs of outstanding high school students in mathematics. In spite of progress being made, it remains clear that the smaller the high school the more acute is the problem of meeting the needs of these students.[30]

The organizational plan at Emerson involves the scheduling of both general and advanced mathematics in the same room at the same time under the same teacher. The class is divided into two groups, and one-half of the class period is allotted for each group. Each year, as the program progresses, revisions have been made to provide longer periods, programmed materials, outside readings, and advanced assignments. Thus students are able to cover many advanced topics of which they would ordinarily be deprived. While the program is no panacea, it has provided satisfactory answers to some of the problems in dealing with outstanding mathematics students in small schools.[31]

In addition to special high school programs, summer institutes offered by the National Science Foundation and by other organizations seek to make provisions for outstanding high school students of mathematics. These have been offered at many colleges, both private and public, spread across the country. Students attending the institutes have interests ranging from physical science to mathematics to engineering. Courses offered include algebra, geometry, analysis, project seminars, higher algebra, probability, the real number system, and directed reading in mathematics. Generally, competition among these students is high and their standards become the norm.[32] While the programs are not essentially administrative provisions of the high schools, they do provide opportunities for outstanding students to pursue courses beyond the high school level and are sources of stimulating and challenging experiences for the participants.

Classroom Provisions for Outstanding Students of Mathematics

Even though the task of providing suitable instructions for outstanding mathematics students is to be shared by everyone, from the classroom teacher to the national leader of curriculum projects, the crucial element in the implementation of an effective program is the classroom teacher. The teacher, heir to such an influential position in the education of all students, must be sensitive to individual needs.[33]

There are times when the student needs to be provided with guidance and direction. There are other times when he needs to be left alone to explore ideas and concepts at his own pace and as he desires. The talented student, especially, must be provided with ample opportunities to take off on his own; otherwise, latent talent might be stifled. As Gardner has pointed out, "In a democratic society, we have an educational responsibility to afford each of our students the opportunity to achieve the best in him."[34]

The teacher can do many things to help the student "achieve the best in him" once he has been provided with basic tools and ideas. First, it is important to remove the pressure of time. Students need the time to think, to organize, to obtain insight into problems, to choose the appropriate procedure and follow it through.[35] Then students must be presented with meaningful problems and materials without being led to answers and conclusions. They should be given information and should be permitted to decide what to do with it.[36]

Other ways that the teacher can challenge, excite, and encourage the outstanding student of mathematics can be cited. The teacher could:

1. Try to ask meaningful questions at the right time.
2. Include optional honor problems in homework assignments.

Such problems should not be simply longer and harder, but should be problems that lead to new ideas and concepts.

3. Include optional bonus questions on regular tests.

4. Have available a class mathematics library for students to borrow from or browse in during spare time.

5. Encourage the talented student to report to the class on some of his findings, discoveries, and outside readings.

6. Make himself available for consultation and discussion.

7. Show films that would arouse mathematical thought and stimulate interest.

8. Take interested students to a computer center.

9. Encourage talented students to participate in mathematics fairs and contests.

10. Encourage talented students to help others, either on a tutorial basis or mathematics help classes.

11. Know when to "get out of the way": only too often the teacher, instead of accelerating the progress, interferes with it.[37]

Whether students are grouped according to ability or not, several alternatives are available to teachers to work with outstanding students within the classroom. The laboratory method, for example, is pedagogically sound for providing for students of varying abilities in the same classroom. The method utilizes an experimental approach that requires the participation of each student and allows him to work at his own rate. The teacher then has time to administer assistance whenever and wherever it is needed. Moreover, students can learn from each other through discussions of their work.[38]

Another alternative, the expository approach (commonly called "show and tell" or "rule and example" method) is a popular method of teaching students in a class of varying abilities, but it does not meet the needs of all students in the class, particularly the gifted student. The gifted student has the greater capacity for independent discovery and may go unchallenged while others are being led to make the discovery he made some time before.[39]

Of the many books, articles, and research reports dealing with the gifted student and with discovery methods of learning, a considerable number concern themselves with teaching and learning as they relate to outstanding students of mathematics. Wide support for the use of discovery methods with these students is in evidence. Even though the expository approach, guided discovery, and pure discovery are frequently discussed, conclusions based on experimentation indicate that discovery methods are more suitable for teaching mathematics to gifted students.[40]

Guided discovery is defined as the approach to instruction in which the teacher attempts to draw from the students certain information through a series of questions intended to guide the student to eventual discovery of a concept or principle. In the pure discovery approach, students are expected to learn concepts and principles without any assistance; the teacher merely mentions certain items or references.[41]

Mercerie[42] reports a significant conclusion drawn by Apolas after the latter had conducted extensive experimentation involving discovery learning: Pure discovery led to more effective learning and permitted students to gain knowledge in less time than it takes for the teacher to guide them. On the other hand, Gallagher[43] reports that investigations by Hendrix and Bruner on both the pure and the guided discovery methods seem to favor guided discovery over pure. In either type of discovery method, however, the teacher must be cautious, warns French,[44] lest they show signs of being too erudite. If caution is not exercised, students may be led to believe that there is nothing for them to discover for themselves.

Finally, diverse research reports favor the assignment of individual projects as a useful way of providing for outstanding students.[45] In some cases where success of using individual projects has been limited, a lack of planned activities has been a significant factor. In order for projects to be successful, the teacher must have time to plan the periods for students to assemble the work and time to give the proper guidance that is needed. When students are working on individual projects, particularly when they have undertaken a difficult project, it usually proves helpful to set aside three or four consecutive class periods to work on them.[46]

Recommendations for High School Mathematics Programs

The impact of science and technology and the advancing mathematical sciences -- the computer, for example -- will continue to influence the directions of the high school mathematics programs. Already changes are being experienced that were deemed impossible only a few years ago.

Various study groups have been discussing and experimenting with new programs that would eliminate superfluous drill and repetition, thus permitting the coverage in nine years of the concepts that are usually taught in twelve years. The spiral approach -- the practice of exposing the student to a concept on a very elementary level and returning periodically to the concept with increasing depth -- has been recommended as a vehicle for making the nine-year plan effective.[47] The Cambridge Committee has developed a program wherein, using the spiral approach, mathematics now being taught in kindergarten through the fifteenth grade can be taught in kindergarten through the twelfth grade. A description of the program for high school follows.

> Grades seven and eight: Algebra and Probability -- real numbers, polynomial functions, sampling, random variables, statistical estimation, and hypothesis testing.
>
> Grade nine: Geometry -- intuitive and synthetic geometry, Euclidean and vector spaces, conics, and transformations.
>
> Grade ten: Geometry, Topology, and Algebra -- geometry of the complex plane, neighborhoods, continuous functions, mappings, triangular matrices, orthogonal transformation.
>
> Grades eleven and twelve: Analysis -- real numbers, sequences, derivatives, differential and integral calculus, calculus of several variables.[48]

Preparation of Secondary School Mathematics Teachers

A change in the nature of mathematics to include broader concepts has led to new theoretical and practical developments. Many topics now taught in the high school have caused a great number of programs for the preparation of high school mathematics teachers to be deemed inadequate. With the wide variety of programs recommended for high schools and the proliferation of new knowledge, it is essential to prepare teachers who can select intelligently from what is changing in content, pace, and sequence. This requires not only enthusiasm and understanding of the new mathematics, but it also requires depth in the traditional concepts as well.[49]

The large number of study groups on the preparation of secondary mathematics teachers reflects the emphatic changes that have taken place in the entire field of mathematics since 1958. The recommendations made regarding teacher preparation have been many. Two of these recommended programs are described in the following paragraphs.

National Council of Teachers of Mathematics (NCTM)

Ten years ago, one year after the advent of Sputnik, the NCTM described what was considered a model program in mathematics for high school teachers. The program included six areas:

1. Analysis -- trigonometry, plane and solid geometry, and calculus
2. Foundations of mathematics -- theory of sets, mathematical or symbolic logic, postulational systems, real and complex systems
3. Algebra -- matrices and determinants, theory of equations, and structure of algebra
4. Geometry -- Euclidean and non-Euclidean matrices and projective, symthetic and analytic
5. Statistics -- probability and statistical influence
6. Applications -- mechanics, theory of games, linear programming, operation research

The Secondary School Curriculum Committee of the NCTM asserted that, as a minimum, teachers of mathematics in grades nine through twelve should have successfully completed a program of at least twenty-four semester hours in the courses outlined, including a full year of calculus.[50]

For teachers preparing to teach advanced placement mathematics in high school, this ten year old program is now considered inadequate.

Many of the subjects recommended for the preparation of the teachers are now being taught in the high schools. Others, not now being taught in the high school, have been recommended by various commissions to be added to the secondary curriculum.[51]

Committee on the Undergraduate Programs in Mathematics (CUPM)

The Committee on the Undergraduate Programs of the Mathematical Association of America outlined a stronger program for the training of mathematics teachers in 1960. These recommendations are divided into four levels on the basis of subjects taught. Level I concerns a program for elementary school teachers and will not be presented here. The other three levels are:

Level II. Teachers of the elements of algebra and geometry

Level III. Teachers of high school mathematics (This level includes any subjects taught other than the ones in Level IV.)

Level IV. Teachers of the elements of the calculus, linear algebra, probability and advanced placement courses (This is a mixed level, consisting of teachers of advanced high school subjects, junior college teachers, and staff members in the university who teach in the first two years.)[52]

The following table gives a breakdown of subjects recommended by CUPM for each level. The term "course" means a three semester hour course or its equivalence in quarter hours.

In addition to the courses recommended for level three, it is recommended that these teachers have a major in mathematics and a minor in an area that requires considerable application of mathematics. For Level IV teachers, it is recommended that a master's degree be acquired which consists of at least twenty-one hours of graduate

TABLE I[53]

NUMBER OF SPECIFIC COURSES RECOMMENDED BY CUPM FOR VARIOUS LEVELS OF MATHEMATICS TEACHERS

Level	Courses				
	Analysis	Algebra	Geometry	Probability and Statistics	Electives*
II	3	1	1	1**	
III	3	2	2	2**	2
IV	4	2	3	2	7**

*Courses recommended for electives are: algebra, geometry, probability and statistics, real variables, complex variables, number theory, topology, history of mathematics, and high speed computer techniques.

**Indicates that subject should include an introduction to the language of sets.

mathematics, in addition to the thirty-three recommended for Level III. The CUPM recommendations are minimal and have already been adopted by many institutions.[54]

Some Findings on the Preparation of In-Service Secondary School Mathematics Teachers

Increased emphasis on improving the quality of mathematics instruction in the public high schools has given rise to summer and in-service academic programs for secondary school teachers. Curriculum planners have raised questions about the number of teachers that have completed plans of study recommended by the various commisions, about the number of mathematics teachers who have majors in mathematics, about the number of mathematics teachers who have attended various institutes, and about the number of teachers who have had special training in mathematics.

A review of some surveys, a number of which are national in scope, on the training of mathematics teachers should indicate how much, if any, the various recommendations have affected the training of secondary teachers of mathematics. Two years after the CUPM recommendations were made, Hendrix[55] conducted a survey to study the effects of the recommendations on teacher training. He noted remarkable changes both in the college courses offered and in institutional certification programs. Smith,[56] in a 1963 survey, found that, of the teacher training institutions surveyed, 55 per cent had no courses especially designed to familiarize prospective teachers with the content of the new mathematical curricular materials, and 77 per cent had no special courses or sections for those returning to do graduate work in mathematics.

A more recent and thorough survey on the preparation of high school mathematics teachers was conducted by the U. S. Office of Education in 1965. The survey included sixty-six schools across the country. The high schools were selected because they were recognized as having leading mathematics programs. In general, the training of the teachers involved in the study was above average. All had bachelor's degrees, 74 per cent with a major in mathematics. Fifty-five teachers had master's degrees; of these, twenty-two had a major in mathematics, twenty-three had a major in education, and ten had majors in other fields. Two teachers had doctorate degrees. An average of thirty-four semester hours of credit beyond calculus had been earned by teachers in the investigation. Furthermore, the impact of the institutes supported by the National Science Foundation was evidenced by the extent to which teachers in the selected schools participated in them. On the average, each teacher had attended two summer institutes and one in-service institute. Eight had participated in NSF academic-year institutes.[57]

Summary

A review of literature related to this study has been presented in this chapter. The aim has been to point out the latest programs and recommendations for outstanding high school students of mathematics. Because the effectiveness of any mathematics program and any provisions made for the student will be dependent, for the most part, upon the teacher, recommendations regarding the preparation of high school teachers of mathematics were also outlined in this chapter.

The search of the literature revealed that a variety of programs for providing for the outstanding students of mathematics are being conducted. Some of the methods involved include grouping according to ability, use of correspondence courses, seminars, special projects, mathematics clubs, and honors courses. The most prevalent method mentioned was the use of ability grouping. The literature also revealed that there is a great deal of enthusiasm for and interest in providing for outstanding students. With regard to the training of mathematics teachers, latest recommendations have been put into practice and have had some effect upon the programs for training high school mathematics teachers.

Chapter III will be a discussion of the design of the study, the methods of securing data, validation of the instrument, and distribution of responses by size and by socio-economic status of schools investigated.

FOOTNOTES

[1]Identification of Gifted Students: Administrative Procedures and School Projects for Academically Talented Students in Secondary Schools (Washington, D. C., 1960), pp. 32-35.

[2]G. H. Hildreth, Introduction to the Gifted (New York, 1966), pp. 17-20.

[3]Julius Hlavaty, "How Provide for the Mathematically Talented?" National Association of Secondary School Principals Bulletin, LII (1968), 98-106.

[4]Ibid., p. 108.

[5]O. A. Runquist, "High School Students Attend College Classes," Minnesota Journal of Education, XLIV (November, 1965), 16-17.

[6]Ibid., pp. 16-17.

[7]Ibid., p. 18.

[8]Julius L. Hlavaty, ed. Mathematics for the Academically Talented Students in Secondary Schools (Washington, D. C., 1959), p. 15.

[9]James Gallagher, ed. Teaching Gifted Students (Boston, 1965), pp. 25-29.

[10]Ibid., p. 29.

[11]Identification of Gifted Students, p. 35.

[12]Gallagher, pp. 34-35.

[13]James B. Conant, "Observations on Grouping," National Association of Secondary School Principals Bulletin, XXXIX (1955), 127-129.

[14]B. Miller, "Consider Student Grouping in Planning Your School," School Executive LXXXII (September, 1963), 62-63.

[15]J. W. Wrightstone, What Research Says About Class Organization for Insurance (Washington, D. C., 1957), p. 27.

[16]L. E. Vredevoe, "Grouping of Secondary School Pupils," California Journal of Secondary Education XXXIV (June, 1959), p. 131.

[17]Julius Hlavaty, Mathematics for the Academically Talented, pp. 16-17.

[18]Ibid., p. 17.

[19]Hlavaty, Mathematics for the Academically Talented, p. 33.

[20]J. D. McAulay, "Training and Retraining of Math Teachers," Science Education, XLIX (1965), 162-164.

[21]Ibid.

[22]James B. Conant, The American High School Today (New York, 1959). p. 40.

[23]B. G. Pauley, "An Evaluation of a Secondary School Program in Mathematics for Able Pupils," The Mathematics Teacher, LIV (1961), 324.

