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THE RELATIONSHIP OF CERTIFICATION AND MATHEMATICS BACKGROUND OF TEACHERS AND PUPIL PERFORMANCE ON THE NCCT-M AFTER REMEDIATION

by

Harriet Anne Hathaway

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APPROVAL PAGE

This dissertation has been approved by the following committee of the Faculty of the Graduate School at the University of North Carolina at Greensboro.

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The purpose of this study was to investigate within the Secondary Remediation Programs in Southeastern North Carolina the relationship between pupil performance on the mathematics portion of the <u>North Carolina Competency Test</u> after remediation and each of four teacher variables -- subject level of certification, grade level of certification, predominant type of mathematics studied, and number of semester hours of mathematics formally studied after high school.

Data were obtained for 498 nonhandicapped eleventh-grade pupils and 16 teachers in 16 public high schools in Southeastern North Carolina for the two-year period, 1979-81. Teacher variable data were obtained through questionnaire. Pupil scores on the <u>North Carolina Competency Test - Mathematics</u> (NCCT-M) were procured through the Division of Research, North Carolina Department of Public Instruction.

For each of the school years, 1979-80, 1980-81, and the two-year period, 1979-81, the relationship between each of the four teacher variables and the numbers of pupils having score gains below and score gains equal to or above the mean gain and the numbers of pupils passing and failing the NCCT-M was tested using chi square. A significance level of .05 was used for all tests.

The findings suggested that of the four teacher variables, only number of semester hours of mathematics formally studied by the teacher made a significant difference in pupil performance on the NCCT-M. An analysis of the data reflected the tendency of teachers studying 21-36

hours to have 1) the largest proportion of pupils exhibiting score gains equal to or above the mean gain and 2) the largest proportion of pupils passing the NCCT-M after remediation.

It was concluded that the mathematics background of the teacher is of importance when that teacher provides instruction in secondary remedial mathematics. Therefore, this variable should be a factor when employing teachers not certified in secondary mathematics to teach secondary remedial mathematics. Suggestions were made for further study on a state-wide scale, using combinations of many different teacher variables, and using different random samples of teachers, including teachers of 7th grade mathematics, 8th grade mathematics, and General Mathematics.

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TABLE OF CONTENTS

Page

CHAPTER

LIST OF TABLES

Table		Page

CHAPTER I

INTRODUCTION

Background of the Problem

Since the early seventies, there has existed a "Back to the Basics" movement, initiated primarily by the public and focused usually on three areas -- mathematics, reading, and writing. This movement, coupled with a growing economic and political conservatism, has moved public education toward an era of accountability.

To ensure that the students graduating from the public schools are competent and literate in certain "essential" skills, many school systems and states have adopted minimum competency testing. According to Carter (1979), minimum competency testing

> is a recent innovation designed (supposedly) to transfer the responsibility for learning from the learner alone to the entire educational delivery system. Ideally this shift would reduce if not eliminate the numbers of students leaving high school as functional illiterates. (p. 7)

It is, in other words, a means, through the use of an evaluative instrument, to assess the performance of students on skills deemed essential by those designing the testing program. Minimum competency may end there, or it may include an accompanying remediation program designed to help students alleviate their exposed deficiencies. In many situations it is directly linked to high school graduation and thus provides tangible meaning to the high school diploma.

Whether minimum competency testing is the most efficient and effective means for meeting the demands of accountability is debatable (Carter, 1979, p. 5). Brickell (1978) urged the consideration of seven points when deciding on a minimum competency testing program:

1. What competencies will you require?
2. How will you measure them?
3. When will you measure them?
4. How many minimums will you set?
5. How high will you set the minimum?
6. Will they be for schools or for students?
7. What will you do about the incompetent? (p. 551)

These are extremely important questions, particularly the last one. As of March 1, 1979, approximately 35 to 40 states had through some action sanctioned minimum standards for their schools (Carter, 1979, p. 7). North Carolina was among this number.

The North Carolina General Assembly, in June of 1977, passed legislation entitled "High School Competency Testing," which became Article 39A of Chapter 15 of The General Statutes of North Carolina. Its purpose (G.S. 115-320.6) is three-fold:

> (i) To assure that all high school graduates possess those minimum skills and that knowledge thought necessary to function as a member of society,
>
> (ii) to provide a means of identifying strengths and weaknesses in the educational process, and
>
> (iii) to establish additional means for making the educational system accountable to the public results. (1977, c. 522, s.1)

This law also established a Competency Test Commission which would have responsibilities of recommending to the State Board of Education appropriate tests to be adopted and minimum standards or levels of performance (G.S. 115-320.8).

Thus, according to the law, a trial testing of all students in the eleventh grade was held in the spring of 1978. Minimum levels for performance were chosen by a group of teachers, who, according to Glass (1979), "met and decided arbitrarily that a standard should be set that would fail 20% of the pupils" (p. 52).

Using the chosen tests, which addressed mathematics and reading and focused on functional application, the first state-wide minimum competency testing as a requirement for graduation was conducted in the fall of 1978 (Gallagher, 1980, pp. 240-241).

"The governor was pressured into promising $5 million in emergency funds if 20% failed; they did" (Glass, 1979, p. 52). Of 81,322 public school students taking the mathematics competency testing, 15% failed to achieve the minimum standard (North Carolina Department of Public Instruction, Division of Research, Note 1). For these students, the legislation required remedial instruction and additional opportunities for test taking.

To provide this remedial instruction, the <u>State Board of Education Proposed Budget for Remediation Funds: Fiscal Year 1978-79</u> (Note 2) cited $4,450,000 in Remediation Funds to be appropriated by the 1977 General Assembly. This money was a) to be distributed to local school systems under the rules and regulations of the State Board of Education and b) to provide leadership at the regional level. The annual appropriation of money has remained constant for the last three years and is allocated to local school systems on a weighted basis. Monies distributed to the local school systems are based entirely on the numbers of failures, with the higher amounts of monies weighted in favor of those students scoring the lowest.

Students who failed in the fall could be retested in the spring and up until the last month of their senior year. Across the state of North Carolina, those students who have failed the mathematics competency test have been provided with remedial instruction. As a result of the money allocations and testing schedule, most remedial instruction has been allocated during the regular nine-months school year. The effects of these remedial efforts over the last three years are shown in Table 1. As evidenced by the research of the North Carolina Department of Public Instruction, Division of Research (Notes 1, 3, 4, 5), there has consistently been progress with a few more students passing the mathematics competency test each year and at each testing.

Between the fall and spring testings there has been evidence of positive effect of remedial instruction in mathematics. Exactly what or who has been responsible for this increase in the number of students who have passed the competency test is not known precisely, for there are many variables. The State Board of Education Program Guidelines for State Remediation Funds (Note 6) have been somewhat loose. Yet, a majority of the monies has been used for employment of teachers, purchase of materials, and inservice for those teachers hired to remediate the students failing the competency test.

Table 1

Percentages of Juniors Passing the

Mathematics Competency Test

	Fall		Spring		
Year	Number Tested	Percentage Passing	Number Tested	Percentage Passing	Total Percentage Passing
1978-79	81,322	85	9,838	52.54	91.78
1979-80[a]	78,435	89	7,658	56	
1980-81[b]	78,425	89.4			

[a]The summary data for "Total Percentage Passing" has been released but could not be obtained.

[b]The summary data for the Spring of 1981 was released for only seniors, not for juniors.

Since the greatest portion of remediation monies has been spent on the hiring of teachers, it appears that a great concern has been the employment of teachers who would be most effectual in facilitating an improvement in pupils' scores and an increase in the number of students successfully meeting the minimum standards. Two other factors contribute to this concern: (1) the critical shortage of qualified and certified secondary mathematics teachers and (2) the impermanency of the teaching position.

The first factor is both a national and state problem. Secondary academic mathematics teaching positions have become more and more difficult to fill when vacancies have occurred. According to the National Science Foundation (1980), there were approximately 1100 unfilled mathematics teaching positions in 1977. Estimates for the next five years (1977-1982) indicated that of the subject areas, mathematics exhibited the greatest demand. Moreover, since 1969-70, there has been a sharp decline in the number of earned degrees (Bachelor's, Master's, and Doctor's) in mathematics. Therefore, when vacancies have appeared in both an academic and a remedial situation, the prospective employee and the administrator have usually chosen the academic position. Thus, the administrator is left to hire other certified personnel for the remedial teaching position.

Because of the rules and regulations governing the allocation of monies, the distributed amount may vary every year. This situation creates an impermanency in the teaching position, with little assurance of employment the following year. Hence, a teacher will more than likely seek a more permanent position after a year of teaching in a secondary remedial mathematics program that is funded through state remediation monies. This situation creates a turn-over rate which is higher for this population than for the more general population of mathematics teachers. Therefore, teachers certified at grade levels other than secondary, in subject areas other than mathematics, and with varying backgrounds in mathematics study are hired to teach the students who have failed the mathematics competency test.

In order to help all of the employed secondary remedial mathematics teachers to begin the remediation programs with understandings of the student, the minimum standards, and mathematics, the Division of

Mathematics of the North Carolina Department of Public Instruction offered a Three-Phase Remediation Inservice Program during the 1978-79 school year. Phase I was held in August, 1978; Phase II, October, 1978; and Phase III, March, 1979. A second Remediation Inservice Program was held in the Fall of 1979 for all newly hired secondary remediation teachers and others who wished to attend. These programs were conducted in each of the eight education regions in the state and provided the same information and assistance state-wide so that the remediation efforts would be consistent throughout North Carolina.

Despite these initial efforts, however, there still exist a relatively high turn-over rate and a large number of teachers teaching secondary remedial mathematics who are not certified in secondary mathematics. Yet, students continue to progress in the remediation programs. Such a situation provokes the thought that the grade level and subject area of certification may be of little significance. Moreover, the number of hours and the type of mathematics a teacher has studied may be of little consequence when teaching the secondary remedial mathematics student.

To date, there has been no study of the results of the North Carolina Competency Test to determine whether there are differences in pupil performance after remediation as a result of the teacher variables of grade level of certification, subject area of certification, the number of semester hours of mathematics studied by the teacher, and the predominant type of mathematics studied by the teachers. No similar studies of competency tests of other states or school systems have been found. Since a significant amount of money has been appropriated by the

General Assembly each year for the purposes of remediation, since there is an inadequate supply of certified secondary mathematics teachers from which to fill remedial mathematics teaching positions, and since the central purpose is to help students become functional literates in society, it is necessary to determine whether differences exist in pupil performance as a result of teacher variables concerning certification and mathematics background.

Statement of the Problem

Purpose

The purpose of this study is to investigate within the Secondary Remediation Programs in North Carolina, the relationship between pupil performance on the mathematics portion of the *North Carolina Competency Test* after remediation and each of four teacher variables -- subject areas of certification, grade levels of certification, the predominant type of mathematics studied, and the number of semester hours studied in mathematics.

Specific Questions

To be addressed in this investigation are several specific questions:

1. Does the teacher's subject area of certification make a difference in the pupil performance on the mathematics portion of the *North Carolina Competency Test*?

2. Does the teacher's grade level of certification make a difference in the pupil performance on the mathematics portion of the *North Carolina Competency Test* after remediation?

3. Does the type of mathematics studied by a secondary remedial mathematics teacher result in differences in the pupil performance on the mathematics portion of the North Carolina Competency Test after remediation?

4. Does the number of semester hours of mathematics studied by a secondary remedial mathematics teacher correlate to pupil performance on the mathematics portion of the North Carolina Competency Test after remediation?

Each of these questions is to be examined for each of the school years, 1979-80 and 1980-81, and then across the two-year period.

Definition of Terms

In order for consistency to exist throughout this discussion, the following terms or phrases require definition:

1. Competency Test

   Since the North Carolina Competency Test consists of two sections, reading and mathematics, and because this study is concerned with only the mathematics portion, the term competency test will refer to only the mathematics portion of the North Carolina Competency Test.

2. Remediation

   This term will mean the instruction or assistance in mathematics that is funded by monies appropriated by the North Carolina General Assembly and provided to the student who has failed the competency test.

3. Pupil

   For the purposes of this study, pupil will be a public school student who has initially failed the competency test.

4. Pupil Performance

   The score obtained on the last testing of the competency test.

5. Teacher

   That educator who provides instruction in remedial mathematics to a pupil who has failed the competency test.

6. Grade Level of Certification

   The range of grades for which a teacher has been trained and has been certified by the state of North Carolina to teach. These levels will be defined as "7-12" or "Not 7-12."

7. Subject Area of Certification

   The area for which the teacher has been trained and has been certified by the state of North Carolina to teach. Such areas are defined as "Secondary Mathematics" or "Not Secondary Mathematics."

8. Teacher Qualifications

   A term encompassing grade levels of certification and subject areas of certification.

9. Type of Mathematics

   The predominant group of mathematics courses studied formally beyond high school. These include "Foundations of Arithmetic;" "Algebra, Trigonometry, and Geometry;" "Consumer;" and "Calculus and Above."

10. Semester Hours of Mathematics

   The number of hours a teacher has formally studied mathematics in courses beyond high school.

Assumptions and Limitations

Assumptions

Assumptions forming the basis of this study are the following:

1. Pupils, given the appropriate remediation, will exhibit a gain in performance between the first and last testings of a competency test.

2. The teacher plays a key role in pupil learning that occurs in a secondary remedial mathematics class.

3. There are many variables which determine the effectiveness of a teacher of secondary remedial mathematics.

4. A statistical study using chi square is a valid and effective means to determine the differences in pupil performance as they relate to teacher variables and the relationships between pupil performance and each of the teacher variables.

Limitations

In addition to these assumptions are several limitations which are admitted, but which will not be explored in this study. These limitations are as follows:

1. There are many variables -- the learning environment, materials, management of materials and learning experiences, methods of presentation, pupil motivation, and teacher-pupil rapport, for example -- which directly or indirectly affect the learning by pupils and, more specifically the remedial mathematics pupils. Though these variables will not be studied, they will influence the pupil performance data and, thus, the findings of this study.

2. Other teacher variables, such as the total number of years of teaching experience and the level of the highest degree obtained by a teacher, may influence the results of this study.

3. Because of delays and changes in money appropriations, employment of teachers, and development and implementation of remediation programs, the amount and type of remediation will vary from one school system to another and from one year to the next. Thus, the variables will be inherent in the pupil performance data.

Significance of the Study

The primary significance of this study is two-fold: 1) a study of this nature has not been conducted in North Carolina and 2) given the critical shortage of qualified and certified secondary mathematics teachers, it is necessary to determine whether the effectiveness of a secondary remedial mathematics program is or is not diminished by the use of teachers who are certified at other grade levels and in other subject areas and who have varying background in mathematics.

Three specific areas to which the findings of this study may pertain can be identified. First is the hiring of teachers. In seeking to employ effective educators in secondary remedial mathematics, one must determine those qualifications which most consistently correlate to effectual remediation and bring about positive pupil performance and which are not detrimental to pupil progress. Second, the inservice given to the remediation teachers by the State Department of Public Instruction and/or the local school system may or may not necessitate change in its focus. Rather than knowledge of mathematics, knowledge of student growth and development may be the desired focus for assurance of effective instruction. The third area is money for remediation since it is directly related to the number of failures and for inservice so that continuous professional growth and development of the teacher can be maintained.

Summary

With the adoption by many states and individual school systems of minimum competency testing and remediation and because of the gross financial support for such programs, the effectiveness of remediation is of importance to educators and the public. Accompanying this concern is the severe shortage of certified and qualified secondary mathematics teachers which requires that teachers trained in other subjects and at other grade levels be hired to teach secondary remedial mathematics.

Therefore, a review of the literature is necessary to determine the effectiveness of existing secondary remedial mathematics programs, to examine the studies related to the secondary remedial mathematics student and his characteristics and performance, and to investigate more specifically the teachers of secondary remedial mathematics and their perceptions, expectations, interaction and behavior, and training.

CHAPTER II

REVIEW OF THE LITERATURE

The purpose of this study is to investigate within the Secondary Remediation Programs in North Carolina, the relationship between pupil performance on the mathematics portion of the North Carolina Competency Test after remediation and each of four teacher variables -- subject area of certification, grade level of certification, number of semester hours studied in mathematics, and the type of mathematics studied.

In view of the components of this study, review of literature and research included in this chapter is organized according to the following topics: (a) remediation, (b) secondary remedial mathematics programs, (c) the secondary remedial mathematics student, and (d) the secondary remedial mathematics teacher.

Remediation

Because many states and school systems have found it necessary to initiate some form of competency testing, the effect on the pupil who either fails or performs poorly has become a concern of many. Often raised is the question of responsibility for some type of remediation. Pipho (1977) offers for consideration by involved educators questions concerning provisions for remediation, financing, student options, effects on the regular educational program, and staffing. Concern for little attention to remedial assistance is cited by Haney & Madaus (1979) and Brickell (1978b). Baron & Sergi (1979) consider an essential element in basic skills legislation to be money for remedial programs, and they believe that no state that has provided monies has allocated sufficient funds for such programs. They then question whether or not an insufficiently funded program should even be implemented.

Though many states have addressed the problem of remedial assistance, as noted by Mizell (1979) the reasoning for providing legislated expenditures may not always be considered sound. Archambault (1979) questions the legitimacy of public monies being allocated for such expenditures, citing that achievement cannot be legislated, that the transformation of incompetent students into competent ones cannot automatically be accomplished by teachers and schools, and that there is not necessarily a known better way to teach the poorly performing student. In addition, Kean & Mattleman (1979) address the unfairness of insufficient time for effective remediation between the legislation and the enactment which results in the denial of a diploma if one fails the competency test.

The National Association of Secondary School Principals (1979) believes that schools must respond with remediation efforts and that such efforts are the benefits of a competency testing program. Different approaches for diagnosing and remediating deficiencies are cited by the NASSP: 1) basic skills, 2) life or survival skills, and 3) a total learning system. Whichever approach is used, the component of remediation is absolutely essential, a strict necessity. Madaus & Airasian

(1979) support this view, arguing that the results of a certifying examination can help redirect teaching to emphasize neglected areas and skills.

Following these concerns expressed about the provision and funding of remediation, the next question focuses on the effectiveness of such a program. Blair (1956) believes the evidence has been sufficient to show that poorly performing students who are given appropriate remediation can improve their arithmetical skills. Appropriate remediation should be not only drill and practice but should be highly stimulating and success-oriented. The NASSP (1979) concurs, as long as sufficient time for improvement of competencies is allowed. However, Mizell (1979) believes that there are too few effective remedial programs in secondary schools.

To be effective, Otto & McMenemy (1966) cite that remedial programs must be developed in light of the realities of facilities and personnel and such programs must vary by grade level and by the characteristics of the pupils involved in the programs. Moreover, pupil motivation is the key to the effectiveness of the remedial program. Remediation should be reserved for those few pupils who are seriously deficient in their competencies, and remediation programs must be thoughtfully conceived and well executed.

Forbes (1978) takes a much broader view and speaks to a total program that will produce mathematically literate pupils. Believing that computational skills and problem-solving skills are the objectives, he argues that the teaching of such objectives should be an integral part of a well-developed, effective total educational program. The learning of the objectives should and must not be delayed until the deficiencies are diagnosed by a competency test required for graduation.

Studies Relating to Secondary Remedial Mathematics Programs

Minimal competency testing and resulting secondary remediation are relatively new, with most programs initiated during the last decade. As a result, the majority of the studies tend to relate to more general remediation programs, with fewer studies directly related to minimal competency test remediation. Selected studies to be discussed in this section involve: a) general remediation programs and b) competency-test-related remediation programs.

General Remediation Programs

In the area of general remedial mathematics programs, those that come to mind are the ones related to ESEA Title I. Barson (1980) studied the progress of tenth grade students who participated in a Title I mathematics program in Philadelphia. Finding that there was significant achievement in mathematics, Barson concluded that a remediation program that uses an integrated approach, attempts to positively build that pupil's self-image, and occurs in a multimedia, multisensory mathematics laboratory environment can be effective at the secondary level. Another study of an ESEA Title I remedial program was conducted by Lesser & Mishken (1976). The results of this study, which addressed the services to eligible non-public-school students, found the program to be successful in improving behavior, in improving mathematics achievement by improving behavior, and in being overall effective in its purpose, despite the fact that it was held after school.

Several studies involve a laboratory setting. Colosimo (1981) formatively assessed a tutorial laboratory program at Waxahachie High School in Texas that was designed to reduce the number of failures of a course by early identification and remediation. The effects and efforts of this laboratory were found to be successful over a three-year period, and Colosimo concluded that two aspects were critical for success: 1) early identification and remediation of weaknesses and 2) development of good study and problem-solving skills. A computation learning lab at Belmont Junior High School, Lakewood, Colorado, is discussed by Doggett (1978). This remedial program, which was characterized by student voluntariness, micro-teaching, drill cards and worksheets, a "growth plan" developed by the student, sequential learning, enthusiastic teachers, and parental support, resulted in dramatic gains in achievement ranging from 0.4 to 6.8 years. Moreover, no regression was found in the posttest scores even with students leaving the program as soon as they achieved the competencies.

A study at the upper end of the educational ladder investigated the effectiveness of a remediation laboratory for low-achievers entering the community college. Papandrea (1974) found that college freshmen who chose a nonlearning laboratory academic program performed significantly better than the students who participated in the learning laboratory program. Self-concept was found not to be affected by the learning laboratory. The differences in the findings of this study and the previous ones might indicate that the age of the student and the motivation for being in the remedial program could be variables affecting the effectiveness of the remediation.

Another remedial program was studied by Shaw (1968-69) to determine the effectiveness of three instructional strategies -- drill, drill with feedback, and mixed drill. Although significant increases in achievement were produced by all strategies, the mixed drill treatment was found to be the best when all factors were considered. Complementing this study is one conducted by Denman (1975). Investigating the effects of different multisensory packages on afterschool remedial efforts with upper middle grades students, Denman found, among several results, that 1) there were substantial but not significant gains for the students receiving remedial help containing manipulatives, prenumber activities, and answer recording, and 2) some type of visual-aid-assisted learning of certain basic computational skills. Thus, it appears from these studies that certain teaching strategies will be more effective than others in meeting the needs of the students in remediation.