[24]Dorothy L. Messler, "A Study of Pupil Age Achievement in Eighth Grade Algebra," The Mathematics Teacher, LIV (1961), 561-562.

[25]Ibid., p. 565.

[26]Pauley, p. 325.

[27]Ibid., p. 332.

[28]W. Eugene Ferguson, "Calculus in the High School," The Mathematics Teacher, LIV (October, 1960), 451.

[29]Ibid., 452.

[30]Bryan Calloway, "A Small High School Meets the Needs of Superior Students in Mathematics," Peabody Journal, XLIII (November, 1965), 233-237.

[31]Ibid., 237.

[32]Alfred J. Vanderlenden, "A Summer Math Program for High Ability Secondary Students," The Mathematics Teacher, LV (1962), 369-370.

[33]Claire M. Newman, "Challenging the Talented Mathematics Students," The Mathematics Teacher, LVI (1963), 525-526.

[34]John W. Gardner, Excellence (New York, 1967), pp. 75-76.

[35]Newman, 525-526.

[36]Ibid., p. 527.

[37]Hlavaty, "How Provide for the Mathematically Talented?" pp. 99-101.

[38]Raymond Sweet, "Organizing a Mathematics Laboratory," The Mathematics Teacher, LX (1967), 117-120.

[39]Ibid., p. 120.

[40]L. J. Mercerie, "The Mathematically Gifted and Discovery Learning," The Mathematics Teacher, LX (1967), 862-863.

[41]Ibid., p. 863.

[42]Ibid.

[43]Gallagher, pp. 162-163.

[44]Sidney French, "General Education--The Second Mile," Journal of General Education, XIX (1967), 89-90.

[45]Frank Wright, "Motivating Students with Projects and Teaching Aids," The Mathematics Teacher, LVIII (1965), 47.

[46]Mercerie, pp. 862-863.

[47]Goals for School Mathematics (New York, 1963), pp. 42-45.

[48]Ibid., p. 45.

[49]Lauren G. Woodby, Emerging Twelfth-Grade Mathematics Programs (Washington, D. C., 1965), p. 7.

[50]Secondary School Committee, National Council of Teachers of Mathematics, "The Secondary Mathematics Curriculum," The Mathematics Teacher, LII (1959), 378-417.

[51]Woodby, p. 8.

[52]R. C. Buck, "Recommendations of the Mathematical Association of America for Training of Teachers of Mathematics," The Mathematics Teacher, LIII (1960), 632-634.

[53]Ibid., p. 634.

[54]Ibid., p. 633.

[55]G. Hendrix, "Report of the Committee on Strengthening the Teaching of Mathematics to the Illinois Section of Mathematical Association of America," American Mathematical Monthly, LXIX (1962), 1003-1007.

[56]Lehi T. Smith, "Curriculum for Education of Teachers Surveyed," Journal of Teacher Education, XII (1963), 475-476.

[57]Woodby, pp. 7-8.

CHAPTER III

DESIGN OF THE STUDY

The first two chapters have been concerned with a general introduction to the study, and an extensive review of literature concerning the making of provisions for outstanding mathematics students. Some of the latest findings on the preparation of high school mathematics teachers were also presented in Chapter II.

A discussion of the design will comprise this chapter. In discussing the design of the study, there will be four major areas of concern. The first part will deal with the method used to select schools and teachers for this investigation. Second, an explanation of the method used to obtain data, including an explanation of the construction of the questionnaire, will be given. The focus of the third area will be the scope and validity of the study. In the last area, an attempt will be made to summarize and point out significant observations about the distribution of responses.

Selection of Schools and Teachers

The population consists of public high schools of North Carolina. The state is divided into three rather distinct geographical regions -- Piedmont, Mountain, and Coastal Plain -- each distinguishable in terms of climate, natural resources, urban development, density of population, and means of livelihood. The Piedmont region is generally recognized as the industrial region of the state; consequently, it is more densely populated. The Mountain region is noted for its natural beauty and attracts many tourists. The Coastal Plain, endowed with a mild climate and abundant waterways, consists of communities which are primarily either agricultural or maritime.[1] The sizes and types of schools in the state are affected by their locations, with numerous larger schools being located in the thickly populated Piedmont region, and more rural schools being located in the agricultural Coastal Plain. For these reasons, the schools were studied by regions.

A random sample of the schools which enroll students in grade categories 9-12 or 10-12 was selected by using a table of random numbers. The sample consisted of 25 per cent of the schools in each region for a total of 63 schools. Information from the selected schools was provided by the principals and those teachers who conducted no fewer than two classes in mathematics. A list of these schools which enroll students in the desired categories was secured from the _North Carolina Educational Directory, 1967-1968_.[2]

Collection of Data

Construction of the Questionnaire

The questionnaire was the sole source of data. Difficulty in scheduling interviews made it impossible to secure information through interviews. Moreover, it was felt that teachers would be reluctant in a personal interview to give the kind of information asked for in the questionnaire. Van Dalen supports this conclusion in his _Understanding Educational Research_.[3]

The process of determining the adequacy of information requested in the questionnaire included the compiling of a preliminary list of methods of making provisions for outstanding mathematics students gathered from literature related to this subject. The list was then reviewed by individual consultation with doctoral students in mathematics education, high school principals, and mathematics teachers. Recommendations of these groups were used to revise the preliminary list of methods.

The tentative questionnaire was then constructed from the preliminary list of items and was submitted to the members of the author's doctoral committee for their suggestions. After revisions were made on the basis of the committee's suggestions, the questionnaire was administered, during the month of August, to a group of experienced teachers and principals not furnishing data for this investigation. Responses and verbalization allowed an indication of validation of the instrument. The instrument was revised again and submitted to the author's doctoral committee for final approval.

Design of the Questionnaire

The approved questionnaire was comprised of two separate parts, one concerned with overall administrative and curricular provisions, and the other with classroom provisions. Each questionnaire was assigned a reference number to make possible identification of participating schools. A copy of the questionnaire is found in Appendix A.

The first part of the questionnaire, completed by each principal, consisted of two sections. Section A contained fourteen questions pertaining to the general nature of the student body, size of school, and administrative provisions for outstanding students in mathematics. Section B inquired about four extracurricular methods that have been highly recommended for stimulating and challenging outstanding mathematics students.

The second part of the questionnaire was completed by each mathematics teacher who taught at least two mathematics classes in the selected schools. The teachers' part consisted of three sections. Section A was concerned with four broad groups of methods of providing for outstanding mathematics students: Special problem assignments, reading assignments, teaching and demonstrations, and special projects; there were nine specific classroom methods of providing for the outstanding mathematics students. These were the most important methods as recommended in Chapter II.

Section B was designed to check the consistency of responses to Part I of the questionnaire. Five questions concerning the nature of special classes, special coaching by teachers, and counseling were repeated in order to verify the principal's impression of what the teachers were doing with what was actually being done.

Questions in Section C were designed to determine the teachers' academic preparation and recency of training. Information about institutions granting degrees, years degrees were conferred, and credit hours earned in specific course categories was requested of each participating teacher.

Submission of the Questionnaires to Schools

Due to difficulty of securing the names of mathematics teachers in selected schools, both parts of the questionnaire, accompanied by letters of explanation, were submitted to principals of the schools in the sample. On October 1, 1968, copies of both Part I and Part II of the questionnaire were mailed to these principals. Each principal was requested to complete Part I of the questionnaire and to ask each mathematics teacher who taught at least two mathematics classes, to complete Part II. Individual self-addressed, stamped envelopes were enclosed for the purpose of returning the completed questionnaires. Accompanying instructions assured the principals and teachers of anonymity.

Another difficulty encountered in distributing the questionnaires was that of determining the exact number of mathematics teachers employed by each school. An estimate was made, however, based upon information provided in the 1967-68 North Carolina Educational Directory.[4] The principal's completed copy of the questionnaire revealed the exact number of mathematics teachers in school. When these were returned, additional copies of Part II were mailed if necessary. All questionnaires, both Part I and Part II, were to be returned on or before November 1, 1968.

Follow-up Letters

In order to insure as large a return as possible, follow-up letters were mailed to all schools in which Part I of the questionnaire, and at least 80 per cent of the copies of Part II of the questionnaire, had not been received by November 5, 1968. A second set of questionnaires, along with stamped, self-addressed envelopes, was also enclosed. Principals and teachers were urged to return all parts of the completed questionnaire by December 1, 1968.

Scope and Validity of the Study

Distribution of Responses by Geographical Regions

In order for a school to be considered as having reported, and thus to be included in the study, two criteria had to be met: A copy of Part I of the questionnaire, completed by the principal, and copies of Part II, completed by at least 50 per cent of the mathematics teachers who were teaching no less than two mathematics classes, had to be received by December 5, 1968. Furthermore, Part I and Part II of the questionnaire from each school had to be reconcilable.

Eighty per cent of the schools responded and were represented in the study. Only one school was eliminated for failing to meet specified criteria. Table II shows a distribution of the responses by geographical regions. The largest and smallest number of responses were received from the Piedmont and Coastal Plain regions, respectively.

TABLE II

NUMBER AND PER CENT OF SCHOOLS, BY GEOGRAPHICAL REGIONS, RETURNING USABLE RESPONSES

Region	Number of Schools in Sample	Number of Schools Responding	Per Cent of Schools Responding
Coastal Plain	18	12	66.7
Piedmont	36	30	83.3
Mountain	9	8	88.9
Total	63	50	80.1

Distribution of Responses by Sizes of Schools

The schools included in this investigation were grouped into six enrollment categories. Table III shows the number and per cent of schools responding by enrollment categories. Since there were no schools with fewer than 100 students included in the population, no schools are represented in that category.

TABLE III

NUMBER AND PER CENT OF SCHOOLS RETURNING USABLE FORMS CATEGORIZED BY SIZE OF SCHOOL

Enrollment Categories	Number of Schools Responding	Per Cent of Total Responses
Less than 100	0	0
100 - 499	6	12
500 - 999	16	32
1000 - 1499	14	28
1500 - 1999	8	16
2000 and over	6	12
Total	50	80

Distribution of Schools by Socio-economic Status

Five socio-economic categories were determined from Havighurst and Neugarten's five-point scale of socio-economic status.[5]

Principals were asked to check the category which best described the socio-economic status of the students in their schools. Table IV exhibits a distribution of schools by socio-economic status as checked by principals. No schools responding had student bodies categorized in the upper socio-economic status.

TABLE IV

NUMBER AND PER CENT OF SCHOOLS INCLUDED IN THE INVESTIGATION ACCORDING TO SOCIO-ECONOMIC STATUS AS CHECKED BY PRINCIPALS

Socio-economic Status	Number of Schools	Per Cent of Schools
Upper	0	0
Upper - middle	16	32
Lower - middle	20	40
Upper - lower	10	20
Lower - lower	4	8
Total	50	100

Responses of Teachers to Questionnaires

Two hundred thirty-nine teachers were mailed questionnaires. The number of teachers returning usable questionnaires was 182 (76.2%). Two teachers returned forms in which important entries were not completed; therefore, the forms were discarded. Number and per cent of teachers returning usable questionnaires are shown in Table V. The number of teachers from the Piedmont region returning usable forms was greater than the number of usable returns from the other two regions combined.

TABLE V

NUMBER AND PER CENT OF TEACHERS RETURNING USABLE QUESTIONNAIRES BY GEOGRAPHICAL REGIONS

Region	Number of Teachers Included in Sample	Number of Teachers Returning Usable Questionnaires	Per Cent of Teachers Returning Usable Questionnaires
Coastal Plain	61	40	65.6
Piedmont	141	112	80.0
Mountain	37	30	81.0
Total	237	182	76.2

Method of Analyzing Data

Since this study is concerned with an analysis of the existing conditions in selected public high schools of North Carolina, grades 9-12, no elaborate statistical interpretation was made. However, the nature of the data on two questions was such that a chi-square test could be used. Data related to the other questions were tabulated and calculated by means of IBM calculator and presented in tables in terms of numbers and per cent so that significant patterns and relations could be studied.

As far as possible, data presented from the questionnaire returns were analyzed in terms of recent findings and recommended administrative and classroom practices for outstanding students, as compiled from related literature. There are schools across the country that have experimented with and have found successful practices for providing for the outstanding students of mathematics. These practices were useful in an overall analysis of the provisions which were being used for outstanding mathematics students in North Carolina.

Analyses were made in terms of geographical regions, school sizes, academic preparation of teachers, and socio-economic status of schools. Recommendations for improving the educational practices for outstanding students were made on the basis of findings presented in the review of related literature.

Summary

The purpose of this chapter has been to give a general description of the design of the study. Major areas discussed were selection of schools and teachers, collection of data, scope and validity of the study, and method of analyzing data.

The initial sample included 25 per cent of the public high schools in North Carolina which enrolled students in grades 9-12 or 10-12, exclusively. Eighty per cent of the principals supplying data for Part I of the questionnaires returned usable forms; seventy-six and two-tenths per cent of the mathematics teachers supplying data for Part II returned usable forms. These teachers taught at least two classes in mathematics.

The tentative questionnaire was constructed by the author, with suggestions from mathematics teachers, mathematics supervisors, principals, and college teachers. The final questionnaire was constructed from the tentative questionnaire by adding and deleting items that members consulted felt were or were not necessary. Before the questionnaire was mailed to teachers and principals, it was approved by the author's doctoral committee.

Some of the most notable facts about the responses were:

1. The largest number of schools and teachers furnishing data for this investigation was in the enrollment category of 500-999 students.

2. The number of schools and teachers from the Piedmont furnishing data for this investigation was greater than the total number from the other two geographical regions -- Coastal Plain and Mountain.

3. There were no schools included in this investigation with fewer than 100 students enrolled; no such schools were included in the population.

4. No schools responding had student bodies categorized in the upper socio-economic status.

In the next chapter a presentation of the findings secured from the questionnaires submitted to the selected principals and teachers will be given.

FOOTNOTES

[1]Marjorie Bond and S. H. Hobbs, North Carolina Today (Chapel Hill, 1947), pp. 9-11.

[2]State Department of Public Instruction, North Carolina Educational Directory, 1967-68 (Raleigh, 1967).

[3]Debald B. Van Dalen, Understanding Educational Research (New York, 1965), pp. 301-309.

[4]North Carolina Educational Directory.

[5]Robert Havighurst and Bernice Neugarten, Society and Education (Boston, 1962), p. 21.

CHAPTER IV

PRESENTATION OF FINDINGS

The concern of the first three chapters has been a general introduction to the study, an extensive review of related literature, and a discussion of the design of the study. Included in Chapter II was a discussion of the responses from principals and teachers.

In this chapter a presentation of the findings from the questionnaire returns will be made. The results will be grouped into six major sections. The first three sections will exhibit data on the extent of provisions, the identification of classroom methods, and the identification of administrative methods of providing for outstanding mathematics students. The fourth section will be devoted to findings on factors that limit or prevent the use of these methods. In section five, data concerning teachers' academic preparation will be presented. The relationship between the total provisions and such factors as school size, socio-economic status of schools, and administrative policy of schools will be shown in the last section. Throughout this chapter the expression "regular use of" a method will mean that the method was reported as being used "all the time" or "frequently".