In examining other variables, Lyon (1975) studied a remedial program in an inner-city school system and found that sex was a significant variable with males being more consistent than females in performance gains. However, race was a nonsignificant factor while trends toward significance were seen for socioeconomic status and years in school beyond grade level. Moreover, the trend toward significance was seen for the variable of teacher effect. Such a study would indicate the necessity for developing a remedial program consistent with the particular needs and characteristics of the student clientele.

Other studies investigated alternative approaches. In a study of an alternative educational program that attempted to improve basic skills within a traditional program, Goldberg (1976) found that junior high students who participated in the alternative program did not achieve significantly differently after eight months than students who remained in the traditional program. However, significant differences did exist in self-concept and attendance. Feshback & Adelman (1974) studied over a three-year period a remedial program for disadvantaged students. The program, which focused on intensive, individualized, and integrated remedial efforts, was found to be effective in significantly increasing achievement of disadvantaged students. Conclusions were in favor of major variations in the instructional program rather than piece-meal intervention attempted by many remedial situations.

Since remediation efforts vary in design, and stress tutorial or individual assistance, individualized instruction requires some attention. In a review of the research on individualized instruction as a viable method for the teaching of secondary mathematics, Hirsch (1976) found that only five of 33 studies reported significant gains in mathematics as a result of individualized instruction, while 24 of the studies evidenced no statistically significant gains. Only one (Baly & Benesch 1969) of those five studies favoring individualized instruction dealt with secondary remediation. Another study (Nix 1970) which looked at individualized instruction in relation to learner characteristics found that students of below average IQ and males exhibited significantly more gains under individualized instruction, although the average student in general mathematics showed no significant difference.

Miller (1976) also conducted a review of individualized instruction in mathematics and found that of 36 studies that considered the effects on the various ability levels, only nine favored the individualized approach for low-ability students. Thus, he concluded that there exists only minor support for the individualized approach being used for low-ability students. This review and the previous one indicate that for a small minority of the students the individualized approach to instruction may be of benefit, but it is only one method to use when designing a remedial program.

Competency-Test-Related Remediation Programs

The second part of this section of the chapter is concerned with remediation programs specifically related to state-mandated minimal competency tests. According to the NASSP (1979), 24 states have mandated competency testing in the area of mathematics. Of these 24, 15 have required remediation. However, only 6 of the 15 provide state funds for remediation. One state, Hawaii, provides state funds but does not require remediation. The studies in this part involve mathematics remediation programs in states that mandate minimal competency testing, but may or may not require remediation or provide state funds for remedial assistance. Because this phenomenon is so new, few studies have been made of the remediation programs, specifically.

California has state-mandated minimal competency testing and requires remediation. However, funds for remedial programs were not allocated although, according to Hart (1978), resources for staff development were provided. Thus, it is a responsibility of the local school district to provide the monies which Sallander (1980) deems difficult in light of Proposition 13. Before the state legislation, there were school districts in California that required minimal competencies for graduation and remedial assistance for the students failing to demonstrate competence. Kern High School District in Bakersfield, California, was the first in the state to make this requirement. Wood (1978), in evaluating this program over the five years of its existence, has found evidence that the mean score on the tests has not been affected. Much energy, money, and many resources have failed to make an impact overall; and thus one questions whether the high school years are too late for students to learn basic arithmetical fundamentals.

Another state that requires minimal competency testing is Oregon; yet it neither requires nor funds remediation. However, according to Herron (1980), goal-based instructional planning is a major thrust of the program. Studies of any district-funded remedial programs were not found, although Hathaway (1980) discusses a Rasch-based approach used in grades K-8 in Portland but does not discuss remedial assistance.

Arizona, which mandates minimal competency testing, neither requires nor financially supports remediation. However, the Phoenix Union School System has attempted to rectify the deficiencies of its students. McCully (1978) discusses the program which provides a second general mathematics course, a reduced student-teacher ratio for general mathematics classes, and instructional aides for increased individual assistance. In addition, teacher in-service programs in diagnostic/ prescriptive procedures are considered important and are provided. A review of the program shows that an increase of 43% of the class of 1977 passing all 16 competency areas occurred in one school year. More dramatic gains were cited for the class of 1980, with there being an increase of 59.5% of the students passing all skill areas after only one year between initial testing and retesting. Between 1973 and 1977, 87.4% more students passed all skill areas. Such results support remedial efforts.

Although Nebraska mandates minimal competency testing but does not tie it to graduation, Westside High School in Omaha requires demonstrated competency for graduation and provides assistance for remediation even though it is not required or funded by the state. Findley (1978) describes the program, citing that pre-competency-test diagnosis is made in the freshman year with students showing deficiencies being given counsel, review with the regular mathematics teacher or in a mathematics laboratory, or placement in a basic arithmetic class. Failures of the eleventh-grade competency test review with a mathematics teacher who is assigned to individual remediation. In 1977, only eight students failed to graduate as a result of minimal competency requirements. The small number of failures is viewed by Findley as a result of the early identification and remediation of deficiencies.

The state of Florida mandates minimal competency testing and requires and funds remediation. According to Fisher (1980), $26.5 million was appropriated by the 1978 legislature to meet the needs identified by the test results. Moreover, Fisher (1978) believes that the failure rate (36%) in mathematics can be reduced to less than 5% through remedial efforts, as experienced in Duval County. Glass (1978) questions the entire minimal competency graduation program in Florida because he sees it based on indefensible technology. However, Turlington (1979) says the program is working as evidenced by mathematics scores in 1978 being ten points higher than those in 1977. Such improvement is attributed to motivation and the compensatory education program since twelfth-grade students retaking the test in 1978 showed significant gains. Dusenberry (1980) investigated the effectiveness of the state compensatory remedial program and a vocational remedial program. He found that students who were in both programs performed better than those in only the state competency program and, more importantly, that students receiving no remediation performed significantly lower than students participating in one or both programs. Thus, Dusenberry supports Turlington's assertions.

North Carolina mandates state-wide minimal competency testing and requires and funds remediation. Gallagher (1980) asserts that the requirement of the local schools to provide remediation is part of the essence of the legislation. Moreover, any student who fails to graduate because of the minimal competency requirement may return for remedial assistance and continue to take the test until age 21. The only study that was found that dealt with remediation and performance on the competency test is by Serow (1980). Spanning a three-semester period (Fall 1978 - Fall 1979), it was found that remediation alone could not guarantee broadly based gains in performance on the competency test. The effectiveness of the program is possibly inhibited by combinations of other factors, but would be enhanced by intensive individualization or very small group settings. Therefore, it is not conclusive that the remedial efforts funded by the legislature are broadly beneficial.

Studies Relating to the Secondary Remedial Mathematics Student

Before one can begin to develop a meaningful and effective remedial program in mathematics, the nature and characteristics of the secondary remedial mathematics student must be understood. The studies in this section involve: a) the characteristics of the secondary remedial mathematics student and b) the mathematics performance of the student, including overall trends in mathematics scores.

Characteristics of the Student

In order to understand the total scope of the remediation of students failing a minimal competency test, it is first necessary to characterize the student who receives remediation. For purposes of this discussion, this student will be referred to as a "low achiever," an "underachiever," or a "slow learner."

Johnson & Rising (1972) give many terms for classifying low achievers but consider, in general, a low achiever to be one who, because of many factors, scores consistently below the 30th percentile in achievement. However, they believe that the slow learner, when given appropriate instruction, can make significant increases in mathematics performance. Kurtz & Spiker (1976) believe a slow learner is technically one whose IQ falls within the 80-90 range. Moreover, students having consistent difficulty with mathematics are either slow learners or learning disabled and thus should be treated differently. Otto & McMenemy (1966) defined five categories of underachievers, ranging from "underachievers with average capacity" to "children with limited experiential background." Further, they believe that except for extreme cases, these students can be successful when taught by a professionally adequate classroom teacher.

Schulz (1972) is more specific in characterizing the slow learner. Such characteristics as poor self-image, cognitive variables, need for immediate gratification, cultural differences, lack of school skills, deficient adult relationships, and the importance of sex differences provide a much broader, more comprehensive view of the slow learner. In addition, they provide the insight that the cognitive variable is only one of many factors to be considered when providing remediation.

In a discussion of planning for low achievers, Wells & Schulte (1970) cite the fear of failure as a striking characteristic of the slow learner. Included, also, are low motivation, lack of a sense of involvement in the learning activity, deficient reading skills, and short attention spans. It is necessary, therefore, to take into account these factors when working with the students in a remedial program.

Wallace (1980) studied the characteristics somewhat more closely in his investigation of the problem-solving behaviors of low-achieving secondary mathematics students. Findings evidenced that many low-achievers have difficulty making translations between general, technical, and symbolic vocabularies, and thus need much structure when working with mathematics problems.

Attitude was investigated in a study involving junior high school students. Knowing that previous studies revealed mixed results as to significant relationships between mathematics achievement and attitudes toward mathematics, Brassell, Brooks, & Petry (1980) studied the variable of ability grouping as determined by district and by teacher. It was found that the low-ranked students had the higher levels of anxiety and the lower levels of attitude, especially when placed in a middle-level class. Therefore, it was concluded that mathematics self-concept and mathematics anxiety tend to be important correlates of achievement in mathematics. Such ideas suggest the necessity for careful consideration of the placement of students and for planning for the reversal of known characteristics when developing effective remedial programs.

Performance of the Student

The preceding characteristics, individually or in various combinations, will affect in some manner the performance of these students. Studies involving declining test scores and performance and its predictors are discussed in this part.

In its second mathematics assessment (1977-1978), the National Assessment of Educational Progress looked at the performance of 13- and 17-year-olds in five basic content areas in mathematics. According to Carpenter, Corbitt, Kepner, Lindquist, & Reys (1980), the 13-year-olds showed no consistent pattern of change except in problem-solving and application where a slight decline was noted. However, it was found that, in general, there appears to have been a consistent pattern of decline in the performance of 17-year-olds across almost all categories during the five years since the first assessment. Findings indicate that skills are being learned at the rote level without an understanding of the underlying concepts. Moreover, there was evidenced a general lack of skills in basic problem-solving.

Munday (1979) somewhat supports this trend of declining scores with a study of basic skills achievement between 1970 and 1977. An average of nearly half a year loss in mathematical concepts was exhibited; yet, this was not considered significant enough to say that the achievement was not consistent over the seven-year period. In addition, it was found that slow students were as consistent in their achievement as the average and fast students.

Two studies investigated possible reasons or explanations for the decline in student achievement. Through a survey, Newport (1979) studied the effect of changing from group instruction to individualized instruction and concluded that the new math resulted in teachers placing less emphasis on the basic skills and in teachers moving away from more traditional modes of instruction to individualized instruction with accompanying transition difficulties. Welch (1980) studied the effect of less time on cognitive measures and more time on affective measures. He found that mathematics achievement, satisfaction, and difficulty have remained unchanged from 1972 to 1976, while attitude toward mathematics has changed positively. Thus, prematurely, the conclusion is that the "enjoying it more, but learning less" explanation can be one of several proposed explanations for the decline in test scores in mathematics. Unfortunately, these studies indicate that it may be the fault of the teacher rather than that of the student as to the lack of increase in mathematics achievement.

In the area of performance and its predictors, several studies have been made. Letteri (1980) investigated the use of the cognitive profile, a combination of seven cognitive dimensions, as a predictor of a junior high school student's performance. He found that the cognitive profile is a basic determinant of one's level of academic achievement as well as an indicator of specific learning deficiencies that contribute significantly to low academic achievement.

Youngman (1980) examined various pupil characteristics and their use as predictors of achievement at the secondary level. Results indicated that intellectual characteristics were strong determinants while attitudinal or personality characteristics had no significant effect on performance. Of the intellectual characteristics, prior achievement in the same subject had the strongest individual effect on mathematics achievement.

Supporting Youngman with an extensive study using NLSM data, Begle (1979) concluded that previous mathematics achievement is the best predictor of mathematics achievement, although none of the achievement variables was predicted very accurately. Moreover, Begle (1979) in reviewing other studies of predictors of achievement found that, though previous achievement in a particular area is the best predictor of achievement in that same area, most predictors carry a rather low significance level thereby reinforcing the idea that students are unpredictable.

Another study looked at selected student characteristics, student involvement in learning, and achievement. Anderson (1975) found that there was a significant positive relationship between student involvement in learning and achievement and between student involvement and certain student and environmental characteristics. In addition, it was found that time-on-task is a critical and alterable variable in school learning and that time-on-task parallelled achievement. These findings support the mediating variable, time-on-task, and the three sets of variables (cognitive entry behaviors, affective entry characteristics, and quality of instruction) hypothesized by Bloom (1971) as affecting achievement level and achievement variation.

Worthen (1980) studied the relationships between functional literacy test performance and certain achievement variables and found that sex, age, IQ, and previous achievement were predictors of performance on a functional literacy test. Along these same lines, Giesbrecht (1980) utilized the list of forty-eight competencies issued by the National Council of Teachers of Mathematics in 1972 to study achievement of certain mathematical competencies and the effects of grade level, the mathematics program, school enrollment size, and sex. The results showed that grade level, the type of mathematics program, the size of the school enrollment, and sex were significantly related to the achievement of specific mathematical competencies. Another study measuring achievement of mathematical competencies of high school seniors was conducted by Cramer (1975). His conclusions parallelled those of Giesbrecht (1980): school enrollment size, sex, and the mathematics program were significant in affecting achievement of mathematical competencies.

A study was made of the relationships between learning environments, academic self-concepts, and mathematics achievement. Studying ninth-grade algebra and general mathematics students, House (1975) found significant evidence for a relationship between learning environments and self-concepts with results exhibiting low self-concepts for nonalgebra students. Uguroglu & Walberg (1979) brought in the variable of motivation in their study and found that motivation measures are relatively weak correlates of achievement.

Thus, there are many factors that might enable a teacher to predict the performance of a student on a mathematics competency test. By understanding the characteristics and realizing possible predictors, early recognition of possible failures of the minimal competency test can be made. This would enable remedial assistance to be given prior to rather than after failure on the competency test.

Studies Relating to the Secondary Remedial Mathematics Teacher

The final section of this chapter concerns the teacher. Many studies involving characteristics of and variables related to teachers have been conducted. However, for the purposes of this section, studies discussed are limited to a) perceptions of the teacher, b) teacher expectations, c) interaction and behavior with students, and d) training and qualifications.

Perceptions of the Teacher

For many, teachers would not be teachers unless they believed they could and would be of benefit to students in the learning process. Perkin (1979) believes the teacher is the key, the one who can unlock the door to learning and thus facilitate the student's becoming his/her own key to knowledge. Agreeing with this, Van Derbur (1976) views the teacher as a very influential person -- one whose thoughts will determine his/her effectiveness and actions with the students and who can succeed in helping students to believe in themselves.

If this is true for teachers in general, then it should be true for mathematics teachers. According to Fey (1979), three studies concerned with current mathematics teaching were conducted by the National Science Foundation (NSF). The first study reviewed literature on curriculum, instruction, evaluation, and teacher education from 1955-1975; the second surveyed teachers, administrators, parents, and students; and the third analyzed case studies in selected schools and districts. In an attempt to synthesize the findings of these three studies, Fey (1979) offered, among others, the following conclusions: 1) teachers feel very inadequate in motivating students in their mathematics classes and desire training in new teaching methods and small-group techniques; 2) teachers greatly limit or enhance their students' learning by the extent of the teacher's knowledge of mathematics, the teacher's beliefs about mathematics, and the determined goals of teaching mathematics; 3) teachers search for stability by choosing from among traditional topics and techniques rather than from among more innovative approaches; and 4) there consistently exist great differences between what mathematics educators recommend and the reality of mathematics education.

Blair (1956) believes that remedial teaching is simply good teaching. Thus, a competent mathematics teacher can be a competent remedial mathematics teacher as long as that teacher is sympathetic to the needs of the student and is capable of diagnosing the weaknesses and prescribing and directing corrective measures.

Therefore, the teacher is perceived to be a very vital part of the learning process. However, teachers admit their own weaknesses and yet do not venture far from that with which they are comfortable and know is successful with students. Moreover, the teacher's beliefs of the nature of mathematics and the goals of mathematics education affect the teaching and learning that take place in the classroom.

Teacher Expectations

As previously discussed, teacher beliefs can be important determinants in the learning process. Since beliefs bring about certain expectations, teacher expectation can be an inhibiting factor or one of enhancement in the realm of student acquisition of knowledge. Few studies involving expectations in mathematics learning were found, possibly because expectations fall in the affective area and possibly because, according to Begle (1979), most of these studies involve the elementary teacher.

However, one study investigated the perceptions of student behavior, social environment, and cognitive performance. Marjoribanks (1978), using a national survey, concluded that the teacher's perception of desirable or undesirable school behavior directly related to the students academic performance despite the social environment or level of intelligence.

In the area of math score declines, teachers were surveyed by Maffei (1978) to determine their reasoning for such declines in mathematics performance. The teachers suggested five factors that individually or in various combinations could be causes for the regression: student deficiencies, poor study habits, modern math and abstraction, lack of minimal academic standards, and administration. It is possible that the expectations in each of these areas contributed to the performance of the students.

Interactions and Behaviors with Students

Perceptions and expectations can be factors in student achievement; but maybe even more influential are the interactions and behaviors of teachers with students. In an effort to identify differences in interactions with successful and unsuccessful students, Freeman (1978) discovered that teachers had twice as much interaction with successful students as they did with unsuccessful students, that the interaction with unsuccessful students was negative while it was positive with successful students, and that sex was insignificant to quantity but significant in positiveness or negativeness.

Examining the variable of teacher clarity, Land & Smith (1979) studied a group of preservice teachers enrolled in an introductory teacher education course. The results verified the effect of teacher vagueness on student achievement found by Smith & Edmonds (1978) by showing that student achievement was greater when students were taught with clear conditions. These studies were followed by another by Smith & Land (1980) which looked at student perception and teacher clarity. Here, it was found that clarity produced higher but not significantly higher student achievement than nonclarity produced and that student perceptions were fairly accurate predictors of student achievement.

Smith (1977) performed another study which examined the effect of teacher discourse. Results of this study indicated that the following correlated positively with mathematics education: specifying the objectives of the lesson, using many relevant examples, using much positive feedback, and being frequently specific rather than vague.

Examining the aspect of teacher discourse further, Heller & White (1975) studied verbal discourse in terms of approval and disapproval behaviors with students of higher and lower abilities. They found that teachers expressed more disapprovals with the lower ability students and that the additional disapprovals were more of the classroom management type. Interestingly enough, the frequencies of approval varied very little from one ability group to another.

Another study of teacher verbal behavior examined its relationship to logical reasoning ability. Gregory & Osborne (1975) concluded from the results that the frequency of teacher use of logic is a significant factor in acquisition of logic by a student.

An interesting study looked at interactions with students from a different viewpoint Madike (1980a) investigated the use of micro-teaching and traditional observations treatments and their effects on achievement. It was found that significantly more interactive behaviors and questioning techniques were utilized by the student teachers having the micro-teaching preparation and that these behaviors and techniques had a positive relationship with student performance.

Another type of behavior is written feedback by the teacher. Bloom & Bourdon (1980) examined the types and frequencies of such feedback and found that teachers used noncorrective feedback three times more than they used corrective feedback. Moreover, the noncorrective feedback was useless two-thirds of the time. Their study did not reflect findings of other studies involving effectiveness of various types of feedback.

One study investigated the particular teacher behaviors and characteristics that differentiate more effective from less effective teachers. Evertson, Emmer, & Brophy (1980) identified the following as being characteristic of the more effective teacher: more developmental work than seatwork; better classroom management; greater clarity; greater questioning behaviors; and greater expectations, confidence, and enthusiasm.

Mattsson (1974), in a study of personality traits, found that at the junior-high level, certain patterns of personality traits were related to effective teaching, but that they were of no significance when teaching mathematics.

As to interactions or behaviors of the remedial teacher, Otto & McMenemy (1966) cited that more positive learning will occur when a counseling point of view is projected, thus producing important interpersonal relationships. Doggett (1978) suggested that student achievement will be improved if the teacher of remedial students will use clear and concise directions; emphasize quick, cordial and positive reinforcement; be sensitive to cognitive and affective needs; and involve students in their own instruction.

Training and Qualifications

Though studies have shown teacher interaction and behavior to be factors in student achievement, the training and qualifications of the teacher must be considered. According to Begle (1979), three reviews of studies of teacher effectiveness indicate the importance of the professional training, although a more recent study causes reconsideration of professional training as an important characteristic. However, it is deemed necessary to examine in this part the preservice training of both elementary teachers and secondary mathematics teachers since teachers certified at all levels K-12 are employed to teach secondary remedial mathematics.

Three studies concern the type and amount of mathematics studied by elementary school teachers. Pigge, Gibney, & Ginther (1979), replicating and comparing with their similar study in 1970, found that the 1975-77 preservice teachers and inservice teachers were better prepared and had greater mathematical understanding than the 1967-79 groups of teachers and that the preservice teachers of 1975-77 were more knowledgeable than the inservice teachers of 1975-77. In another study by Pigge, Gibney, & Ginther (1980), the number of mathematics courses and mathematics understanding were investigated. Comparing these findings with their initial study in 1970, they concluded the following: 1) the more years of high school mathematics and the more college mathematics courses, the greater the mathematical understanding; 2) there is an increase in the amount of mathematics studied since 1970 by elementary teachers in high school and college; and 3) there is more mathematical understanding by these teachers. In the third study, Swadener (1978) examined the elementary preservice programs of colleges and universities and found that these institutions do not agree on their responsibilities for providing mathematics courses for the prospective elementary teacher.