Extent of Provisions

Administrative Provisions

Data from the questionnaire completed by principals indicated that all schools were making some administrative provisions for outstanding mathematics students, but these methods varied from school to school. Additional comments written on the questionnaire indicated that the principals were interested in, as well as enthusiastic about, providing programs for the special needs of outstanding mathematics students.

The most common administrative methods used to provide for outstanding mathematics students were ability grouping and special counseling. Forty-two (84%) of the fifty principals responding in this investigation indicated that ability grouping was practiced regularly in their schools. Thirty-nine (78%) of the principals indicated that special counseling was used in their schools.

The least frequently checked of the administrative methods listed in the questionnaire were mathematics contests among schools and field trips. Both methods were used regularly in only eight (16%) of the schools surveyed in this investigation. Other methods used were mathematics contests within schools, mathematics contests among schools, special coaching, mathematics clubs, and opportunities to pursue courses not offered within the high schools. These methods were very infrequently employed in schools contacted.

All of the schools supplying data for this investigation provided the traditional sequence of high school mathematics courses: general mathematics, algebra I, algebra II, and geometry. In addition to these courses, over 50 per cent of the schools offered courses in trigonometry and advanced mathematics. A very few schools offered courses in algebra III, functions, analytic geometry and calculus, and modern geometry. Statistical treatment of data concerning courses offered is presented in Table VI.

TABLE VI

NUMBER AND PER CENT OF SCHOOLS IN WHICH SPECIFIC MATHEMATICS COURSES ARE OFFERED WITHIN THE SCHOOL

Name of Course	Numbers of Schools Offering Course (N = 50)	Per Cent of Schools Offering Course
Algebra I	50	100.0
Algebra II	50	100.0
Plane Geometry	50	100.0
General Mathematics	50	100.0
Advanced Mathematics	35	70.0
Trigonometry	35	70.0
Modern Mathematics	20	40.0
Analytic Geometry and Calculus	9	18.0
Algebra III	5	10.0
Modern Geometry	5	10.0
Functions	4	8.0
Analysis	2	4.0
Number Theory	1	2.0
Statistics	1	2.0

Classroom Provisions

Most of the 182 teachers included in this study indicated that they feel a sense of obligation to make provisions within the classroom for the outstanding student. Noteworthy enthusiasm and interest were revealed by the comments they made on the questionnaire returns.

The most widely used classroom method marked on the questionnaire was that of enrichment through encouragement of outstanding students to do supplementary problems. Seventy-seven per cent of the 182 teachers indicated that this method was used regularly. Moreover, 74 per cent of the teachers regularly used the method of allowing outstanding mathematics students to exhibit solutions to special problems.

The least commonly marked classroom methods were those of requiring outstanding students to do special projects and assigning students supplementary problems from sources other than regular texts. Both methods were used regularly by 43.3 per cent of the teachers.

Other classroom methods that could be readily classified were assignment of supplementary problems from regular texts, encouragement of outstanding students to do free reading, and use of outstanding students to help coach other students and to help in teaching. Classroom methods, like administrative methods, varied greatly from teacher to teacher and from school system to school system.

A number of additional methods were mentioned by some teachers, which further indicated the extent to which provisions were being made. These methods were based upon individual student needs and were difficult to classify. At least two teachers mentioned special arrangement of the classes to provide for independent study groups. Several teachers permitted outstanding mathematics students to travel at their own pace, thus enabling some students to cover algebra I, algebra II, and geometry in two years. Still another teacher permitted one student, enrolled in advanced math, to study analytic geometry and calculus under his supervision.

Methods of Providing for Outstanding Students

In the preceding section a discussion of the extent of provisions for outstanding students was presented. An individual treatment of each of the methods which could be classified will be given in the following paragraphs.

Administrative Methods

Generally, North Carolina has no special state-wide policy of providing for outstanding students of mathematics, but local systems are encouraged to formulate their own policies in this regard. The state board of education also encourages experimentation and allows considerable latitude in the development of curricular programs. Where little or no provisions are made for outstanding students, the state control has not been a restricting factor.[1]

Ability grouping. Ability grouping is a method of classifying pupils into homogeneous sections, generally with reference to intelligence, for the purpose of instruction.[2] Forty-two principals (84%) indicated that ability grouping was generally practiced in their schools. Six principals indicated that, even though ability grouping was practiced, it was not practiced in mathematics all the time. The number of students enrolling in mathematics courses determined whether or not ability grouping was used in these schools. These were commonly small schools.

There was notable variation in the criteria used for ability grouping. In most of the forty-two schools in which ability grouping was practiced, a combination of several criteria was used to select students. No school used I. Q. along; however, in seven (14.28%) of the forty-two schools practicing ability grouping, only previous grades were used. Table VII exhibits the number and per cent of schools in which various criteria were used.

TABLE VII

NUMBER AND PER CENT OF SCHOOLS IN WHICH VARIOUS CRITERION MEASURES ARE USED AS A BASIS FOR ABILITY GROUPING

Criterion	Number of Schools in Which Criterion was Used (N = 42)	Per Cent of Schools in Which Criterion was Used
A. Single measure:		
Previous Grades	32	76.0
Achievement Test	30	71.0
Intelligence Quotient	24	57.0
Reading Ability	18	41.0
Teacher Recommendation	12	30.0
SAT Score	3	7.0
Aptitude Test	2	5.0
B. Combinations:		
One	7	16.6
Two	8	20.0
Three	6	14.3
Four or More	21	50.0

Special Classes. Classes especially designed to provide for outstanding students are being used in North Carolina, although not as extensively as the practice of ability grouping. Eleven principals (22%) reported the use of ability grouping in their schools, but reported that they fail to provide special classes in mathematics.

There were also four principals reporting the use of special classes, although, in general, ability grouping was not practiced.

Twenty-two (70%) of the thirty-two principals reporting the use of special classes to provide for outstanding mathematics students in their schools, indicated that special classes were smaller in enrollment than regular classes; six principals (16.6%) indicated that special classes and regular classes were the same size in enrollment; two principals (6.2%) indicated that the enrollment of special classes was larger than that of the regular classes.

The nature of the work done in special classes varied from school to school. Four principals (12.5%) indicated that the special classes covered the same units as regular classes with a faster pace. In eight (25%) of the schools using special classes, the course of study followed was entirely different from that of the regular classes. Table VIII exhibits a distribution on the nature of work done in special classes.

Courses in which special classes were provided ranged from first year algebra to advanced mathematics, and analytic geometry and calculus. Special classes were more frequently offered in algebra and advanced mathematics. Table IX summarizes the courses in which special classes were provided for outstanding students.

A comparison of Tables VII and IX shows a notable similarity of the criterion measures used for ability grouping and for special classes. However, a student's expressed interest was not used as a criterion measure for ability grouping but was used for special classes.

TABLE VIII

NUMBER AND PER CENT OF SCHOOLS IN WHICH SPECIAL CLASSES WERE PROVIDED FOR OUTSTANDING MATHEMATICS STUDENTS ON THE BASIS OF THE NATURE OF WORK COVERED

Nature of Work Covered	Number of Schools Following Course of Study (N = 32)	Per Cent of Schools Following Course of Study
Covers same units but with more depth	10	31.3
Covers same units but with added materials in each unit	10	31.3
Follows a course of study that is entirely different from regular classes	8	25.0
Covers same units with a faster pace	4	12.4

Criteria for selecting students for special classes varied markedly. Most schools, however, used several criteria. Of the thirty-two principals reporting the use of special classes, twenty-seven (85.7%) indicated that several criteria were used in their schools. A summary of the use of various criteria used to select students for special classes is shown in Table X.

TABLE IX

NUMBER AND PER CENT OF SCHOOLS IN WHICH SPECIAL CLASSES WERE PROVIDED IN SPECIFIC MATHEMATICS COURSES

Name of Course	Number of Schools Offering Special Class (N = 32)	Per Cent of Schools Offering Special Class
Advanced Mathematics	14	43.3
Algebra and Trigonometry	14	43.3
Algebra II	12	37.5
Algebra I	10	31.2
Analytic Geometry and Calculus	9	28.1
Plane Geometry	8	25.0
Functions	4	12.5
Analysis	2	6.3
Solid Geometry	2	6.3
College Algebra	2	6.3
Foundations	1	3.1
Statistics	1	3.1
Theory of Numbers	1	3.1

Scheduling special work with teachers. Another administrative method of providing for outstanding mathematics students is to permit them to study on their own under the supervision of mathematics teachers. This method is particularly useful in schools where there are not enough students to offer a formal course. Twenty-nine (58%) of the fifty principals reported that the scheduling of outstanding students to work under the supervision of mathematics teachers was practiced regularly. Table XI shows a summary of the findings concerning this method.

Coaching groups. Coaching groups are groups of teachers used

TABLE X

NUMBER AND PER CENT OF SCHOOLS IN WHICH VARIOUS CRITERION MEASURES WERE USED AS A BASIS FOR SELECTING STUDENTS FOR SPECIAL CLASSES

Criterion	Number of Schools in Which Criterion is Used (N = 32)	Per Cent of Schools in Which Criterion is Used
A. Single Measure		
Previous Mathematics Grades	25	78.1
Students' Expressed Interest	25	78.1
Recommendation of Mathematics Teachers	22	70.0
Achievement Test Scores	20	62.5
Intelligence Quotient	14	43.7
All Previous Grades	5	15.6
Recommendation of All Teachers	5	15.6
Parents' Request	5	15.6
Other (SAT Score)	2	6.2
B. Combinations		
One	0	0.0
Two	5	15.6
Three	6	15.6
Four or more	21	50.0

TABLE XI

NUMBER AND PER CENT OF SCHOOLS HAVING SPECIFIC POLICIES OF SCHEDULING OUTSTANDING STUDENTS TO WORK UNDER SPECIAL SUPERVISION OF MATHEMATICS TEACHERS

Policy	Number of Schools Following Policy (N = 50)	Per Cent of Schools Following Policy
Never Done	15	30
Scheduled Only Outside of Regular Class Periods	14	28
Scheduled Only During Teachers' Non-teaching Period	12	24
Scheduled During Any Period	9	18

to tutor individual students in a subject or area for the purpose of accomplishing some specific objective.[3] These groups are sometimes used in situations in which the number of students is not large enough to have a formal class. Provisions were made for special coaching of outstanding mathematics students in twenty-one (42%) of the schools contacted in this investigation. Nine (43%) of the 21 schools identified preparation for college entrance examinations as being the major purpose for providing such activities. A distribution of schools that had special coaching groups is shown in Table XII on the basis of the purpose of providing such activities.

TABLE XII

NUMBER AND PER CENT OF SCHOOLS IN WHICH COACHING GROUPS WERE PROVIDED ON THE BASES OF PURPOSES OF PROVIDING SUCH ACTIVITIES

Purpose	Number of Schools Providing Coaching Groups (N = 21)	Per Cent of Schools Providing Coaching Groups
College Entrance Exams	9	43.0
Preparation for College	4	19.0
Further Depth and Comprehension	3	17.6
Various Contests	3	17.6
Achievement Test	2	9.5

Principals of seven (14%) of the schools where coaching groups were used reported that the assignment of special coaching of outstanding students was considered a part of the regular teaching load. No schools indicated that teachers received special pay for such work.

Courses offered outside the high school. Sometime students request courses not offered in their schools or courses beyond the high school level. Nineteen principals (38%) indicated that provisions were made for outstanding mathematics students to take courses not included in the school curriculum. A summary of the ways in which opportunities are provided for outstanding students to pursue courses not offered within the high school is given in Table XIII. The Govenor's school is a state operated school established to accommodate a limited number of outstanding students.

TABLE XIII

NUMBER AND PER CENT OF SCHOOLS IN WHICH OPPORTUNITIES ARE PROVIDED FOR BEYOND SCHOOL CLASSES IN VARIOUS WAYS

How Opportunity is Provided	Number of Schools Providing Opportunity (N = 19)	Per Cent of Schools Providing Opportunity
Enrollment in Courses at Nearby Colleges	8	42.0
Independent Study	4	21.0
Governor's School	3	15.8
Enrollment in Correspondence Courses	2	10.6
Other Schools in System	2	10.6

Mathematics clubs. A mathematics club is an organized group of individuals, having a somewhat homogeneous level of interest and ability in mathematics, who meet periodically to discuss mathematical topics.[4] The use of mathematics clubs as a means of providing for outstanding mathematics students was reportedly used regularly by fourteen (28%) of the schools supplying data in this investigation. The term "regular", it should be remembered, means "all the time" or "frequently", responses indicated on the questionnaire. Statistics concerning the use of mathematics clubs are summarized in Table XIV.

TABLE XIV

NUMBER AND PER CENT OF SCHOOLS IN WHICH SPECIFIED FREQUENCIES OF USE OF MATHEMATICS CLUBS ARE REPORTED

Frequency of Use of Method	Number of Schools Using Method (N = 50)	Per Cent of Schools Using Method
All the time	4	8
Frequently	10	20
Rarely	11	22
Never	25	50

Mathematics contests within school. Mathematics contests within schools are types of organized competition sponsored by teachers in the schools.[5] Fifteen principals (30%) reported the regular use of mathematics contests within schools. Table XV shows a summary of the frequency of use of mathematics contests within schools.

TABLE XV

NUMBER AND PER CENT OF SCHOOLS IN WHICH SPECIFIED FREQUENCIES OF THE USE OF MATHEMATICS CONTESTS WITHIN SCHOOLS ARE REPORTED

Frequency of Use	Number of Schools (N = 50)	Per Cent of Schools
All the time	8	16.0
Frequently	7	14.0
Rarely	11	22.0
Never	24	48.0

Mathematics contests among schools. The use of mathematics contests among schools, types of organized competition in mathematics locally or nationally, was practiced regularly in eight (16%) of the schools surveyed in this investigation. A summary of the frequencies of use of mathematics contests among schools is presented in Table XVI.

Field trips. A field trip is one arranged by a teacher or other school official which is undertaken for educational purposes.[6] Such trips may be taken to colleges, to industrial sites, to computer centers, etc. Field trips, the last of the administrative methods which were included in the questionnaire, were used regularly by only eight

TABLE XVI

NUMBER AND PER CENT OF SCHOOLS IN WHICH SPECIFIED FREQUENCIES OF THE USE OF MATHEMATICS CONTESTS AMONG SCHOOLS WERE REPORTED

Frequency of Use	Number of Schools (N = 50)	Per Cent of Schools
All the time	1	2.0
Frequently	7	14.0
Rarely	16	32.0
Never	27	54.0

TABLE XVII

NUMBER AND PER CENT OF SCHOOLS IN WHICH SPECIFIED FREQUENCIES OF THE USE OF FIELD TRIPS FOR MATHEMATICS STUDENTS WERE REPORTED

Frequency of Use	Number of Schools (N = 50)	Per Cent of Schools
All the time	0	0.0
Frequently	8	16.0
Rarely	28	56.0
Never	17	34.0

(16%) of the fifty schools furnishing data for this study. A summary of the statistics concerning the frequencies of use of field trips is presented in Table XVII.