If these data are accurate, it is difficult to ascertain the reasons for greater mathematical understandings as cited previously. In another study by Pigge, Gibney, & Ginther (1978), results indicated that several factors may influence the mathematical understanding of elementary teachers: 1) the size of the area where one desires to teach, 2) the size of the community where they graduated from high school, 3) the subject they preferred to teach, and 4) the subject they least preferred to teach. Thus, placement of teachers should match preferences of teachers.

Examining the effect of different mathematics requirements on mathematics understanding, Withnell (1967) produced results indicating the following: 1) mathematical understanding was low and even as many as nine semester hours of mathematics are inadequate; 2) mathematics courses for elementary teachers were better suited for middle-and low-ability students; 3) high school preparation was very important, especially in algebra and geometry; and 4) ability, attitude, and mathematics background (high school and college) were important factors in determining mathematics understanding.

The computational competencies of preservice elementary teachers were studied by Olson (1977), who found that compared with representatives of the adult population, the preservice teachers scored as well if not better. However, there was evidenced need for improvement. Therefore, elementary teachers are understanding mathematics more and are adequate in the computational abilities.

Pitkin (1968) looked at attitudes in relation to college mathematics background. He found that attitude toward mathematics was not reflective of type or amount of college mathematics background, but that attitudes toward pupils were related to the background. Changing to the cognitive aspect, Lorenz (1978) investigated the effects of teacher experience, graduate work, and National Teacher Examination (NTE) grade. Though no significant correlations were found, the study showed highest residual gains for students taught by teachers with master's degrees and lowest residual gains for students taught by teachers with NTE "C" grade certificates.

Sparks (1977) considered the effect of teacher preparation and experience on verbal problem-solving performance. Evidence showed that experience was not a factor and that the difference in preparation was of no significant difference. Yet, Neel (1976) looked at experience combined with education level and the effect on average residual growth in achievement. Again, these factors were of no significance.

Another study that examined the effect of the NTE score was conducted by Sheehan & Marcus (1978). This study differed from others in that it emphasized the Weighted Common Examinations score (WCET). Results indicated that only when variance of student achievement measures and teacher race were included was the WCET a significant predictor of student achievement in mathematics.

The training of elementary teachers has always been a formidable task if simply because they teach all subject areas. However, because elementary teachers are being hired to teach secondary remedial mathematics, as well as the mathematics at the elementary level, the position of mathematics in their training is critical.

One then turns toward the preparation of the secondary mathematics teacher and the effects such preparation has on student achievement.

Johnson & Byars (1977) conducted a status study in 1974 of the current trends in secondary preservice programs. Surveying colleges and universities across the nation, they found that the requirements of content courses have increased and that the number of courses allowing more flexibility, creativity, and practicality is greater. Another status survey was performed by Aviv & Cooney (1979). Among other results, this study indicated that extensive study in mathematics was demanded by most colleges and that field experience prior to teaching was extensive, most important, but difficult to organize and execute.

Jamski (1977) compared the number of semester hours required for certification of teachers between 1957 and 1974. His study exhibited an increase in the requirement both nationwide and in all geographic areas of the country. Though quantity has increased, Jamski recommended that quality still needs to be studied.

Looking in depth at one institution, Cook (1970) examined the preservice program at the University of South Dakota. The questionnaires presented evidence that former graduates felt their preservice to be strong in analysis, but weak in geometry, abstract algebra, statistics, and computer science. Johnson & Byars (1978) examined the needs for application courses in the preservice program. Using a nationwide survey, they found that the area of applications is given the least consideration when requirements for mathematics are determined. This finding appeared to run counter to the emphasis on applications suggested by many mathematics educators.

One study attempted to determine additional learning needs as perceived by secondary mathematics teachers. Hendrickson & Virant (1978) surveyed teachers in Minnesota and found that secondary mathematics teachers felt a need for further training in techniques and materials, motivation, individualized instruction, and applications -- not for more mathematics courses.

The relationship of secondary mathematics teacher preparation to student achievement is discussed in three studies. Achievement in solving verbal problems was studied by Richardson (1974). Teachers who had received instruction in problem-solving strategies tended to show an increase in learning for general mathematics students, thus indicating that specific preparation was a factor. Watson (1970) looked at the effect of background on the Scholastic Aptitude Test - Mathematics (SAT-M) scores of twelfth-grade students. He found that the number of semester hours of mathematics studied by a teacher and the size of the teacher's school were significant as predictors of achievement. However, no single course or grouping of mathematics courses was significant as a predictor. Comparing preparation in micro-teaching with that of a traditional nature and their relationships with student achievement, Madike (1980) concluded that teachers prepared in the use of nine micro-teaching skills brought about significant increases in secondary student achievement in mathematics. Moreover, those trained in traditional approaches did no better than teachers with no preparation in causing significant increases in student achievement.

In light of the preparation of teachers and with the increasing utilization of minimal competency testing, one study examined the influence of such testing on preservice education. From a survey, Riggs & Lewis (1979) found that increases in mathematics coursework and teaching methods were greatly exceeded by those in reading, language arts, and writing. In addition, some increased emphasis of the development of remedial techniques was observed; and over half of the responding institutions indicated projected emphasis on about half of the curricular or skill areas. This reinforces the need for specialized training in sensitivity to needs and means to meet these needs, as advocated by Taylor (1978).

Harris & Davis (1979) agreed and criticized the narrowness and nature of preservice programs as deficiencies toward meeting the varied needs of the students who will be citizens in this complex society. They stressed the importance of preservice programs providing essential preparation in diagnostic, prescriptive, and implementation skills if effective educational programs are to exist. Otto & McMenemy (1966) also stressed these skills, but saw the acquisition of them through training as limited. The teacher's point of view is of equal importance. Moreover, they insisted that formal training in remedial teaching should not create certification requirements that become barriers, but that these standards should instead serve as guides for greater competence.

Summary

The studies cited in this review of related literature and research were concerned with four areas: (a) remediation, (b) secondary remedial mathematics programs, (c) the secondary remedial mathematics student, and (d) the secondary remedial mathematics teacher.

Conclusions of the studies and literature concerning remediation in general support the general conclusion that remediation can be effective. However, such programs should be better funded, should begin before high school, and should be an integral part of the existing instructional program.

Studies and literature addressing secondary remedial mathematics programs support the conclusion that remedial mathematics programs are more effective when variations of the traditional instructional approaches, environments, and materials are utilized. The few studies related specifically to programs related to required minimal competency tests reinforced this same conclusion.

In the area of the secondary remedial mathematics student, research studies and literature were consistent in identification of characteristics particular to this type of student. Performance of these students was found to be positive, with significant improvement in mathematics dependent upon various factors.

Studies and literature related to the teacher of secondary remedial mathematics support the following conclusions:

1. A good teacher can be a good remediation teacher. Despite the fact that teachers will admit their weaknesses in teaching, few will alter their style to accommodate variations in approaches and materials.

2. Teacher expectations can directly and indirectly affect the academic performance of students in mathematics.

3. Teachers are more successful with positive student achievement when the interaction and behavior with students is more frequent, of greater clarity, more specific, more approving, of a questioning nature, and more affective.

4. Elementary teachers today are better prepared and have greater mathematical understanding although various factors will determine to what degree.

5. Secondary mathematics teachers are better trained in terms of quantity of college mathematics courses, have need for further training in areas other than pure mathematics, and exhibit the usefulness of specific preparation for bringing about significant increases in student performance.

In light of the conclusions supported by the studies and literature in this section, teachers have better training today and can be effective in teaching secondary remedial mathematics. However, few of the studies pertaining to teachers and programs directly related to secondary minimal competency tests were available. Therefore, it is difficult to draw conclusions concerning the effects of teacher variables on the performance of students in secondary remedial mathematics programs, especially in North Carolina.

CHAPTER III

PROCEDURES

This study is concerned with the relationship of pupil performance on the North Carolina Competency Test - Mathematics (NCCT-M) after remediation and four teacher variables -- subject area of certification, grade level of certification, predominant type of mathematics studied, and number of semester hours studied in mathematics. Data were obtained from a sample of 498 pupils and 16 teachers in 16 public high schools in the Southeast Education Region of North Carolina. The North Carolina Competency Test - Mathematics (NCCT-M) was used as a measure of pupil performance; the NCCT-M was administered to the pupils of this study in Fall 1979, or Fall 1980, and in Spring 1980, or Spring 1981. Data concerning the four variables of the teachers involved in this study were obtained by questionnaire.

The purpose of this chapter is to describe the research design, the delimitation of the study, selection of the criterion instrument, selection of the sample of subjects, and collection of data.

Research Design

To determine whether a relationship existed between pupil performance on the mathemtics portion of the North Carolina Competency Test after remediation and each of four teacher variables, the North Carolina Competency Test - Mathematics (NCCT-M) was used. Since the test is given in both the fall and spring semesters of a particular school year, scores for pupils from both semesters were used. Fall scores were utilized as the pretest measures; spring scores, the post-test measures.

Two school years were chosen for this study - 1979-80 and 1980-81. The school year 1978-79 was the first year of legislated minimum competency testing and remediation. For various reasons, all schools did not begin remedial efforts immediately following the fall testing. Therefore, there was little consistency among the schools in the amount and kind of remediation provided. Decreases in monies in 1981-82 caused drastic changes in the programs in many schools, again creating little consistency. During the school years 1979-80 and 1980-81, most remediation programs were stable as well as fairly consistent among the different schools.

Only juniors identified as nonhandicapped were used in the study. This was to assure that the pupil 1) had the ability to perform successfully on the NCCT-M, 2) could successfully learn when given remedial assistance in mathematics, and 3) was not enrolled in special classes for a majority of the school day.

Variables in this study included the NCCT-M scores as the dependent variable and the certification and mathematics background of teachers as independent variables. The independent variables were a) subject area of certification, b) grade level of certification, c) predominant type of mathematics studied, and d) the number of semester hours of mathematics formally studied beyond high school. Included in the category, "predominant type of mathematics," were 1) Fundamentals of Arithmetic (FOA); 2) Algebra, Trigonometry, Geometry (ATG); 3) Consumer (CON); and 4) Calculus and Above (CALC).

For each of the school years, three tables were constructed to facilitate calculations:

1) Pretest/posttest scores for each of the non-handicapped juniors failing the fall test and repeating the spring test were matched with the corresponding teacher and his or her variables.

2) Differences in fall and spring scores of pupils were calculated and matched with the corresponding teacher and his or her variables.

3) Number of pupils passing and number of pupils failing the spring test were calculated and matched with the corresponding teacher and his or her variables.

These tables provided the data for the chi square tests which were conducted for each of the school years, 1979-80, 1980-81, and across the two years, 1979-81. Descriptions of tests and analyses of data are included in the following chapter.

Delimitation of the Study

The research in this study is delimited to the following factors:

1. 16 Southeastern North Carolina schools chosen because each employed only one state-funded teacher of remedial mathematics.

2. The 498 eleventh-grade pupils enrolled in mathematics remediation because of initially failing the NCCT-M and the 16 teachers who taught these pupils remedial mathematics in grade eleven.

3. The nonhandicapped eleventh-grade pupils who took the NCCT-M in either Fall, 1979, or Fall, 1980, and repeated the test in Spring, 1980, or Spring, 1981.

4. The variables of the teachers as revealed by the teacher questionnaire.

5. Pupil performance as measured by the North Carolina Competency Test - Mathematics.

6. Two versions of the test which resulted in different emphases.

Selection of the Criterion Instrument

The North Carolina Competency Test - Mathematics (NCCT-M), administered each semester since Fall, 1978, in the public schools of North Carolina, was chosen in this study as the measure of achievement in mathematical literacy. The NCCT-M is the means used by North Carolina to insure mathematical literacy of its pupils upon graduation. Secondary mathematics remediation, required by law for those pupils failing one or both parts of the North Carolina Competency Test, is directly linked to the mathematical competencies expected of one receiving a diploma from North Carolina schools.

As one of two parts of the North Carolina Competency Test required for graduation, the NCCT-M was originally published by CTB-McGraw Hill. For the school year 1980-81, the contract was awarded to Scholastic; therefore, there existed a slight difference in emphases and in the levels of difficulty of the two tests. However, scores for the 1980-81 test were equated with those for the 1979-80 test to provide continuity and consistency from one year to the next and between the two forms of the test.

The content validity of the NCCT-M has been argued by many to be too simply as an indicator of mathematical literacy. However, as indicated in the legislation (The General Statutes of North Carolina, 1978), the purpose of the North Carolina Competency Test is to ensure the possession of minimal skills and functional knowledge by the high school graduate. The NCCT-M speaks to both. Its two components are as follows:

1. Computation - Forty items involving simple computation of whole numbers, fractions, decimals, and percentages are involved in this section. The computation involves addition, subtraction, multiplication, and division.
2. Application - This section included eighty items involving the application of arithmetic in everyday and consumer-related situations.

Thus, the contents of the NCCT-M reflect the minimal skills and knowledge set forth in the legislation.

For the purpose of minimal competency and high school graduation, there is a specific passing score. Pupils are required to score a minimum of 77 out of a maximum of 120.

Selection of Sample

Sixteen southeastern North Carolina schools were chosen as a sample. These schools were chosen because a) only one teacher of remedial mathematics was hired using state remediation funds, b) all nonhandicapped pupils failing the Competency Test received remediation from this teacher, and c) the teachers were accessible for collection of teacher variable data. The sample included large and small schools and provided a variety of teacher certification areas and backgrounds in mathematics course work.

The sample chosen for this study was not a random sample of the schools in North Carolina; all schools are from one particular region of the state. However, the sample does include both city and county schools in 11 counties in southeastern North Carolina.

The pupils comprising the sample were nonhandicapped juniors in the 16 North Carolina schools during each of the school years, 1979-80, 1980-81. For the purposes of this study, only those pupils who had initially failed the Competency Test and who were enrolled in a secondary remedial mathematics class were chosen. A total of 498 pupils (252 in 1979-80 and 246 in 1980-81) were involved in this study.

Teachers in this study were chosen because a) each was the only teacher of secondary remedial mathematics funded by state remediation monies in the particular school, b) each taught all nonhandicapped juniors who had initially failed the Competency Test, c) each had taught the secondary remedial mathematics for two consecutive school years (1979-80, 1980-81) in the school, and d) each was accessible for obtaining teacher data. The sample of teachers included 16 teachers.

Collection of Data

To determine the schools and teachers for the sample, a review was made of lists of remediation teachers for the school years, 1979-80 and 1980-81. These lists were on file in the office of the Mathematics Coordinator of the Southeast Regional Education Center. From those lists, a list was compiled of those teachers who had taught both years in the particular school, were funded by state remediation monies, and were accessible even if having moved out of the vicinity.

A letter was mailed to these teachers explaining the study and requesting their cooperation in completing an accompanying questionnaire (See Appendices A and B). A similar letter was sent to the LEA Remediation Contact Person in each school system having a selected teacher (See Appendix C). The questionnaire requested specific information for the study, as well as other information of importance to the Regional Mathematics Coordinator. Two follow-up letters were sent in order to obtain sufficient teacher data. Of the 29 teachers responding, 16 were chosen because they were the only teachers of secondary remedial mathematics for nonhandicapped juniors failing the Competency Test in their particular schools.

The following procedure was followed in obtaining pupil data for the school years, 1979-80, 1980-81:

1. Formal application was made to the Division of Research, State Department of Public Instruction, requesting permission to obtain and use Competency Test scores for nonhandicapped juniors

in the Southeast Education Region of North Carolina (See Appendix D). Specific scores requested were Failing Scores Fall 1979, Failing Scores Fall 1980, Passing Scores Spring 1980, and Passing Scores Spring 1981.

2. With approval from the State Department of Public Instruction (See Appensix E), pupil names and scores, identified by school number, were obtained.
3. Names of pupils failing in the Fall of one school year were matched with those passing in the following Spring. These names were matched with the appropriate school and teacher. A list was compiled of paired fail/pass scores by teacher for each school year.
4. Additional data were found to be necessary; therefore, failing Spring scores for pupils failing in the Fall were obtained. After matching these names with names from the Fall and with the appropriate teacher, another list of paired scores was compiled for each school year.

This completed the collection of data for the study.

Summary

In this study, the North Carolina Competency Test - Mathematics (NCCT-M) was used as the measure of pupil performance. A questionnaire was developed by the author and provided the teacher variable data. The sample from which the data were collected consisted of 16 teachers and 498 pupils (252 in 1979-80, 246 in 1980-81) in 16 public high schools in southeastern North Carolina. Analysis of the data was handled by the author and will be interpreted in the following chapter.

CHAPTER IV

ANALYSIS OF FINDINGS

Introduction

The purpose of this study was to examine within the Secondary Remediation Programs in southeastern North Carolina, the relationship between pupil performance on the mathematics portion of the *North Carolina Competency Test* after remediation and each of four teacher variables -- subject area of certification, grade level of certification, the predominant type of mathematics studied, and the number of semester hours of mathematics formally studied after high school.

Data for this study were obtained from a sample of 498 pupils and 16 teachers in 16 public high schools in the Southeast Education Region of North Carolina. Results of the *North Carolina Competency Test - Mathematics* (NCCT-M) for each of the school years, 1979-80, 1980-81, provided the pupil data, which were procured from the Division of Research, North Carolina Department of Public Instruction. These results provided the dependent variables. Teacher information was obtained from questionnaires sent directly to the teachers. These data provided the independent variables.

The following null hypotheses were tested in this study:

$H_0(1)$: Certification of the teacher to teach mathematics does not make a significant difference in the gains in pupil scores on the NCCT-M after remediation.

$H_0(2)$: Certification of the teacher to teach grades 7-12 does not make a significant difference in the gains in pupil scores on the NCCT-M after remediation.

$H_0(3)$: The predominant type of mathematics studied by the teacher does not make a significant difference in the gains in pupil scores on the NCCT-M after remediation.

$H_0(4)$: The number of semester hours of mathematics formally studied by the teacher does not make a significant difference in the gains in pupil scores on the NCCT-M after remediation.

$H_0(5)$: Certification of the teacher to teach mathematics does not make a significant difference in the number of pupils passing the NCCT-M after remediation.

$H_0(6)$: Certification of the teacher to teach grades 7-12 does not make a significant difference in the number of pupils passing the NCCT-M after remediation.

$H_0(7)$: The predominant type of mathematics studied by the teacher does not make a significant difference in the number of pupils passing the NCCT-M after remediation.

$H_0(8)$: The number of semester hours of mathematics formally studied by the teacher does not make a significant difference in the number of pupils passing the NCCT-M after remediation.

In the null hypotheses $H_0(1)$ and $H_0(5)$, the independent variable was the subject area of certification. For each teacher, these data were recorded as (1) Not Math or (2) Math. Null hypotheses $H_0(2)$ and $H_0(6)$ involved the independent variable, grade level of certification. Collected data were categorized as (1) Not 7-12 or (2) 7-12.

The independent variable for the null hypotheses $H_0(3)$ and $H_0(7)$ was the predominant type of mathematics studied by the teacher. These data were ranked (1) Fundamentals of Arithmetic (FOA); (2) Algebra, Trigonometry, Geometry (ATG); (3) Consumer (CON); and (4) Calculus and Above (CALC). Category (1) was considered to be the least difficult level of mathematics; category (4), the most difficult level.

For the null hypotheses $H_0(4)$ and $H_0(8)$, the independent variable was the number of semester hours of mathematics formally studied beyond high school by the teacher. Data were ordered in the following manner: (1) 3-6 hours, (2) 9-18 hours, (3) 21-24 hours, (4) 27-36 hours, (5) 39-42 hours, and (6) 42 + hours. For the purposes of testing, categories (1) and (2) were combined and (3) and (4) were combined. No responses were given in category (5).

The analysis of data was conducted in two parts. Each part involved four hypotheses -- each hypothesis being one of the four teacher variables. Part I utilized the gains (differences) from Fall to Spring NCCT-M scores. The null hypotheses $H_0(1)$, $H_0(2)$, $H_0(3)$, and $H_0(4)$ were tested in this part. For each of the school years, 1979-80, 1980-81, the gain between Fall and Spring NCCT-M scores for each pupil was calculated and matched with a teacher and his/her variables. The mean gain in scores for each school year and for the two-year span, 1979-81, were calculated; then the individual score gains were categorized as either "Below the Mean Gain" or "Equal To or Above the Mean Gain." The chi square test was conducted for each of the school years, 1979-80, 1980-81, and the two-year period, 1979-81.

Part II of this analysis of the research data was concerned with the actual numbers of pupils failing or passing the Spring test. In this part, the null hypotheses $H_0(5)$, $H_0(6)$, $H_0(7)$, and $H_0(8)$ were tested. For each school year, the number of pupils failing or passing the NCCT-M were calculated for each teacher and matched with the teacher variables. Since the minimum passing score was 77, the data were categorized as either "Below 77" or "Equal To or Above 77." Again, the chi square test was conducted for each variable for each of the school years, 1979-80, 1980-81, and the two-year period, 1979-81.

Part I

An Analysis of the Relationships Between Teacher Variables and Gains in Pupil Scores

The purpose of the analysis in Part I was to identify the teacher variables that made a significant difference in the gains pupils made in their test scores between the fall and spring testings of the NCCT-M.

The null hypotheses tested in Part I are as follows:

$H_0(1)$: Certification of the teacher to teach mathematics does not make a significant difference in the gains in pupil scores on the NCCT-M after remediation.

$H_0(2)$: Certification of the teacher to teach grades 7-12 does not make a significant difference in the gains in pupil scores on the NCCT-M after remediation.

$H_0(3)$: The predominant type of mathematics studied by the teacher does not make a significant difference in the gains in pupil scores on the NCCT-M after remediation.

$H_0(4)$: The number of semester hours of mathematics formally studied by the teacher does not make a significant difference in the gains in pupil scores on the NCCT-M after remediation.