Classroom Methods

Methods involving special assignments. Teachers supplying data for this investigation were requested to indicate the frequency with which they used various types of special assignments. Responses revealed that these activities were provided by either encouraging outstanding students to do supplementary problems according to interest and ability, or by assigning them supplementary problems from regular texts or other sources. One hundred forty teachers (77%) reported the regular use of the encouragement of outstanding mathematics students to do supplementary problems. A summary of the frequency of use of the policy of encouraging outstanding students to do supplementary problems according to interest and ability is exhibited in Table XVIII.

TABLE XVIII

NUMBER AND PER CENT OF TEACHERS' FREQUENCY OF ENCOURAGING OUTSTANDING STUDENTS TO DO SUPPLEMENTARY PROBLEMS ACCORDING TO INTEREST AND ABILITY

Frequency of Use	Number of Teachers (N = 182)	Per Cent of Teachers
All the time	40	22.0
Frequently	100	55.0
Rarely	35	19.0
Never	7	4.0

Tables XIX and XX summarize the frequency with which the teachers used the policy of assigning supplementary problems from regular texts and the frequency with which they used the policy of assigning supplementary problems from sources other than regular texts, respectively.

TABLE XIX

NUMBER AND PER CENT OF TEACHERS' FREQUENCY OF ASSIGNING SPECIAL PROBLEMS FROM REGULAR TEXTS ACCORDING TO INTEREST AND ABILITY

Frequency of Use	Number of Teachers (N = 182)	Per Cent of Teachers
All the time	29	15.9
Frequently	98	53.3
Rarely	48	27.2
Never	7	3.6

Supplementary reading. Another means of making special provisions for outstanding mathematics students is that of supplementary reading. Supplementary reading, for the purpose of this study, is defined as reading used for the purpose of enriching the materials of instruction. Such reading may be done freely or may be required by the teacher. Both methods reportedly were used by teachers supplying data for this study.

One hundred ten (61.4%) of the mathematics teachers in the study

TABLE XX

NUMBER AND PER CENT OF TEACHERS' FREQUENCY OF ASSIGNING SPECIAL PROBLEMS ACCORDING TO INTEREST AND ABILITY FROM SOURCES OTHER THAN REGULAR TEXTS

Frequency of Use	Number of Teachers (N = 182)	Per Cent of Teachers
All the time	22	12.0
Frequently	57	31.3
Rarely	75	41.7
Never	28	15.0

regularly encouraged outstanding students to do free reading outside class; seventy-nine (43.3%) assigned outstanding students supplementary reading. Tables XXI and XXII summarize the frequency of use of the policy of encouraging outstanding students to do free reading and the frequency of use of the policy of assigning them supplementary reading, respectively.

Teaching and demonstration. Permitting outstanding students to help in teaching mathematical concepts, in coaching other students, and in performing demonstrations are other means of providing for outstanding mathematics students in the classroom. Classroom coaching differs from that of administrative coaching in that the former is done by students, whereas the latter is done by teachers.

The policy of permitting outstanding mathematics students to help in teaching was followed regularly by 126 (79.1%) of the teachers

TABLE XXI

NUMBER AND PER CENT OF TEACHERS' FREQUENCY OF ENCOURAGING OUTSTANDING STUDENTS TO DO FREE READING OUTSIDE OF CLASS

Frequency of Use	Number of Teachers (N = 182)	Per Cent of Teachers
All the time	34	18.6
Frequently	76	42.8
Rarely	49	26.5
Never	23	12.1

TABLE XXII

NUMBER AND PER CENT OF TEACHERS' FREQUENCY OF ASSIGNING OUTSTANDING STUDENTS SUPPLEMENTARY READING

Frequency of Use	Number of Teachers (N = 182)	Per Cent of Teachers
All the time	22	12.0
Frequently	57	31.3
Rarely	75	41.7
Never	28	15.0

reporting; one hundred twenty-three (67.4%) of the teachers regularly permitted these students to coach other students. Another method, that of permitting outstanding students to exhibit solutions of special problems, was used regularly by 136 (74.6%) of the teachers. Summaries of the data pertaining to these methods are presented in Tables XXIII, XXIV, and XXV.

TABLE XXIII

NUMBER AND PER CENT OF TEACHERS' FREQUENCY OF PERMITTING OUTSTANDING STUDENTS TO HELP TEACH AND DO DEMONSTRATIONS

Frequency of Use	Number of Teachers (N = 182)	Per Cent of Teachers
All the time	34	18.6
Frequently	92	50.5
Rarely	38	20.9
Never	18	10.0

TABLE XXIV

NUMBER AND PER CENT OF TEACHERS' FREQUENCY OF PERMITTING OUTSTANDING STUDENTS TO COACH OTHER STUDENTS

Frequency of Use	Number of Teachers (N = 182)	Per Cent of Teachers
All the time	34	18.6
Frequently	89	48.8
Rarely	48	25.3
Never	14	7.3

TABLE XXV

NUMBER AND PER CENT OF TEACHERS' FREQUENCY OF PERMITTING OUTSTANDING STUDENTS TO EXHIBIT SOLUTIONS OF SPECIAL PROBLEMS

Frequency of Use	Number of Teachers (N = 182)	Per Cent of Teachers
All the time	44	24.1
Frequently	92	50.5
Rarely	27	15.0
Never	19	10.4

Special projects. A fourth means of providing for outstanding students in the classroom in to encourage or require them to construct special projects. A project is defined as a significant, practical unit of activity having educational value and aimed at one or more definite goals of understanding. Projects usually involve investigations and solutions to problems and manipulations of physical materials.[6]

Forty-one (22.7%) of the teachers contacted in this study indicated that they regularly use special projects. Statistical treatment of the data concerning the assignment of special projects is shown in Table XXVI.

TABLE XXVI

NUMBER AND PER CENT OF TEACHERS' FREQUENCY OF REQUIRING OUTSTANDING STUDENTS TO CONSTRUCT SPECIAL PROJECTS

Frequency of Use	Number of Teachers (N = 182)	Per Cent of Teachers
All the time	7	4.0
Frequently	34	18.7
Rarely	89	48.7
Never	52	28.6

Limiting Factors

Administrative Factors

A number of factors limiting or preventing the use of administrative methods of providing for outstanding mathematics students were checked by principals. The major types of factors mentioned showed little variation from school to school.

The fifty principals responding to the questionnaire were asked to check the frquency of a list of factors that limited or prevented the use of four specific methods of providing for outstanding mathematics students. Therefore, each factor limiting or preventing the use of the four administrative methods discussed above could have been checked a maximum of 200 times.

Lack of teacher time was checked more frequently as limiting or preventing the use of the administrative methods of providing for outstanding mathematics students. Lack of teacher time as a limiting or preventing factor in the use of various methods of making provisions for outstanding students of mathematics was checked by principals eighty-three times (41.5%). Table XXVII shows number and per cent of times factors were checked as limiting or preventing the regular use of methods.

TABLE XXVII

NUMBER AND PER CENT OF COMMON FACTORS LIMITING OR PREVENTING THE USE OF ADMINISTRATIVE METHODS OF PROVIDING FOR OUTSTANDING MATHEMATICS STUDENTS

Limiting Factor	Total Number of Times Mentioned (N = 200)	Per Cent of Times Mentioned
Lack of Teacher Time	83	41.5
Lack of Teacher Interest	45	22.5
Lack of Student Time	41	20.5
Lack of Student Interest	37	18.5
No such Opportunity Exists	40	20.0
Other	9	4.5

Classroom Limiting Factors

The 182 teachers responding to the nine classroom methods were asked to check the frequency of a list of factors that limited or prevented the use of these methods. There were 1638 cases in which any specific factor could have been checked. Lack of teacher time was the most widely checked factor; it was indicated 986 times (60%). A summary of common factors limiting or preventing the use of classroom methods of providing for outstanding mathematics students discussed in the preceding section is presented in Table XXVIII.

TABLE XXVIII

NUMBER AND PER CENT OF COMMON FACTORS LIMITING OR PREVENTING THE USE OF CLASSROOM METHODS FOR OUTSTANDING MATHEMATICS STUDENTS

Limiting Factor	Total Number of Times Mentioned (N = 1638)	Per Cent of Times Mentioned
Lack of Teacher Time	986	60.0
Lack of Student Time	915	56.0
Lack of Student Interest	668	40.8
Lack of Supplementary Materials	543	33.2
Lack of Teacher Interest	164	10.0
Other (Administrative Problems, Lack of Opportunity)	147	9.0

Relationship Between Programs for Outstanding Students and Academic Preparation of Teachers

Academic Preparation of Mathematics Teachers

Statistical treatment of the data resulted in the following major findings relative to academic preparation of mathematics teachers. All teachers reporting had at least a bachelor's degree and sixty-one teachers (31%) also had master's degrees. One hundred twenty-eight teachers (70%) earned their bachelor's degrees with majors in mathematics. Of the teachers who had earned master's degrees, however, only eighteen (29.5%) had a graduate major in mathematics. Tables XXIX and XXX summarize the areas in which baccalaureate majors and minors were received. Similarly, Tables XXX and XXI summarize the majors and minors in which master's degrees were earned.

TABLE XXIX

NUMBER AND PER CENT OF MAJORS IN BACCALAUREATE DEGREES RECEIVED BY MATHEMATICS TEACHERS

Major Areas	Number of Teachers Majoring in Area (N = 182)	Per Cent of Teachers Majoring in Area
Mathematics	128	70.4
General Science	20	10.9
Education	12	6.5
Social Science	5	2.8
Business and Economics	5	2.8
English	5	2.8
Biology and Chemistry	3	1.6
Physics	2	1.1
Physical Education	2	1.1

TABLE XXX

NUMBER AND PER CENT OF MINORS IN BACCALAUREATE DEGREES RECEIVED BY MATHEMATICS TEACHERS

Minor Area	Number of Teachers Minoring in Area (N = 182)	Per Cent of Teachers Minoring in Area
Mathematics	37	20.3
Education	32	16.5
Social Science	25	13.3
General Science	22	12.2
English	8	4.4
Foreign Language	8	4.4
Physics	5	2.9
Biology and Chemistry	4	2.2
Business and Economics	4	2.2
No Minor	32	16.4

TABLE XXXI

NUMBER AND PER CENT OF MAJORS IN MASTERS' DEGREES RECEIVED BY MATHEMATICS TEACHERS

Major Area	Number (N = 61)	Per Cent
Education	22	36.1
Mathematics	18	29.5
Social Science	5	8.1
General Science	5	8.1
Statistics	2	3.3
Other Areas (Business, English)	9	14.7

TABLE XXXII

NUMBER AND PER CENT OF MINORS IN MASTERS' DEGREES RECEIVED BY MATHEMATICS TEACHERS

Minor Area	Number (N = 182)	Per Cent
Mathematics	22	36.1
Education	15	24.6
General Science	10	16.3
Social Science	5	8.2
Other Areas	4	6.6
None	5	8.2

The total graduate and undergraduate credits earned in mathematics by teachers contacted in this investigation ranged from seven to ninety-four semester hours, with a mean of 37.3 semester hours. In order to facilitate the analysis of the data concerning the academic preparation of teachers, it was convenient to classify these data into four categories based upon CUPM recommendations. (See page 27 .) It should be noted that Category I here is not the same as Category I which relates to elementary teachers in CUPM recommendations. A description of the categories follows:

Category I: Teachers who have earned less than 18 hours in mathematics courses and teachers who cannot be categorized on Level II, III, or IV because of diversity of courses completed.

Category II: Teachers who have completed at least 18 semester hours in areas of mathematics as specified: 9 in analysis, 3 in algebra, 3 in geometry, and 3 in probability and statistics. Teachers in this category do not qualify for higher categories.

Category III: Teachers who have a major in mathematics and a minor in some related area, and who have completed at least 33 hours in areas of mathematics as specified: 9 in analysis, 6 in algebra, 6 in geometry, 6 in probability and statistics, 6 electives in real or complex variables, foundations of mathematics, and functional analysis. These teachers do not qualify for a higher category.

Category IV: Teachers who have masters' degrees with at least 54 semester hours (graduate and undergraduate) in specific areas of mathematics or comparable areas as follows: 12 in analysis, 6 in algebra, 9 in geometry, 6 in probability and statistics, and 21 in such areas as real variables, computer science, number theory, topology, foundations of mathematics, modern algebra, and numerical analysis.

A summary of the academic categories completed by the teachers surveyed in this investigation is shown in Table XXXIII.

TABLE XXXIII

NUMBER AND PER CENT OF MATHEMATICS TEACHERS WHO MEET SPECIFIED PREPARATION CATEGORIES IN MATHEMATICS

Preparation Category	Number of Teachers (N = 182)	Per Cent of Teachers
I	39	21.4
II	71	39.1
III	53	29.1
IV	19	10.4

Recency of Academic Preparation of Mathematics Teachers

Years in which the baccalaureate degrees had been obtained by mathematics teachers surveyed in this investigation ranged from 1932 to 1968. Ninety-three teachers (51%) had received their baccalaureate degrees since 1957. This is significant in that the greatest impetus has been given to mathematics since that date, when Russia launched Sputnik I. Number and per cent of baccalaureate degrees obtained in specific time periods are exhibited in Table XXXIV.

Dates of maters' degrees earned by mathematics teachers included in this investigation ranged from 1937 to 1968. Thirty-eight teachers (62.5%) who had earned masters' degrees received them since 1957. Table XXXV presents number and per cent of masters' degrees received in selected time periods.

TABLE XXXIV

NUMBER AND PER CENT OF BACCALAUREATE DEGREES OBTAINED BY MATHEMATICS TEACHERS IN SPECIFIC TIME PERIODS

Period Degree Was Earned	Number of Teachers Earning Degree in Period (N = 182)	Per Cent of Teachers Earning Degree in Period
Before 1938	29	15.6
Between 1938-1947	22	12.0
Between 1948-1957	38	21.0
Between 1958-1967	77	42.4
After 1967	16	9.0

TABLE XXXV

NUMBER AND PER CENT OF MASTERS' DEGREES OBTAINED BY MATHEMATICS TEACHERS IN SPECIFIC TIME PERIODS

Period Degree Was Earned	Number of Teachers Earning Degree in Period (N = 61)	Per Cent of Teachers Earning Degree in Period
Before 1938	2	3.2
Between 1938-1947	2	3.2
Between 1948-1957	19	31.1
Between 1958-1967	30	49.1
After 1967	8	13.4

One hundred sixty-two (89%) of the 182 teachers providing data had earned some credit in mathematics courses since 1958. The methods of obtaining this credit were by enrolling in college and university courses, by attending seminars, or by in-service training. Table XXXVI shows the number and per cent of teachers receiving most recent training in specific periods.

TABLE XXXVI

NUMBER AND PER CENT OF TEACHERS RECEIVING MOST RECENT TRAINING IN SPECIFIC TIME PERIODS

Period in Which Most Recent Credit Was Earned	Number of Teachers Earning Credit in Period (N = 182)	Per Cent of Teachers Earning Credit in Period
Before 1953	10	5.4
Between 1953-1957	12	6.6
Between 1958-1962	34	18.7
Between 1963-1967	92	50.6
After 1967	34	18.7

Relationship Between the Training of Teachers and Programs for Outstanding Mathematics Students

An analysis of the percentage distribution of the data on administrative, classroom, and curricular provisions for outstanding students showed the following: The number of administrative provisions for outstanding mathematics students in each school ranged from one to nine, with an average of three and four-tenths methods. The number of classroom methods ranged from three to nine, with an average of six and five-tenths methods. The total administrative and classroom provisions in each school ranged from four to eighteen; the average number of total provisions (classroom and administrative) was nine and eight-tenths methods.

Schools included in the study offered a sequence of courses ranging from general mathematics through analytic geometry. The average program consisted of general mathematics through advanced mathematics. Teachers of mathematics courses had earned average credit of 37.3 semester hours in mathematics.

In order to study the relationship between the methods of providing for outstanding mathematics students and academic preparation of mathematics teachers, it is necessary to define the term "average" as it relates to the number of provisions made in each school and as it relates to the number of credit hours in mathematics earned by mathematics teachers. A specific aspect of condition related to the program was considered average when it met the appropriate criterion mentioned below:

1. The average number of administrative provisions was 3 - 4.
2. The average number of classroom provisions was 6 - 7.

3. The average of the total number of administrative and classroom provisions was 9 - 10.

4. The sequence of courses ranged from general mathematics to advanced mathematics.

5. The total number of provisions for outstanding mathematics students consisted of 9 - 10 administrative and classroom provisions, and the courses offered ranged from general mathematics to advanced mathematics.

6. The average number of semester hours in mathematics earned by mathematics teachers was 37 - 38.

Schools in which the number of provisions was greater than the averages listed above were classified as "above-average"; in cases where the numbers were less, the schools were classified as "below-average." The same labels were used in classifying the number of semester hours in mathematics earned by teachers.

An analysis of the data by per cents revealed no identifiable relationship between the academic preparation of teachers and the total number of provisions for outstanding students. Table XXXVII shows number and per cent of schools in which average, below-average, and above-average provisions for outstanding mathematics students are made with respect to various aspects of the mathematics programs in schools. A chi-square analysis of the relationship between total provisions in the schools and the academic preparation of mathematics teachers is presented in Table XXXVIII. A table of critical values revealed that the calculated value of 5.26 was significant between .05 and .10.

TABLE XXXVII

NUMBER AND PER CENT OF SCHOOLS IN WHICH AVERAGE, BELOW-AVERAGE, AND ABOVE PROVISIONS FOR OUTSTANDING MATHEMATICS STUDENTS ARE MADE WITH RESPECT TO VARIOUS ASPECTS OF THE MATHEMATICS PROGRAMS

Aspect of the Program	Condition of Programs in Schools					
	Below-Average		Average		Above-Average	
	Number	Per Cent	Number	Per Cent	Number	Per Cent
Administrative Provisions in School	17	34.0	23	46.0	10	20.0
Classroom Provisions in School	12	24.0	9	18.0	29	58.0
Curricular Provisions in School	10	20.0	27	54.0	13	26.0
Administrative and Classroom Provisions	14	28.0	17	34.0	19	38.0
Total Provisions	17	34.0	24	48.0	9	18.0
Academic Preparation of Mathematics Teachers in School	24	48.0	8	16.0	18	36.0

TABLE XXXVIII

A CHI-SQUARE ANALYSIS OF THE RELATIONSHIP BETWEEN TOTAL PROVISIONS IN SCHOOLS AND ACADEMIC PREPARATION OF MATHEMATICS TEACHERS

Academic Preparation of Mathematics Teachers	Total Provisions in Schools		
	Below Average	Average	Above Average
Average or Above-Average (38 sem. hours and above)	24	38	27
Below-Average (37 sem. hours and below)	36	41	16
Chi-square = 5.26	df = 2	$.05 < P < .10$	

Relationship Between Recency of Training of Mathematics Teachers and Programs for Outstanding Mathematics Students

Although all schools had some teachers who had earned some recent credit in mathematics courses, an identifiable relationship between the better-than-average programs for outstanding mathematics students and the recency of academic preparation of teachers was found to exist. Slightly less than eighty-one per cent of the mathematics teachers in the schools in which better-than-average provisions were being made had received credit in mathematics courses since 1962. Table XXIX exhibits number and per cent of schools in which average, below-average, and above-average programs for outstanding mathematics students are made as compared to the recency of academic training of teachers. An above-average program for outstanding mathematics students is defined in the preceding section. A chi-square analysis of these data is presented in Table XL. The value of chi-square is significant between .01 and .001.

TABLE XXXIX

NUMBER AND PER CENT OF SCHOOLS IN WHICH AVERAGE, BELOW-AVERAGE, AND ABOVE-AVERAGE PROVISIONS ARE MADE FOR OUTSTANDING MATHEMATICS STUDENTS AS COMPARED TO RECENCY OF ACADEMIC PREPARATION OF MATHEMATICS TEACHERS

Period in Which Most Recent Credit was Earned	Total Provisions in the Schools					
	Below-Average (N = 50)		Average (N = 89)		Above-Average (N = 43)	
	Number of Teachers in Schools	Per Cent of Teachers in Schools	Number of Teachers in Schools	Per Cent of Teachers in Schools	Number of Teachers in Schools	Per Cent of Teachers in Schools
Before 1953	7	14.0	2	2.2	1	2.3
Between 1953-1957	5	10.0	6	6.0	2	4.6
Between 1958-1962	15	30.0	14	15.7	4	10.0
Between 1963-1967	18	36.0	50	56.2	24	58.4
After 1967	5	10.0	17	20.4	12	24.7

TABLE XL

A CHI-SQUARE ANALYSIS OF THE RELATIONSHIP BETWEEN TOTAL PROVISIONS IN SCHOOLS AND RECENCY OF TRAINING OF MATHEMATICS TEACHERS

Total Provisions in Schools	Recency of Training of Mathematics Teachers		
	Prior to 1958	1958-1962	Since 1963
Above-Average	3	4	36
Average	8	14	67
Below-Average	12	15	23

Chi-square = 18.15 df = 4 $.01 < P < .001$

Courses Taught by Mathematics Teachers

A variety of subjects, ranging from modern mathematics to advanced placement mathematics, were taught by mathematics teachers included in this investigation. These courses can be classified on the three levels of high school mathematics suggested by the Committee on Undergraduate Programs in Mathematics: algebra and geometry only; other more advanced high school subjects, such as algebra III, trigonometry, and modern mathematics; and advanced placement mathematics, such as functions, analytic geometry and calculus, statistics, and advanced mathematics. Where teachers teach courses in more than one level, they are classified according to the highest level subject taught. Number and per cent of mathematics teachers who teach courses in specific levels are shown in Table XLI. A comparison of the academic preparation of mathematics teachers who teach on these levels and the suggested recommendations on academic preparation for those teaching on these levels will be made in Chapter V.

TABLE XLI

NUMBER AND PER CENT OF MATHEMATICS TEACHERS WHO TEACH COURSES ON LEVELS RECOMMENDED BY CUPM

Course Category	Number Teaching Courses in Categories (N = 182)	Per Cent of Teachers Teaching in Categories
Algebra and Geometry	95	52.1
High School Mathematics	62	34.2
Advanced Placement Mathematics	25	13.7

Relationship Between Provisions for Outstanding Mathematics Students and Geographical Regions, School Size, Socio-Economic Status, and Administrative Policy

No general difference between total provisions for outstanding mathematics students were found to be related to geographical regions, school size, socio-economic status, or administrative policy. However, ability grouping and special classes were found to be related to school enrollment size; schools providing opportunity for students to pursue courses beyond high school offering was related to geographical region; Tables XLII, XLIII, and XLIV present the findings concerning the administrative provisions for outstanding mathematics students on the basis of school enrollment size, socio-economic status, and geographical region.

Course offerings were found to be related to school enrollment size, socio-economic status, and geographical regions. Variety of course offerings were related positively with school enrollment size and socio-economic status. The Piedmont region was more identifiable in providing an extensive curricular program for outstanding mathematics students. Tables XLV, XLVI, and XLVII present data concerning course offerings on the bases of school enrollment size, socio-economic status, and geographical region.

Tables XLVIII, XLIX, and L exhibit data concerning classroom provisions on the bases of school enrollment size, socio-economic status, and geographical region. No general relationship between classroom provisions, school enrollment size, and socio-economic status were found to exist; however, the Mountain region had a noticeably higher frequency of percentage in making classroom provisions for outstanding mathematics students.

TABLE XLII

NUMBER AND PER CENT OF SCHOOLS BY ENROLLMENT CATEGORIES IN WHICH SPECIFIC ADMINISTRATIVE METHODS OF PROVIDING FOR OUTSTANDING MATHEMATICS STUDENTS ARE USED REGULARLY

Method	School Enrollment Size											
	100-499 (N = 6)		500-999 (N = 16)		1000-1499 (N = 14)		1500-1999 (N = 8)		2000 & over (N = 6)		Total (N = 50)	
	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Math clubs	0	0.0	6	37.5	3	21.4	4	50.0	2	33.3	14	28
Math contests within schools	0	0.0	6	37.5	3	21.4	4	50.0	2	33.3	15	30
Math contests among schools	0	0.0	2	6.3	2	14.3	1	12.5	3	50.0	8	16
Field trips	1	16.6	1	12.5	3	27.5	2	25.0	1	16.6	8	16
Ability grouping	4	66.7	12	75.0	12	86.0	8	100.0	6	100.0	42	84
Special classes	2	33.3	8	50.0	10	71.4	6	75.0	5	83.3	31	62
Special coaching	3	50.0	6	37.5	5	41.7	4	50.0	2	33.3	21	42
Special counseling	4	66.7	14	81.3	10	71.4	7	87.5	4	66.6	39	78
Opportunity to pursue courses beyond H.S.	2	33.3	4	25.0	6	42.7	3	37.5	4	66.6	19	38

TABLE XLIII

NUMBER AND PER CENT OF SCHOOLS BY SOCIO-ECONOMIC STATUS LEVELS IN WHICH SPECIFIC ADMINISTRATIVE METHODS OF PROVIDING FOR OUTSTANDING MATHEMATICS STUDENTS ARE USED REGULARLY

	Socio-Economic Status									
	Lower-Lower (N = 4)		Upper-Lower (N = 10)		Lower-Middle (N = 20)		Upper-Middle (N = 16)		Total (N = 50)	
Method	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Mathematics clubs	1	25.0	3	30.0	5	25.0	5	31.3	14	28.0
Mathematics contests within schools	1	25.0	3	30.0	6	30.0	5	31.3	15	30.0
Mathematics contests among schools	1	25.0	2	20.0	1	5.0	4	25.0	8	16.0
Field Trips	1	25.0	1	10.0	2	10.0	4	25.0	8	16.0
Ability Grouping	2	50.0	9	90.0	15	75.0	16	100.0	42	84.0
Special Classes	2	50.0	5	50.0	12	60.0	12	75.0	31	62.0
Special Coaching	1	25.0	3	30.0	7	35.0	5	31.3	21	42.0
Special Counseling	3	75.0	7	70.0	16	80.0	13	81.2	39	78.0
Opportunity to pursue courses beyond H.S.	2	50.0	4	40.0	8	40.0	5	31.3	19	38.0

TABLE XLIV

NUMBER AND PER CENT OF SCHOOLS BY GEOGRAPHIC REGIONS IN WHICH SPECIFIC ADMINISTRATIVE METHODS OF PROVIDING FOR OUTSTANDING MATHEMATICS STUDENTS ARE USED REGULARLY

	Geographical Region							
	Coastal Plain (N = 12)		Mountain Region (N = 8)		Piedmont Region (N = 30)		Total (N = 50)	
Method	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Math clubs	4	33.3	2	25.0	8	26.6	14	28.0
Math contest within schools	4	33.3	3	37.5	8	26.6	15	30.0
Math contest among schools	1	8.3	2	25.0	5	16.6	8	16.0
Field trips	1	8.3	2	25.0	5	16.6	8	16.0
Ability grouping	11	91.6	6	75.0	25	83.3	42	84.0
Special classes	7	58.3	6	75.0	18	60.0	31	62.0
Special Coaching	6	50.0	3	25.0	12	40.0	21	42.0
Special Counseling	10	83.2	4	50.0	25	50.0	39	78.0
Opportunity to pursue courses beyond H.S.	4	33.3	3	37.5	12	40.0	19	38.0

TABLE XIV

NUMBER AND PER CENT OF SCHOOLS BY ENROLLMENT CATEGORIES IN WHICH SPECIFIC MATHEMATICS COURSES ARE OFFERED

Name of Course	School Enrollment Size											
	100-499 (N = 6)		500-999 (N = 16)		1000-1499 (N = 14)		1500-1999 (N = 8)		2000 & over (N = 6)		Total (N = 50)	
	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
General Mathematics	6	100.0	16	100.0	14	100.0	8	100.0	6	100.0	50	100.0
Algebra I	6	100.0	16	100.0	14	100.0	8	100.0	6	100.0	50	100.0
Algebra II	6	100.0	16	100.0	14	100.0	8	100.0	6	100.0	50	100.0
Plane Geometry	6	100.0	16	100.0	14	100.0	8	100.0	6	100.0	50	100.0
Modern Geometry	0	0.0	0	0.0	0	0.0	2	25.0	3	50.0	5	10.0
Trigonometry	3	50.0	10	62.5	9	64.3	7	87.5	6	100.0	35	70.0
Algebra III	0	0.0	0	0.0	2	14.3	1	12.5	0	0.0	5	10.0
Advanced Mathematics	5	83.3	15	94.0	12	85.7	7	87.5	6	100.0	45	90.0
Business Mathematics	3	50.0	7	44.0	5	35.7	2	25.0	2	33.3	18	36.0
Modern Mathematics	0	0.0	1	6.3	3	21.4	2	25.0	0	0.0	6	12.0
Functions	0	0.0	0	0.0	0	0.0	2	25.0	2	33.3	4	8.0
Analysis	0	0.0	0	0.0	0	0.0	0	0.0	2	33.3	2	4.0
Analytic Geometry and Calculus	0	0.0	0	0.0	0	0.0	5	62.5	4	66.7	9	18.0
Statistics	0	0.0	0	0.0	0	0.0	1	12.5	0	0.0	1	2.0
Number Theory	0	0.0	0	0.0	0	0.0	0	0.0	1	25.0	1	2.0

TABLE XLVI

NUMBER AND PER CENT OF SCHOOLS BY SOCIO-ECONOMIC STATUS LEVELS IN WHICH SPECIFIC COURSES WERE OFFERED WITHIN THE SCHOOL

Name of Course	Socio-Economic Status									
	Lower-Lower (N = 4)		Upper-Lower (N = 10)		Lower-Middle (N = 20)		Upper-Middle (N = 16)		Total (N = 50)	
	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
General Mathematics	4	100.0	10	100.0	20	100.0	16	100.0	50	100.0
Algebra I	4	100.0	10	100.0	20	100.0	16	100.0	50	100.0
Algebra II	4	100.0	10	100.0	20	100.0	16	100.0	50	100.0
Plane Geometry	4	100.0	10	100.0	20	100.0	16	100.0	50	100.0
Modern Geometry	1	25.0	1	10.0	2	10.0	1	6.3	5	10.0
Trigonometry	2	50.0	5	50.0	13	65.0	15	93.7	35	70.0
Algebra III	2	50.0	0	0.0	2	10.0	1	6.3	5	10.0
Advanced Mathematics	2	50.0	9	90.0	18	90.0	16	100.0	45	90.0
Business Mathematics	0	0.0	5	50.0	6	30.0	7	43.8	18	36.0
Modern Mathematics	0	0.0	0	0.0	3	15.0	3	19.0	6	12.0
Functions	0	0.0	0	0.0	2	10.0	2	12.5	4	8.0
Analysis	0	0.0	0	0.0	1	0.0	1	6.6	2	4.0
Analytic Geometry and Calculus	0	0.0	1	10.0	4	15.0	4	25.0	9	18.0
Statistics	0	0.0	0	0.0	0	0.0	1	6.3	1	2.0
Number Theory	0	0.0	0	0.0	0	0.0	1	6.3	1	2.0