Table 2 was constructed to match to each teacher and his or her variables the numbers of pupils exhibiting score gains between fall and spring testings that were below or equal to and above

Table 2

Numbers of Students Having Score Gains Below or

Equal To and Above the Mean Gains

Variables				1979-80				1980-81				1979-81		
1	2	3	4	Total N	Total Gain	$N<\mu$	$N\geq\mu$	Total N	Total Gain	$N<\mu$	$N\geq\mu$	Total N	$N<\mu$	$N\geq\mu$
1	2	3	1	15	239	7	8	23	230	17	6	38	22	16
1	2	1	2	15	180	10	5	18	461	2	16	33	11	22
1	1	1	1	12	106	8	4	9	131	5	4	21	12	9
1	2	3	1	10	225	2	8	6	96	2	4	16	4	12
1	1	2	1	3	38	3	0	6	141	0	6	9	2	7
1	1	4	2	8	201	2	6	5	36	4	1	13	6	7
1	1	2	1	9	102	6	3	7	32	6	1	16	12	4
1	1	2	1	7	128	3	4	9	19	7	2	16	9	7
1	1	3	1	15	351	5	10	12	149	8	4	27	13	14
2	2	4	2	10	336	1	9	7	167	3	4	17	4	13
2	2	2	3	11	152	8	3	8	142	5	3	19	11	8
1	1	1	1	17	318	6	11	12	303	1	11	29	7	22
1	1	2	1	24	364	13	11	37	604	17	20	61	28	33
1	2	3	1	8	71	6	2	20	337	8	12	28	13	15
1	2	1	1	15	253	7	8	16	177	10	6	31	17	14
2	2	4	3	73	1035	41	32	51	695	28	23	124	67	57
				252	4099			246	3760			498		
				μ = 16.3				μ = 15.3				μ = 15.8		

Note. Variable 1: 1 = Not Math; 2 = Math

Variable 2: 1 = Not 7-12; 2 = 7-12

Variable 3: 1 = FOA; 2 = ATG; 3 = CON; 4 = CALC

Variable 4: 1 = 3-18; 2 = 21-36; 3 = 42 +

the mean gains for each of the school years, 1979-80, 1980-81, and for the two years, 1979-81. This table also provided for each teacher the total number of pupils and the score gain summation for each of the years of testing.

Tables 3-14 illustrate the relationships between the specific teacher variables and the numbers of pupils having score gains below or equal to and above the mean gains between Fall and Spring scores. The pupil data were categorized as either "$N<\mu$" (numbers of score gains below the mean gain) or "$N \geq \mu$" (numbers of score gains equal to or above the mean gain). Each table represents one of the two single school years or the two-year period. Tables 3-5 test hypothesis $H_0(1)$; Tables 6-8, hypothesis $H_0(2)$; Tables 9-11, hypothesis $H_0(3)$; and Tables 12-14, hypothesis $H_0(4)$.

Variable 1: Subject Area of Certification

The Tables 3-5 illustrate the relationships in hypothesis $H_0(1)$ which is as follows:

> $H_0(1)$: Certification of the teacher to teach mathematics does not make a significant difference in the gains in pupil scores on the NCCT-M after remediation.

To analyze the relationships in this hypothesis, the chi square test was conducted for each of the school years, 1979-80, 1980-81, and the total period, 1979-81.

Table 3

Subject Level of Certification Compared with Gains in Pupil Scores in 1979-80

	$N < \mu$	$N \geq \mu$
Not Math	78	80
Math	50	44

Note. $\mu = 16.3$

$X^2 = 0.359$ for df = 1, $p < .05$

Table 4

Subject Level of Certification Compared with Gains in Pupil Scores in 1980-81

	$N < \mu$	$N \geq \mu$
Not Math	87	93
Math	36	30

Note. $\mu = 15.3$

$X^2 = 0.746$ for df = 1, $p < .05$

Table 5

Subject Level of Certification Compared with

Gains in Pupil Scores in 1979-81

	$N < \mu$	$N \geq \mu$
Not Math	156	182
Math	82	78

Note. $\mu = 15.8$

$X^2 = 1.125$ for df = 1, $p < .05$

Table 3 illustrates the relationships for 1979-80. An examination of the data shows that for the teachers not certified to teach mathematics there was a slightly larger proportion of pupils exhibiting gains equal to or above the mean gain than the number of pupils having gains below the mean gain. The reverse was exhibited for the teacher certified to teach mathematics, with the larger number of pupils showing gains below the mean. This pattern was repeated in Table 4 (1980-81), and again in Table 5 (1979-81).

However, because the differences between numbers of pupils showning gains below or equal to and above the mean for each of the subvariables were so slight, there was no significant differences. This was reflected by the chi square statistics -- Table 3: $X^2 = 0.359$, Table 4: $X^2 = 0.746$, and Table 5: $X^2 = 1.125$. For degrees of freedom = 1, $p < .05$, X^2 must equal or exceed 3.84; no test yielded such a statistic. Therefore, $H_o(1)$ cannot be rejected.

Variable 2: Grade Level of Certification

Tables 6-8 reflect the relationships in hypothesis $H_0(2)$ which is as follows:

> $H_0(2)$: Certification of the teacher to teach grades 7-12 does not make a significant difference in the gains in pupil scores on the NCCT-M after remediation.

As seen in the first set of tables, none of the chi square tests for Tables 6-8 yielded significance. For degrees of freedom = 1, $p < .05$, X^2 must be equal to or greater than 3.84. Table 6 produced $X^2 = 0.357$, Table 7, $X^2 = 0.016$; and Table 8, $X^2 = 0.266$. Thus, all were well below 3.84. Therefore, $H_0(2)$ cannot be rejected.

Table 6

Grade Level of Certification Compared with

Gains in Pupil Scores in 1979-80

	$N < \mu$	$N \geq \mu$
Not 7-12	46	49
7-12	82	75

Note. $\mu = 16.3$
$X^2 = 0.357$ for df = 1, $p < .05$

Table 7

Grade Level of Certification Compared with

Gains in Pupil Scores in 1980-81

	$N < \mu$	$N \geq \mu$
Not 7-12	48	49
7-12	75	74

Note. $\mu = 15.3$

$X^2 = 0.016$ for df = 1, $p < .05$

Table 8

Grade Level of Certification Compared with

Gains in Pupil Scores in 1979-81

	$N < \mu$	$N \geq \mu$
Not 7-12	89	103
7-12	149	157

Note. $\mu = 15.8$

$X^2 = 0.266$ for df = 1, $p < .05$

<u>Variable 3: Predominant Type of Mathematics</u>

The relationships in hypothesis $H_0(3)$ are illustrated in Tables 9-11. Hypothesis $H_0(3)$ is as follows:

> $H_0(3)$: The predominant type of mathematics studied by the teacher does not make a significant difference in the gains in pupil scores on the NCCT-M after remediation.

To test this hypothesis, the major variable was subdivided into four categories: 1) Fundamentals of Arithmetic (FOA); 2) Algebra, Trigonometry, Geometry (ATG); 3) Consumer (CON); and 4) Calculus and Above (CALC).

For there to be significance at df = 3, $p < .05$, X^2 must be equal to or above 7.81. Only Table 10 (1980-81) produced significance, with $X^2 = 8.304$. An examination of the data reveals that the least difficult level of mathematics (FOA) tended to reflect a greater proportion of pupils exhibiting score gains equal to or above the mean gain. In fact, as the level of difficulty increased, the proportion decreased. Thus, for the school year 1980-81 (Table 10), hypothesis $H_0(3)$ can be rejected. However, for the school year 1979-80 (Table 9) and the two years, 1979-81 (Table 11), $H_0(3)$ cannot be rejected.

Table 9

Predominant Type of Mathematics Compared with

Gains in Pupil Scores in 1979-80

	$N < \mu$	$N \geq \mu$
FOA	31	28
ATG	33	21
CON	20	28
CALC	44	47

Note. $\mu = 16.3$

$X^2 = 4.187$ for $df = 3$, $p < .05$

Table 10

Predominant Type of Mathematics Compared with

Gains in Pupil Scores in 1980-81

	$N < \mu$	$N \geq \mu$
FOA	18	37
ATG	35	32
CON	35	26
CALC	35	28

Note. $\mu = 15.3$

$X^2 = 8.804^a$ for $df = 3$, $p < .05$

[a]Significant since $X^2 \geq 7.81$.

Table 11

Predominant Type of Mathematics Compared with

Gains in Pupil Scores in 1979-81

	$N < \mu$	$N \geq \mu$
FOA	47	67
ATG	62	59
CON	52	57
CALC	77	77

Note. μ = 15.8

X^2 = 2.862 for df = 3, p $<$ .05

Variable 4: Semester Hours of Mathematics

Tables 12-14 reflect the relationships in hypothesis $H_o(4)$ which is as follows:

$H_o(4)$: The number of semester hours of mathematics formally studied by the teacher does not make a significant difference in the gains in pupil scores on the NCCT-M after remediation.

The variable, semester hours, was for testing, subdivided into three categories: 1) 3-18 hours, 2) 21-36 hours, 3) 42 + hours. Tables 12 and 13 do not produce any significance. Both tables do reflect a tendency for the second category, 21-36 hours, to show a greater portion of pupils exhibiting score gains equal to or above the mean gains. This category roughly corresponds to a baccalaureate degree in mathematics. However, the third category, 42 + hours, which correlates to work beyond the undergraduate level yields a reverse trend;

slightly more than half the number of pupils showed score gains below the mean gain for each of the individual school years.

Only Table 14 (1979-81) reflects relationships which, when tested, produce significance. For degrees of freedom = 1, $p < .05$, X^2 must be equal to or above 5.99. Data in Table 14 yielded $X^2 = 7.911$ which is significant. Table 13 produced $X^2 = 5.790$ which is very close to 5.99; and the trends discussed for the data in this table are repeated in Table 14. Teachers who studied 21-36 hours of mathematics tended to have greater proportions of pupils producing score gains equal to and above the mean gain. Teachers having studied the most mathematics in terms of semester hours reflected the smallest proportion of pupils exhibiting score gains equal to or above the mean gain. Thus, for the two-year period, 1979-81, the hypothesis $H_o(4)$ can be rejected.

Table 12

Semester Hours of Mathematics Compared with

Gains in Pupil Scores in 1979-81

	$N < \mu$	$N \geq \mu$
3-18	66	69
21-36	13	20
42 +	49	35

Note. $\mu = 16.3$

$X^2 = 3.843$ for df = 2, $p < .05$

Table 13

Semester Hours of Mathematics Compared with

Gains in Pupil Scores in 1980-81

	$N < \mu$	$N \geq \mu$
3-18	81	76
21-36	9	21
42 +	33	26

Note. μ = 15.3

X^2 = 5.790 for df = 2, $p < .05$

Table 14

Semester Hours of Mathematics Compared with

Gains in Pupil Scores in 1979-81

	$N < \mu$	$N \geq \mu$
3-18	139	153
21-36	21	42
42 +	78	65

Note. μ = 15.8

X^2 = 7.911[a] for df = 2, $p < .05$

[a]Significant since $X^2 \geq 5.99$.