TABLE XLVII

NUMBER AND PER CENT OF SCHOOLS BY GEOGRAPHICAL REGIONS IN WHICH SPECIFIC MATHEMATICS COURSES WERE OFFERED WITHIN THE SCHOOL

Name of Course	Geographical Region							
	Coastal Plain (N = 12)		Mountain Region (N = 8)		Piedmont Region (N = 30)		Total (N = 50)	
	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
General Mathematics	12	100.0	8	100.0	30	100.0	50	100.0
Algebra I	12	100.0	8	100.0	30	100.0	50	100.0
Algebra II	12	100.0	8	100.0	30	100.0	50	100.0
Plane Geometry	12	100.0	8	100.0	30	100.0	50	100.0
Modern Geometry	0	0.0	0	0.0	5	16.6	5	10.0
Trigonometry	7	58.3	4	50.0	24	80.0	35	70.0
Algebra III	0	0.0	0	0.0	5	16.6	5	10.0
Advanced Mathematics	10	83.3	5	62.6	20	66.7	35	70.0
Business Mathematics	8	67.0	5	62.5	5	16.6	18	36.0
Modern Mathematics	0	0.0	0	0.0	6	20.0	6	12.0
Functions	0	0.0	0	0.0	4	13.3	4	8.0
Analysis	0	0.0	0	0.0	2	6.6	2	4.0
Analytic Geometry and Calculus	1	8.3	1	12.5	7	23.3	9	18.0
Statistics	0	0.0	0	0.0	1	3.3	1	2.0
Number Theory	0	0.0	0	0.0	1	3.3	1	2.0

TABLE XLVIII

NUMBER AND PER CENT OF TEACHERS IN SCHOOLS BY ENROLLMENT CATEGORIES WHO USE SPECIFIC CLASSROOM METHODS OF PROVIDING FOR OUTSTANDING MATHEMATICS STUDENTS REGULARLY

Outstanding Students Are–	School Enrollment Size: 100-499 (N = 20)		500-999 (N = 41)		1000-1499 (N = 40)		1500-1999 (N = 33)		2000 & over (N = 48)		Total (N = 182)	
	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Encouraged to do supplementary problems	14	70.0	36	87.8	34	85.0	29	90.0	37	77.0	140	77.0
Assigned supplementary problems from regular texts	10	50.0	29	70.7	28	70.0	25	76.0	35	73.0	127	69.2
Assigned supplementary problems from other sources	5	25.0	16	40.0	17	42.5	13	36.4	28	60.0	79	43.3
Assigned supplementary reading	10	50.0	21	51.2	18	45.0	11	33.3	19	40.0	79	43.3
Encouraged to do free outside reading	9	45.0	18	44.0	28	70.0	22	66.6	33	70.0	110	61.4
Allowed to help in teaching	10	50.0	29	70.7	35	87.5	26	72.8	36	75.0	136	69.1
Allowed to coach other students	8	40.0	32	80.0	28	70.0	15	45.5	40	83.3	123	67.4
Allowed to exhibit solutions to special problems	9	45.0	34	83.0	34	85.0	29	90.0	40	83.3	146	74.6
Encouraged to do special projects	4	20.0	10	24.4	9	22.5	8	24.2	10	20.0	41	22.5

TABLE XLIX

NUMBER AND PER CENT OF TEACHERS IN SCHOOLS IN SOCIO-ECONOMIC STATUS CATEGORIES WHO USE SPECIFIC CLASSROOM METHODS OF PROVIDING FOR OUTSTANDING MATHEMATICS STUDENTS REGULARLY

Outstanding Students Are—	Socio-Economic Status									
	Lower-Lower (N = 20)		Upper-Lower (N = 40)		Lower-Middle (N = 55)		Upper-Middle (N = 67)		Total (N = 182)	
	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Encouraged to do supplementary problems	10	50.0	30	75.0	38	70.0	62	92.5	140	77.0
Assigned supplementary problems from regular texts	12	60.0	30	75.0	40	72.6	45	67.2	127	69.2
Assigned supplementary problems from other sources	9	45.0	19	47.5	22	40.0	29	47.5	79	43.3
Assigned supplementary reading	8	40.0	21	52.5	21	38.1	29.5	47.5	79	43.3
Encouraged to do free outside reading	8	40.0	24	60.0	35	60.0	43	70.0	110	61.4
Allowed to help teach	12	60.0	28	70.0	42	76.4	54	88.5	136	69.1
Allowed to coach other students	12	60.0	36	80.0	41	74.5	34	50.7	123	67.4
Allowed to exhibit solutions to special problems	18	90.0	30	75.0	40	72.7	46	70.0	146	74.6
Encouraged to do special projects	5	25.0	10	25.0	16	30.0	10	15.0	41	22.5

TABLE L

NUMBER AND PER CENT OF TEACHERS IN SCHOOLS BY GEOGRAPHICAL REGIONS WHO USE SPECIFIC CLASSROOM METHODS OF PROVIDING FOR OUTSTANDING MATHEMATICS STUDENTS REGULARLY

	Geographical Region							
	Coastal Plain (N = 12)		Mountain Region (N = 8)		Piedmont Region (N = 30)		Total (N = 50)	
Outstanding Students Are-	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Encouraged to do supplementary problems	30	75.0	20	66.6	90	80.4	140	77.0
Assigned supple-mentary problems from regular texts	26	65.0	25	83.3	76	62.5	127	69.2
Assigned supple-mentary problems from other sources	16	40.0	16	53.3	47	42.0	79	43.3
Assigned supple-mentary reading	15	37.5	16	53.3	48	43.0	79	43.3
Encouraged to do free outside reading	25	62.5	21	70.0	64	57.1	110	61.4
Allowed to help in teaching	27	67.5	29	96.6	80	71.4	136	69.1
Allowed to coach other students	26	65.0	21	70.0	76	68.0	123	67.4
Allowed to exhibit solutions to special problems	28	70.0	26	86.6	92	82.1	146	74.6
Encouraged to do special projects	10	25.0	7	26.6	24	4.0	41	22.5

FOOTNOTES

[1]John W. Smith, "Case History, Charlotte-Mecklenburg Schools," National Association of Secondary School Principals Bulletin (1968), 65-66.

[2]Carter V. Good, ed., Dictionary of Education (New York, 1954), p. 103.

[3]Ibid., p. 103.

[4]Ibid., p. 226.

[5]Ibid., p. 290.

[6]Ibid., p. 44.

[7]Ibid., p. 147.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The major purpose of this study was to determine and analyze provisions being used in randomly selected North Carolina public high schools to provide for outstanding mathematics students. The term "outstanding student" was not limited to the gifted as usually defined by educators; however, the gifted students were included in the group designated as outstanding students. It was realized that the term "outstanding student" would be variously interpreted from school to school, hence the individual school determined, in keeping with a general definition provided in the questionnaire, which students they consider to be outstanding.

One objective of the study was to gather data of an interpretative nature concerning the programs for outstanding mathematics students in North Carolina public high schools. Then, on the basis of these data, to suggest to the school personnel of the state ways to improve the quality of these programs.

The investigation was carried out by seeking answers to six specific questions pertaining to the administrative and classroom provisions for outstanding mathematics students. Findings were studied and interpreted by geographical regions, by school size, and by socio-economic status of schools. Additional questions were posed which concerned the academic preparation and recency of training of mathematics teachers in the selected schools. The major focus of this chapter will be findings on the various questions posed in this study.

Review of Methods and Procedures of the Study

A list of administrative and classroom provisions for outstanding mathematics students was compiled from a review of the literature. This list was used to develop a series of questions concerning administrative and classroom provisions for outstanding students. The questions were then submitted to experienced mathematics teachers, supervisors, and principals, and the initial questionnaire was prepared on the basis of their recommendations.

After the tentative questionnaire had been constructed, some indication of its validity was gained by consultations with teachers and principals. The final revised questionnaire consisted of two parts. Part I was comprised of questions concerning administrative policies and procedures for designating and providing for outstanding mathematics students. Part II consisted of inquiries about classroom procedures for identifying students and designing programs for the outstanding mathematics students. A list of questions pertaining to the academic preparation of mathematics teachers was also included in the second part of the questionnaire.

The schools were randomly selected from a list of the public high schools of North Carolina which enrolled students in grade categories 9 through 12 and 10 through 12, exclusively. The principals and those teachers who taught at least two mathematics classes in each school furnished data for this investigation.

Returns were received from schools of varied sizes and socio-economic status, excluding schools with enrollment less than one hundred and those representative of the upper socio-economic groups. Absence of responses from schools with enrollment less than one hundred is accounted for in that none were included in the population; thus the enrollment categories represented ranged from 100 through 499 and up to 2000. The total sample consisted of fifty schools, and usable responses were received from 182 teachers in the selected schools. The teachers' enthusiasm for providing for outstanding mathematics students was indicated by the large percentage of returns, by the comments written on the questionnaire, and by their willingness to cooperate in any feasible way.

Interpretations of Findings Related to Specific Questions

1. To what extent were provisions being made for outstanding mathematics students?

Some provisions for outstanding mathematics students were being made in all schools furnishing data in this investigation. Although the questionnaire identified eighteen administrative and classroom methods of providing for outstanding mathematics students, only nine were being used regularly by more than 60 per cent of the principals and teachers. Of the nine methods being used regularly, three were administrative and the other six were classroom methods.

The three administrative methods used regularly were ability grouping, special classes, and special counseling. While this may be better than doing nothing at all, Hlavaty[1] supports the idea that this is only the initial step in formulating procedures for discovering outstanding students and fostering adequate programs which challenge them to their full capacity. Other administrative methods can be used;

but these generally require more time in planning than methods now in regular use.

In over 50 per cent of the schools, teachers were expected to work with outstanding students of mathematics any time during the school day or after school; yet, only 14 per cent of the principals recognized that the extra work was not a part of the regular teaching load. In no schools were teachers given extra pay for working with students after school. This may partially explain why less than five per cent of the teachers stated that they regularly work with outstanding students after school.

Seventy per cent of the schools offered a traditional sequence in mathematics courses from algebra I through advanced mathematics or algebra III. Calculus and analytic geometry was not a popular fifth-year course offered in the selected schools.

2. <u>What were the methods of making provisions for outstanding mathematics students?</u>

Nine administrative methods of providing for outstanding mathematics students were identified in the questionnaire. Responses from principals indicated that several of these methods were used regularly to provide for outstanding mathematics students. The term "regular" was defined as "all the time" or "frequently." The methods most widely used regularly by principals were:

a. Ability grouping 84%

b. Special counseling 78%

c. Special classes 62%

Other administrative methods identified in the questionnaire but not widely used regularly were:

a. Special coaching 42%

b. Extra-curricular courses . . . 38%

c. Mathematics clubs 28%

d. Inter-school contests 16%

e. Intra-school contests 14%

f. Field trips 10%

Nine classroom methods of providing for outstanding mathematics students were also identified in the questionnaire. Of these methods, six were being used regularly by more than 50 per cent of the teachers furnishing data for this investigation. Responses indicated that outstanding students were:

a. Encouraged to do supplementary problems . . . 77%

b. Allowed to exhibit solutions to problems . . 75%

c. Allowed to help teach 69%

d. Assigned supplementary problems 69%

e. Allowed to coach other students 67%

f. Encouraged to do free reading 61%

Three methods identified in the questionnaire were used by fewer than 50 per cent of the teachers. Responses indicated that outstanding students were:

a. Assigned problems from other sources 43%

b. Assigned supplementary reading 43%

c. Encouraged to do special projects 23%

Some principals and teachers were unusually sensitive to the needs of individual students. Their sensitivity was shown in their creative approaches to meeting their needs. For example, one teacher used special organization of classes to allow for independent study on topics of interest. Another reported that some students were permitted to travel at a rate which enabled them to complete algebra I, geometry, and algebra II in two years, rather than the usual three. One principal reported the use of a special committee to provide for outstanding mathematics students.

A number of other methods reported by teachers, such as encouraging outstanding mathematics students to prepare scrap books and bulletin boards, were useful in stimulating interest. In general, these methods do little about the really significant problem of providing the needed challenge. Wright[2] and Hlavaty[3] highly recommend special projects, mathematics clubs, and contests for providing intellectual challenge for outstanding mathematics students, but these methods were very infrequently employed by principals and teachers furnishing data for this investigation.

Sufficient curricular programs must be provided that not only permit the student to go faster but with more depth as well. If, as Conant[4] suggests, one of the most important administrative ways of providing for outstanding mathematics students is to provide a wide range of mathematics courses, in few schools included in the study were programs provided that were considered adequate. In 70 per cent of the schools traditional sequences of mathematics courses of algebra I through advanced mathematics were provided. Fifth-year courses, (those pre-supposing four years of mathematics beginning with algebra I), which were entirely different from algebra were offered in only thirteen schools. Of these thirteen schools, analytic geometry was provided in nine, analysis in two, number theory in one, and statistics in one. In his 1965 survey for the U. S. Office of Education, Woodby[5] found that analytic geometry and calculus was becoming the accepted fifth-year mathematics course. The present survey revealed that in a majority of the selected public schools, however, fifth-year courses that stress additional topics in algebra are still offered.

3. <u>What factors limited or prevented the use of the methods of providing for outstanding mathematics students?</u>

Principals and teachers indicated that administrative and classroom methods of providing for outstanding mathematics students were limited by a number of the factors mentioned in the questionnaire. The factors checked by principals as limiting or preventing the use of administrative methods of providing for outstanding mathematics students are listed below in descending order of per cent of times mentioned.

a. Lack of teacher time 42%

b. Lack of teacher interest 23%

c. Lack of student time 21%

d. Lack of opportunity 20%

e. Lack of student interest 19%

f. Other factors 5%

The factors checked by teachers as limiting or preventing the use of classroom methods are listed below in descending order of per cent of times mentioned.

a. Lack of teacher time 60%

b. Lack of student time 56%

c. Lack of student interest 41%

d. Lack of supplementary materials. . 33%

e. Lack of teacher interest 9%

f. Other factors 9%

Both teachers and principals agreed that lack of teacher time was the strongest factor interfering with their making adequate provisions for outstanding mathematics students. Wright[6] recommends special projects and contests as very useful ways of providing for outstanding mathematics students. He cautions, however, that lack of teacher time has been a major factor in cases where little or no success was experienced.

4. What was the relationship between the programs provided for outstanding mathematics students and academic preparation of teachers?

An analysis of the percentage distribution of the data for this question resulted in the following major findings concerning the academic preparation of teachers:

a. Bachelors' degrees 100%

b. Bachelors' degrees, majors in mathematics 70%

c. Bachelors' degrees, majors in mathematics, related minor 20%

d. Bachelors' degrees, majors in other areas 30%

e. Masters' degrees 30%

f. Masters' degrees, majors in mathematics . . . . 30% (of the 30%)

g. Masters' degrees, majors in education . . . . 36% (of the 30%)

h. Fewer than eighteen hours in mathematics 20%

i. Mean number of semester hours . . . 37

j. Range of total hours in mathematics. 7 to 94

No identifiable relationship between the total programs for outstanding mathematics students and the academic preparation of teachers was found to exist. In considering the various aspects of the program, however, the following facts were noted:

a. Classroom provisions rated above-average . . . 58%

b. Administrative provisions rated above-average. 20%

c. Curricular programs rated above-average . . . 26%

d. Faculties rated above-average 36%

In spite of these facts, only nine (18%) schools had above-average total programs in mathematics. An analysis of the data (Table XXXIX, page 80) shows that the above-average administrative provisions were noted in schools where classroom provisions were average or below-average. Similarly, the above-average classroom provisions were more prevalent in schools where above-average administrative provisions were found less frequently. An additional analysis by chi-square (Table XXXVIII, page 78) shows that the null hypothesis of no difference between the academic preparation of mathematics teachers in average, above-average, and below-average programs for outstanding mathematics students could not be rejected. The chi-square test was significant at the .10 level but not at the .05 level. The responsibility for providing stimulating and challenging programs for outstanding mathematics students is to be shared by the administration and by classroom teachers. Each has a definite responsibility and one cannot be assumed by the other. Yet, the foregoing facts appear to indicate that the administrative and classroom provisions tended to supplant rather than complement each other.

A comparison of courses recommended by CUPM for various levels of mathematics teachers (Table I, page 27), with teachers who have completed specific mathematics courses (Table XXXIII, page 73), and with teachers who teach specific courses (Table XLI, page 81) appears to indicate that the preparation of teachers in the mathematics classrooms today (1968) still fall below the minimum requirements which were recommended in 1960 by CUPM. Findings were as follows:

a. Twenty-one per cent of the teachers failed to meet minimum requirements recommended for any high school courses.

b. Though 52 per cent of the teachers were assigned algebra and geometry, only 39 per cent had completed the minimum requirements to teach these subjects.

c. Thirty-four per cent of the teachers were assigned more advanced high school courses, but only 29 per cent had completed the minimum requirements to teach these courses.

d. Fourteen per cent of the teachers taught advanced placement mathematics, but only 10 per cent had completed the minimum requirements.

Although the mean average number of semester hours completed by mathematics teachers was 37.3 semester hours, results show that teachers at all levels failed to meet the minimum requirements recommended by CUPM in 1960. Though there is continuing agitation for much stronger high school mathematics programs, such as the one recommended by the Cambridge Committee in 1963 (See page 24), fewer than 20 per cent of the mathematics teachers involved in the study had the very minimum preparation for teaching courses in such a program.

Since 51.9 per cent of the teachers had received their baccalaureate training after 1957, it would appear that, due to the age of the teachers and to the changes in the programs for preparing mathematics teachers in the past decade, adequately prepared teachers could be more easily trained to teach in stronger programs if encouraged to continue their training. A school system can and should make appropriate provisions for outstanding students by improving the quality of teachers presently assigned to work with them. Hlavaty[7] suggests the following ways to improve the quality of in-service teachers:

a. Plan appropriate in-service training courses.

b. Encourage teachers to take these courses.

c. Advertise all courses -- in-service, college, summer institutes -- that will improve the quality of teachers.

d. Hold mathematical conferences.

5. What was the relationship between the programs provided for outstanding mathematics students and the recency of training of mathematics teachers?

A positive relationship between the classroom provisions for outstanding mathematics students and the recency of academic training of mathematics teachers was identified. Data revealed that when schools were rated above-average, average, and below-average, on the basis of total programs for outstanding mathematics students, the following per cent of the teachers had received additional training since 1962:

a. Above-average 83%

b. Average 76%

c. Below-average 46%

A chi-square analysis of the data also showed that there was a positive relationship between the total provisions in the schools and the recency of training of mathematics teachers in these schools. The terms average, below-average, and above-average were defined in Chapter IV. (See page 76.)

6. <u>Were the uses of these methods related to geographical regions, school size, socio-economic status, and administrative policy?</u>

No consistent pattern of relationship was found between all aspects of the programs for outstanding mathematics students and geographical regions, school enrollment size, socio-economic status, or administrative policy. Some specific observations or tendencies were noted, however. These observations were:

a. Courses which stressed concepts different from algebra were more frequently provided in the Piedmont region. Above-average faculties were more frequently found in schools in the Piedmont region.

b. Schools with enrollment between 1500 and 1999 and those with enrollments between 500 and 999 more frequently provided special coaching.

c. Schools in the Mountain region had a higher frequency of above-average classroom provisions.

d. Socio-economic status appeared not to be a factor in provisions for outstanding mathematics students.

e. Lack of administrative policy was perceived as a handicap to teachers in their use of mathematics clubs and contests within and among schools.

In addition to the responses to the specific questions included in the questionnaire, comments made by teachers in spaces provided on the questionnaire revealed the following important features about the above-average programs for outstanding mathematics students:

a. Teachers were generally sympathetic and willing to experiment with new ways of meeting the needs of outstanding students.

b. The major responsibility for determining and providing programs for outstanding students rested with members of the mathematics department.

c. The nature of special classes departed greatly from the nature of regular classes.

d. Special counseling of outstanding students was usually provided.

e. Opportunities were usually provided for outstanding students to pursue courses beyond the high school level.

Conclusions

After a detailed analysis of the data from this investigation, it was possible to arrive at the following conclusions:

Concerning the Administration

1. Some administrators do markedly better than others in providing for outstanding mathematics students.

2. In schools recognized as having better-than-average provisions for outstanding mathematics students, administrators usually provided special guidance and opportunities for outstanding students to pursue courses not offered in the school.

3. Administrative and classroom provisions tended to supplant rather than complement each other.

4. In only a few schools were the curricular programs considered to be of adequate range, such as the ones recommended by Woodby[8] and Conant.[8]

5. The most frequently provided fifth-year course was advanced mathematics.

6. Lack of policies concerning the use of mathematics clubs, contests, and field trips seriously handicapped administrative provisions for outstanding mathematics students.

7. In schools recognized as having better-than-average overall provisions for outstanding mathematics students, a combination of administrative and classroom provisions was used.

Concerning the Classroom Teacher

1. There was widespread interest in and enthusiasm among teachers for making provisions for outstanding mathematics students.

2. Teachers considered as doing a better-than-average job of providing for outstanding mathematics students used a variety of classroom provisions.

3. Teachers in schools that were recognized as having better-than-average provisions for outstanding mathematics students appeared to be sympathetic and creative and were generally willing to experiment with new methods.

4. Because of the heavy demands on their time, teachers were handicapped in their attempts to do an adequate job.

5. Teachers recognized as doing a better-than-average job in providing for outstanding students had earned recent credit in mathematics courses.

6. Academic preparation of mathematics teachers in 1969 fell below the 1960 recommendations of CUPM.

Recommendations

On the basis of a thorough analysis of the findings from the fifty schools and 182 teachers supplying data for this investigation, it seems that several recommendations are appropriate. These recommendations result from a comparison of programs in selected schools with suggested provisions presented in Chapter II of this study.

Recommendations for School Administrators

In order to improve the administrative provisions for outstanding high school mathematics students, the following recommendations are made:

1. Administrators should consider more extensive use of mathematics clubs, contests within schools, and contests among schools.

2. Administrators could provide special activities for outstanding students such as advanced placement courses, computer courses, and programmed materials; where special activities require additional time on the part of teachers, this should be considered a part of teaching loads. This may in some cases require a reduction in the regular class loads of

some teachers.

3. Special classes should be provided for outstanding mathematics students; these classes should be distinctly different from regular classes. They should be smaller and teachers should use discovery and laboratory methods of teaching rather than the lecture method.

4. When considering special classes, administrators should use previous mathematics grades, recommendations from mathematics teachers, and I. Q. score as selection criteria.

5. Members of the mathematics department should be encouraged to initiate programs and activities for mathematics students.

6. Because of continued agitation for the improvement of total programs for mathematics students, teachers with more extensive and more recent training in mathematics should be assigned to work with outstanding students.

7. Administrators' assessment of the relevency of programs provided for outstanding mathematics students could be aided by use of community personnel.

8. An extensive use of mathematics clubs, seminars, and films could be employed to provide for outstanding students in small schools where it is impossible to establish classes and difficult to provide day-to-day contact between students with similar interests and abilities.

Recommendations for Teachers

In order to improve the classroom provisions for outstanding mathematics students, the following recommendations are made:

1. The teachers should develop a program of individual projects and exhibits; projects undertaken by outstanding students should be more challenging and should require more originality.

2. Teachers should help outstanding students plan and work on projects outside class; such teachers could be relieved of other extra-curricular responsibilities. In some cases where there is a large number of outstanding mathematics students, a reduction in the number of classes taught may be necessary.

3. Teachers should make supplementary problem assignments to outstanding mathematics students; such problems should not be assigned as busy work, but should instead lead to new concepts.

4. Teachers should give more frequent consideration to the use of field trips.

5. Teachers should utilize outstanding mathematics students to help in teaching and to perform demonstrations for the class.

6. Teachers should utilize laboratory and discovery methods of teaching; The Mathematics Teacher frequently carries articles on laboratory and discovery methods of teaching.

7. Teachers should realize that outstanding students can discover for themselves what many students cannot; therefore, they should be left alone to uncover new ideas and patterns.

Recommendations for Further Study

Findings revealed that many problems are encountered in efforts to provide for outstanding mathematics students. Lack of related studies made it difficult to compare the overall conditions of the schools furnishing data in this investigation with conditions of schools in other states. A more extensive study may point up other problems. The problems recommended for further study are:

1. How successful are these methods now being used to provide for outstanding mathematics students?

2. What difference, if any, is there between the programs in schools where ability grouping is provided and programs in schools where ability grouping is not provided?

3. What are valid criteria for determining the success of methods of providing for outstanding students?

4. What is the difference in the progress of students in special classes and those who are not placed in special classes?

5. What are the significant differences between the characteristics of mathematics teachers recognized as doing a good job and those not doing a good job?

Movement toward a "new mathematics" has been in progress for more than a decade. In spite of the efforts of numerous and various study groups, foundations, and government-supported agencies, when all aspects are considered, there still exist serious deficiencies in both the preparation of mathematics teachers and the programs being provided for mathematics students in North Carolina. An indictment against teachers and schools programs cannot be considered an exoneration of policymakers — legislators and school administrators. They share a responsibility for effecting a more adequate program in mathematics and for encouraging the best preparation of teachers. If they meet this responsibility by making possible equitable teaching loads, sufficient preparation time, and extensive opportunities for professional growth and advancement, more meaningful and effective programs for training mathematics students can be realized.

FOOTNOTES

[1]Julius Hlavaty, "How Provide for the Mathematically Talented?" _National Association of Secondary School Principals Bulletin_, LII (1968), 100-106.

[2]Frank Wright, "Motivating Students with Projects and Teaching Aids," _The Mathematics Teacher_, LVIII (1965), 47.

[3]Hlavaty, pp. 102-106.

[4]James B. Conant, _The American High School Today_ (New York, 1959), p. 40.

[5]Lauren G. Woodby, _Emerging Twelfth-Grade Mathematics Programs_ (Washington, D. C., 1965), p. 7.

[6]Wright, pp. 47-48.

[7]Hlavaty, pp. 100-106.

[8]Conant, p. 40, and Woodby, p. 7.

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APPENDIXES

APPENDIX A

TENTATIVE QUESTIONS FOR THE INSTRUMENT

1. What is the enrollment of your school?

2. What is the total number of mathematics teachers in your school?

3. What is the category that best describes the socio-economic status of your school?

4. Does your school practice ability grouping?

5. What criteria are used as a basis for ability grouping?

6. Are apecial classes provided for outstanding mathematics students?

7. What criteria are used as a basis for selection of students for special classes?

8. What is the nature of work done in special classes?

9. What is the written policy of your school with respect to scheduling outstanding mathematics students to work under special supervision of mathematics teachers on special projects?

10. Are teachers used to coach outstanding mathematics students?

11. Does your school provide an opportunity for outstanding mathematics students to pursue courses beyond the high school level?

12. Is special counseling provided for outstanding mathematics students?

13. Are mathematics clubs of a general nature used in your school?

14. Are mathematics contests within the school used?

15. Are mathematics contests among schools used?

16. Is acceleration used in your school to provide for outstanding mathematics students?

17. Are enrichment materials used to provide for outstanding mathematical students?

18. Are community resources utilized to make provisions for outstanding mathematics students.

19. Are outstanding students assigned special projects?

20. Are outstanding mathematics students encouraged to do special projects?

21. Are outstanding mathematics students allowed to exhibit solutions to special problems?

22. Are outstanding mathematics students allowed to help in teaching?

23. Are outstanding mathematics students allowed to coach other students?

24. Are outstanding students assigned supplementary reading?

25. Are outstanding mathematics students encouraged to do supplementary problems according to interest and ability?

26. Are outstanding students assigned supplementary problems from regular texts?

27. Are outstanding mathematics students assigned supplementary problems from sources other than regular texts?

28. Are outstanding mathematics students encouraged to participate in science fairs?

29. Are outstanding mathematics students encouraged to submit articles to student journals?

30. Are field trips used to provide for outstanding mathematics students?

APPENDIX B

PERSONS OFFERING SUGGESTIONS FOR CONSTRUCTION AND VALIDATION OF THE INSTRUMENT

Spencer E. Durante
West Charlotte Senior High School
Charlotte, North Carolina

Leroy Waters
North Mecklenburg High School
Charlotte, North Carolina

William P. Hytche
Maryland State College
Princess Anne, Maryland

Raymond Fleischmann
Oklahoma State University
Stillwater, Oklahoma

David Hunter
Central Piedmont Community College
Charlotte, North Carolina

Paul Mohr
Clearwater Campus, Saint Petersburg Junior College
Clearwater, Florida

Jean Rorie
Charlotte-Mecklinburg Schools
Charlotte, North Carolina

Hiraum Johnston
Oklahoma State University
Stillwater, Oklahoma

APPENDIX C

LETTER TO PRINCIPAL OF SCHOOL

82 - 5 South University Place
Stillwater, Oklahoma 74074
October 1, 1968

Dear Principal:

I am a native North Carolinian who has spent more than a decade teaching in the secondary schools and colleges of my state. I have a longstanding interest in the methods of instruction employed in our classrooms, and particularly in mathematics classes. Presently, I am on leave from Johnson C. Smith University and am engaged in a study at Oklahoma State University dealing the methods being used to make provisions for outstanding mathematics students in the public schools of North Carolina. I expect to be able to use the results of the study for my doctoral dissertation.

Your school has been selected as a part of the random sample for the study. I am, therefore, soliciting your cooperation in the completion of the questionnaires enclosed with this letter. Please complete Part I and ask each mathematics teacher -- those who teach at least two mathematics classes -- to complete a copy of Part II. In order for the data from your school to be of value in the study, your completed copy of Part I and a completed copy of Part II from each of your mathematics teachers must be returned as soon as possible before November 1, 1968.

Stamped, addressed envelopes are enclosed for the return of the completed questionnaires. No specific references will be made to the schools selected to participate in the study. A complete roster of schools included in the study will appear in the appendices. This study should be of tremendous value in the teacher education programs in North Carolina.

Please accept my sincere thanks for your effort and cooperation in helping me to conduct this study. If additional copies of Part II are needed, indicate the fact when you return your copy and I shall gladly supply them.

Very truly yours,

Rufus G. Pettis

APPENDIX D

LETTER TO MATHEMATICS TEACHER

82 - 5 South University Place
Stillwater, Oklahoma 74074
October 1, 1968

Dear Teacher:

I am a native North Carolina teacher of more than ten years' standing, and I have a deep interest in the methods of instruction employed in the classrooms of our schools and colleges, particularly in the area of mathematics. Presently, I am on leave from Johnson C. Smith University and am engaged in a study (at Oklahoma State University) of the methods being used to make provisions for outstanding mathematics students in the public schools of North Carolina. I expect to use the results of the study for my doctoral dissertation.

Your school has been selected as a part of the random sample for the study. I am seeking the cooperation of each math teacher in the school in obtaining data for the study. Please complete the attached questionnaire and return it as early as possible before November 1, 1968. The questionnaire is to be completed only by those who teach at least two mathematics classes.

A stamped, addressed envelope is attached for the return of your questionnaire. No specific references will be made to the teachers or the schools selected to participate in the study; therefore, it will not be necessary for you to put your name any place on the questionnaire.

May I take this opportunity to offer my sincere thanks to you for your cooperation and assistance in the conduct of this study.

Very truly yours,

Rufus G. Pettis

APPENDIX E

FOLLOW-UP LETTER

82 - 5 South University Place
Stillwater, Oklahoma 74074
November 1, 1968

Dear Principal:

Several weeks ago you received a set of questionnaires on the methods of providing for outstanding mathematics students in your school. We have not yet received your response. We are sending a second set of questionnaires and asking that you complete them and return them as soon as possible.

We are asking that you complete Part I and return it at your earliest convenience. Please request each of your mathematics teachers who teach at least two classes of mathematics to complete a copy of Part II and mail it in the enclosed stamped, addressed envelopes. We are anxious to have the data from your school included in this study and will be grateful for the immediate return of the questionnaires. You are reminded again that no specific reference to your school will be made in the study and that a complete roster of schools participating in the study will appear in the appendices.

If you have already mailed the forms to us, kindly disregard this second request.

Again accept my thanks for your cooperation in the conduct of the study.

Sincerely yours,

Rufus G. Pettis

APPENDIX F

QUESTIONNAIRE

Part I: Completed by Principal

Part II: Completed by Mathematics Teachers

Ref. No. _______

AN ANALYSIS OF METHODS BEING USED TO MAKE PROVISIONS FOR OUTSTANDING STUDENTS OF MATHEMATICS IN NORTH CAROLINA
by Rufus G. Pettis
Oklahoma State University - Stillwater, Oklahoma

PART I: TO BE FILLED OUT BY PRINCIPAL

(The term outstanding student, for the purposes of this study, may be defined as the student who falls within the top 15% of the student body, who possesses both highly rated intellect as determined by I. Q. and intrinsic motivation toward mathematics, or who has indicated by such criteria as achievement test scores, course grades, and high interest that he is capable of performing at a high level if such opportunities are available.)

SECTION A

DIRECTIONS: Please respond to the following questions by checking or writing in the item that best describes your school. Feel free to suggest any omitted item that you feel should be included.

1. Which of the following best describes the enrollment classification of your school?

☐ Less than 100 ☐ 1000 - 1499
☐ 100 - 499 ☐ 1500 - 1999
☐ 500 - 999 ☐ 2000 or over

2. What is the total number of mathematics teachers in your school? (Count only those teaching at least two classes.)

____

3. How many students are currently enrolled in math courses? _______

4. Which of the following are offered in in your school?

☐ Algebra I ☐ General Math
☐ Algebra II ☐ Trigonometry
☐ Plane Geometry ☐ Advanced Math
☐ Other (Please specify.) _______

5. Which of the following best describes the socio-economic status of students in your school?

☐ Lower-lower ☐ Upper-middle
☐ Upper-lower ☐ Upper
☐ Lower-middle

6. Does your school practice ability grouping? ☐ Yes ☐ No

7. If yes, what criteria are used as a basis for grouping?

☐ I. Q. scores ☐ Reading ability
☐ Achievement tests ☐ Previous grades
☐ Other (Please describe.) _______

8. Are special classes provided for outstanding students of mathematics?

☐ Yes ☐ No

9. If yes, please answer the following questions:

a. Course(s) in which special classes are provided: _______

b. Which criteria are used as a basis for selection of students for special classes? (Check one or more.)

☐ I. Q. scores
☐ Previous math grades
☐ All previous grades
☐ Students' expressed interest
☐ Recommendation of math teacher
☐ Recommendation of all teachers
☐ Parents' request
☐ Achievement test scores
☐ Other (Please describe.) _______

c. How do special classes compare with regular classes in size?

☐ Smaller than regular classes
☐ Same size as regular classes
☐ Larger than regular classes

d. Which of the following best describes the nature of work done in such classes as compared to regular classes?

☐ Covers same units with a faster pace
☐ Covers same units but with more depth
☐ Covers same units but with additional topics
☐ Follows a course of study that is entirely different from regular classes

10. Which best describes your school with respect to the policy of scheduling students to work under supervision of teachers on special mathematics activities?

☐ Never done
☐ Scheduled only outside of regular class periods
☐ Scheduled only during teachers' non-teaching periods
☐ Scheduled during any period

11. Are teachers used to coach outstanding students of mathematics?

☐ Yes ☐ No

(over)

a. If such activities are encouraged, check the purposes for which they are used.

- ☐ College entrance examinations
- ☐ Various contests
- ☐ Achievement tests
- ☐ Other (Please describe.)________________

b. Are such assignments considered a part of the regular teaching load?

☐ Yes ☐ No

12. Does your school provide opportunities for outstanding students to pursue courses not offered in your school or courses above the high school level?

☐ Yes ☐ No

13. If #12 is answered yes, how are these opportunities provided?

- ☐ Enrollment in correspondence courses
- ☐ Enrollment in courses at nearby college
- ☐ Independent study
- ☐ Other (Please specify.)________________

14. Which of the following best describes your school's policy regarding special counseling of outstanding math students?

- ☐ Not provided
- ☐ Sometimes provided
- ☐ Usually provided

15. Please describe briefly any method or technique used in your school for discovering, encouraging, and providing for outstanding students that has not been mentioned above.

____

SECTION B

DIRECTIONS: Following are several methods that have been used by other schools. Please indicate, by checking the appropriate items, the use and limitation of these methods in your school.

	FREQUENCY OF USE OF METHOD				FACTORS LIMITING OR PREVENTING USE OF METHOD						
	All the time	Frequently	Rarely	Never	LACK OF - teacher time	- teacher interest	- student time	- student interest	No such opportunity exists	Other (please specify)	
USE OF MATH CLUBS											
USE OF MATHEMATICAL CONTESTS WITHIN THE SCHOOL											
USE OF MATHEMATICAL CONTESTS AMONG SCHOOLS											
USE OF FIELD TRIPS FOR OUTSTANDING STUDENTS OF MATHEMATICS											

Ref. No. ________

AN ANALYSIS OF METHODS BEING USED TO MAKE PROVISIONS FOR OUTSTANDING STUDENTS OF MATHEMATICS IN NORTH CAROLINA

by Rufus G. Pettis
Oklahoma State University - Stillwater, Oklahoma

PART II-A: TO BE FILLED OUT BY TEACHERS WHO TEACH AT LEAST TWO COURSES IN MATHEMATICS

(The term outstanding student, for the purposes of this study, may be defined as the student who falls within the top 15% of the student body, who possesses both highly rated intellect as determined by I. Q., and intrinsic motivation toward mathematics, or who has indicated by such criteria as achievement test scores, course grades, and high interest that he is capable of performing at a high level if such opportunities are available.)

DIRECTIONS: Please respond to each of the following descriptions of classroom methods of making provisions for outstanding students by checking the appropriate column which best describes your answer to each item listed below	FREQUENCY OF USE OF METHOD: All the time	Frequently	Rarely	Never	FACTORS LIMITING OR PREVENTING USE OF METHOD: LACK OF - teacher time	- suppl. materials	- student time	- student interest	- teacher interest	Other (specify) ____			COURSES IN WHICH METHODS ARE USED: Gen. or Mod. Math	Alg. I or Alg. II	Plane or Sol. Geom.	Adv. Math or Trig.	Calc. or Anal. Geom.	Other (specify) ____			
SPECIAL ASSIGNMENTS FOR OUTSTANDING STUDENTS																						
1. Encouraged to do supplementary problems according to interest and ability																						
2. Assigned supplementary problems from regular text																						
3. Assigned supplementary problems from sources other than text																						
READING ASSIGNMENTS FOR OUTSTANDING STUDENTS																						
1. Assigned supplementary readings																						
2. Encouraged to do free reading outside of class																						
THE USE OF OUTSTANDING STUDENTS FOR TEACHING AND DEMONSTRATIONS																						
1. Allowed to help in teaching other students																						
2. Allowed to coach other students																						
3. Allowed to exhibit solutions of special problems to class																						
SPECIAL PROJECTS																						

PLEASE DESCRIBE IN THIS SPACE ANY METHOD OR TECHNIQUE NOT MENTIONED ABOVE THAT YOU USE IN THE CLASSROOM TO ENCOURAGE OR PROVIDE FOR OUTSTANDING STUDENTS:

PART II-B: TO BE FILLED OUT BY TEACHERS WHO TEACH AT LEAST TWO COURSES IN MATHEMATICS

DIRECTIONS: Please respond to the following questions by checking items which best describes your school. Feel free to suggest any omitted item that you feel should be included.

1. Are special classes provided for outstanding students of mathematics?

   ☐ Yes ☐ No

2. If yes, please answer the following:

   a. Course(s) in which special classes are provided:__________

   ____

   b. Which criteria are used for selection of students for special classes? (Check one or more.)

   - ☐ I. Q.
   - ☐ Previous math grades
   - ☐ All previous grades
   - ☐ Students' expressed interest
   - ☐ Recommendation of math teachers
   - ☐ Recommendation of all teachers
   - ☐ Parents' request
   - ☐ Achievement tests
   - ☐ Other (please specify)______

   ____

   c. Which best describes the nature of work done in such classes as compared to regular classes?

   - ☐ Covers same units with a faster pace
   - ☐ Covers same units but with more depth
   - ☐ Covers same units but with added material in each unit
   - ☐ Follows a course of study entirely different from regular classes

3. Which best describes your school regarding the policy of scheduling students to work under the supervision of teachers on special mathematics activities?

   - ☐ Never done
   - ☐ Scheduled only outside of regular class periods
   - ☐ Scheduled only during teachers' non-teaching periods
   - ☐ Scheduled during any period

4. Are teachers used to coach outstanding mathematics students?

   ☐ Yes ☐ No

   a. If such activities are encouraged, for what purposes are they used?

   - ☐ College entrance examinations
   - ☐ Various contests
   - ☐ Achievement tests
   - ☐ Other (please describe)_____

   ____

   b. Are such assignments considered a regular part of the teaching load?

   ☐ Yes ☐ No

5. Which best describes your school's policy regarding counseling of outstanding math students?

   - ☐ Not provided
   - ☐ Sometimes provided
   - ☐ Usually provided

DIRECTIONS: Please record in the appropriate columns information regarding your academic training.

	BACHELOR'S	MASTER'S
NAME(S) OF DEGREE(S)		
YEAR(S) CONFERRED		
ACADEMIC MAJOR		
ACADEMIC MINOR		
INSTITUTION GRANTING DEGREE		

TOTAL HOURS EARNED IN MATHEMATICS:

Semester hours ______

Quarter hours ______

How many credit hours have you earned in each of the following areas and in what year(s) was credit earned?

HOURS		YEAR(S)	HOURS		YEAR(S)
	Modern Mathematics			Probab. and Statistics	
	Modern Algebra			Analysis	
	Geometry			Number Theory	
	Foundations of Math			Other areas	

APPENDIX G

NAME AND LOCATION OF HIGH SCHOOLS INCLUDED IN THE INVESTIGATION BY GEOGRAPHICAL REGIONS

Coastal Plain

Charity, Rose Hill
Dillard, Goldsboro
East Duplin, Beulaville
E. E. Smith, Fayetteville
Fike, Wilson
Greene Central, Snow Hill
Jacksonville, Jacksonville
New Bern, Trent Park
Pine Forest, Fayetteville
Seventy-First, Fayetteville
Scotland, Laurinburg
Whiteville, Whiteville

Mountain

Charles D. Owens, Swannanoa
East Henderson, Henderson
Enka, Enka
Hudson, Hudson
Polk Central, Mill Springs
Swan County, Bryson City
Rutherfordton-Spindale, Rutherfordton
Watauga, Boone

Piedmont

Anson, Wadesboro
Atkins, Winston-Salem
Bandys, Catawba
Belmont, Belmont
Claremont Central, Hickory
Crest, Shelby
Durham High, Durham
East Rowan, Salisbury
Flat Surry, Pilot Mountain
Frank L. Ashley, Gastonia
Garinger, Charlotte
Grimsley, Greensboro
Hillside, Durham
Hunter Huss, Gastonia
J. F. Webb, Oxford
Lucy C. Ragsdale, Jamestown
Myers Park, Charlotte
Needham Broughton, Raleigh
Page Senior, Greensboro
Piedmont, Monroe
Second Ward, Charlotte
Smith Senior, Greensboro
Southeast, Greensboro
St. Stephens, Hickory
Valdese Senior, Valdese
Walter Williams, Burlington
West High, Linwood
West Charlotte, Charlotte
West Mecklenburg, Charlotte
West Wilkes, Miller Creek

VITA

Rufus Grier Pettis

Candidate for the Degree of

Doctor of Education

Thesis: AN ANALYSIS OF THE METHODS BEING USED TO MAKE PROVISIONS FOR OUTSTANDING HIGH SCHOOL MATHEMATICS STUDENTS IN NORTH CAROLINA

Major Field: Higher Education

Biographical Data

Personal Data: Born on June 19, 1936, in Charlotte, North Carolina, the son of Mr. and Mrs. Grier Pettis.

Education: Graduated from George Fish High School, Fort Mill, South Carolina, in 1954; received the Bachelor of Science degree with a major in mathematics from Benedict College, Columbia, South Carolina, in 1958; received the Master of Science degree with a major in mathematics from Atlanta University, Atlanta, Georgia, in 1963; participated in National Science Foundation summer institutes at North Carolina College, Durham, North Carolina, 1962 and 1963; studied at the University of North Carolina at Chapel Hill, 1965 and 1966 summer sessions; completed requirements for the Doctor of Education degree at Oklahoma State University in May, 1970.

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