Summaries

Because each of the four hypotheses, $H_0(1)$, $H_0(2)$, $H_0(3)$, and $H_0(4)$, were tested separately and for each of the school years, 1979-80, 1980-81, and the two-year period, 1980-81, Tables 15-18 summarize the data of the previous tables.

The summaries in Tables 15-17 categorize the data and statistics by school periods. In Table 15 (1979-80), no test for any variable produced significance. Table 16 (1980-81) shows significance for only hypothesis $H_0(3)$. The type of mathematics studied by the teacher tended to make a difference in the gains in pupil scores on the NCCT-M after remediation. For the two-year period, 1979-81 (Table 17), hypothesis $H_0(4)$ was rejected. The number of semester hours formally studied by the teacher tends to make a difference in the score gains pupil exhibit on the NCCT-M after remediation.

Table 18 reflects the degrees of freedom and chi square statistics for each of the tests of each variable for each school year(s). Only two tests indicated significance: a) Predominant Type, 1980-81 (Table 10) and b) Semester Hours, 1979-81 (Table 14). Of these two, the latter is of more significance since it reflects the total two years rather than one particular year.

Table 15

Summary of Numbers of Pupils Exhibiting Score Gains Below or Equal To and Above the Mean Gain for the School Year 1979-80

VARIABLE		$N < \mu$	$N \geq \mu$	df	X^2
Subject	- Not Math	78	80	1	0.359
	- Math	50	44		
Grade	- Not 7-12	46	49	1	0.357
	- 7-12	82	75		
Type	- FOA	31	28	3	4.187
	- ATG	33	21		
	- CON	20	28		
	- CALC	44	47		
Hours	- 3-18	66	69	2	3.843
	- 21-36	13	20		
	- 42 +	49	35		

Note. $\mu = 16.3$

$p < .05$

Table 16

Summary of Numbers of Pupils Exhibiting Score Gains Below or Equal To and Above the Mean Gain for the School Year 1980-81

VARIABLE		$N < \mu$	$N \geq \mu$	df	X^2
Subject	- Not Math	87	93	1	0.746
	- Math	36	30		
Grade	- Not 7-12	48	49	1	0.016
	- 7-12	75	74		
Type	- FOA	18	37	3	8.804[a]
	- ATG	35	32		
	- CON	35	26		
	- CALC	35	28		
Hours	- 3-18	81	76	2	5.790[b]
	- 21-36	9	21		
	- 42 +	33	26		

Note. $\mu = 15.3$

$p < .05$

[a]Significant at df = 3, $X^2 = 7.81$.

[b]Significant at df = 2, $X^2 = 5.99$.

Table 17

Summary of Numbers of Pupils Exhibiting Score Gains Below or Equal To and Above the Mean Gain for the Two-Year Period 1979-81

VARIABLE		$N < \mu$	$N \geq \mu$	df	X^2
Subject	- Not Math	156	182	1	1.125
	- Math	82	78		
Grade	- Not 7-12	89	103	1	0.266
	- 7-12	149	157		
Type	- FOA	47	67	3	2.862
	- ATG	62	59		
	- CON	52	57		
	- CALC	77	77		
Hours	- 3-18	139	153	2	7.911[a]
	- 21-36	21	42		
	- 42 +	78	65		

Note. $\mu = 15.8$

$p < .05$

[a]Significant at df = 2, $X^2 = 5.99$.

Table 18

Summary of Chi Square Statistics for

Tests of Data in Tables 3-14

VARIABLE	TABLE	SCHOOL YEAR(S)	df	X^2
1 Subject Area	3	1979-80	1	0.359
	4	1980-81		0.746
	5	1979-81		1.125
2 Grade Level	6	1979-80	1	0.357
	7	1980-81		0.016
	8	1979-81		0.266
3 Predominant Type	9	1979-80	3	4.187
	10	1980-81		8.804[a]
	11	1979-81		2.862
4 Semester Hours	12	1979-80	2	3.843
	13	1980-81		5.790
	14	1979-81		7.911[b]

Note. $p < .05$

[a]Significant at df = 3, $X^2 = 7.81$.

[b]Significant at df = 2, $X^2 = 5.99$.

Part II

An Analysis of the Relationships Between Teacher Variables and Numbers of Pupils Failing or Passing the NCCT-M

The purpose of Part II was to determine the teacher variables that made a significant difference in the numbers of pupils passing the NCCT-M after remediation.

In this part, the null hypotheses, $H_0(5)$, $H_0(6)$, $H_0(7)$, and $H_0(8)$, were tested using chi square. The null hypotheses are as follows:

$H_0(5)$: Certification of the teacher to teach mathematics does not make a significant difference in the number of pupils passing the NCCT-M after remediation.

$H_0(6)$: Certification of the teacher to teach grades 7-12 does not make a significant difference in the number of pupils passing the NCCT-M after remediation.

$H_0(7)$: The predominant type of mathematics studied by the teacher does not make a significant difference in the number of pupils passing the NCCT-M after remediation.

$H_0(8)$: The number of semester hours of mathematics formally studied by the teacher does not make a significant difference in the number of pupils passing the NCCT-M after remediation.

Table 19 was constructed giving the numbers of pupils passing or failing the Spring NCCT-M after remediation for each of the school years 1979-80, 1980-81, and the two-year period, 1979-81. These numbers were matched with the appropriate teacher and his/her variables.

Table 19

Numbers of Pupils Passing and Failing

Spring NCCT-M Tests

VARIABLES				SPRING 1980			SPRING 1981			SPRINGS 1980, 1981		
1	2	3	4	N≥77	N<77	Total N	N≥77	N<77	Total N	N≥77	N<77	Total N
1	2	3	1	10	5	15	8	15	23	18	20	38
1	2	1	2	10	5	15	18	0	18	28	5	33
1	1	1	1	7	5	12	7	2	9	14	7	21
1	2	3	1	7	3	10	4	2	6	11	5	16
1	1	2	1	3	0	3	6	0	6	9	0	9
1	1	4	2	6	2	8	1	4	5	7	6	13
1	1	2	1	7	2	9	3	4	7	10	6	16
1	1	2	1	5	2	7	4	5	9	9	7	16
1	1	3	1	13	2	15	7	5	12	20	7	27
2	2	4	2	10	0	10	6	1	7	16	1	17
2	2	2	3	8	3	11	7	1	8	15	4	19
1	1	1	1	14	3	17	12	0	12	26	3	29
1	1	2	1	18	6	24	19	18	37	37	24	61
1	2	3	1	4	4	8	11	9	20	15	13	28
1	2	1	1	8	7	15	9	7	16	17	14	31
2	2	4	3	41	32	73	31	20	51	72	52	124
				171	81	252	153	93	246	324	174	498

Note. Variable 1: 1 = Not Math; 2 = Math

Variable 2: 1 = Not 7-12; 2 = 7-12

Variable 3: 1 = FOA; 2 = ATG; 3 = CON; 4 = CALC

Variable 4: 1 = 3-18; 2 = 21-36; 3 = 42+

The relationships between the particular teacher variables and the pupil data from Table 19 are illustrated for each of the school year(s) in Tables 20-31. Pupil data are categorized as either "N<77" (number of pupils failing) or "N≥77" (number of pupils passing). Each table represents one of the two single school years or the two-year period. Tables 20-22 reflect hypothesis $H_0(5)$; Tables 23-25, hypothesis $H_0(6)$; Tables 26-28, hypothesis $H_0(7)$; and Tables 29-31, hypothesis $H_0(8)$.

Variable 1: Subject Area(s) of Certification

Tables 20-22 illustrate the relationships in hypothesis $H_0(5)$ which is as follows:

> $H_0(5)$: Certification of the teacher to teach mathematics does not make a significant difference in the number of pupils passing the NCCT-M after remediation.

In terms of whether a teacher is certified to teach mathematics, Tables 20-22 reflect very little difference in the proportions of pupils passing the NCCT-M after remediation. Chi square tests of the data indicate no significance for any of the school years. The single school year, 1979-80, produces $X^2 = 1.793$, the largest of the three statistics. However, for degrees of freedom = 1, $p < .05$, X^2 must be equal to or exceed 3.84 for significance. Thus, hypothesis $H_0(5)$ cannot be rejected.

Table 20

Subject Level of Certification Compared with Numbers of Pupils Failing and Passing the Spring NCCT-M in 1979-80

	$N < 77$	$N \geq 77$
Not Math	46	112
Math	35	59

Note. $X^2 = 1.793$ for df = 1, $p < .05$

Table 21

Subject Level of Certification Compared with Numbers of Pupils Failing and Passing the Spring NCCT-M in 1980-81

	$N < 77$	$N \geq 77$
Not Math	71	109
Math	22	44

Note. $X^2 = 0.792$ for df = 1, $p < .05$

Table 22

Subject Level of Certification Compared with

Numbers of Pupils Failing and Passing

the Spring NCCT-M in 1979-81

	$N < 77$	$N \geq 77$
Not Math	117	221
Math	57	103

Note. $X^2 = 0.050$ for df = 1, $p < .05$

Variable 2: Grade Level(s) of Certification

The relationships in hypothesis $H_o(6)$ (stated below) are reflected in Tables 23-25.

$H_o(6)$; Certification of the teacher to teach grades 7-12 does not make a significant difference in the number of pupils passing the NCCT-M after remediation.

An examination of Tables 23-25 reveals that in 1979-80 (Table 23) the larger proportion of pupils passed the NCCT-M for the teachers not certified to teach grades 7-12. This was the same trend for 1979-81 (Table 25), but the trend was reversed in 1980-81 (Table 24), when a slightly larger proportion of pupils passed the NCCT-M for the teacher certified to teach grades 7-12. For significance with degrees of freedom = 1, $p < .05$, X^2 must be equal to or above 3.84. Only for 1979-80 (Table 23) does the data produce significance, with $X^2 = 5.598$. For that year only can hypothesis $H_o(6)$ be rejected.

Table 23

Grade Level of Certification Compared with Numbers of Pupils Failing and Passing the Spring NCCT-M in 1979-80

	$N < 77$	$N \geq 77$
Not 7-12	22	73
7-12	59	98

Note. $X^2 = 5.598^a$ for df = 1, $p < .05$

[a]Significant since $X^2 = 3.84$.

Table 24

Grade Level of Certification Compared with Numbers of Pupils Failing and Passing the Spring NCCT-M in 1980-81

	$N < 77$	$N \geq 77$
Not 7-12	38	59
7-12	55	94

Note. $X^2 = 0.122$ for df = 1, $p < .05$

Table 25

Grade Level of Certification Compared with

Numbers of Pupils Failing and Passing

the Spring NCCT-M in 1979-81

	$N < 77$	$N \geq 77$
Not 7-12	60	132
7-12	114	192

Note. $X^2 = 1.880$ for $df = 1$, $p < .05$

Variable 3: Predominant Type of Mathematics

Tables 26-28 reflect the relationships in hypothesis $H_0(7)$ which is as follows:

$H_0(7)$: The predominant type of mathematics studied by the teacher does not make a significant difference in the number of pupils passing the NCCT-M after remediation.

For this variable, four categories were constructed: 1) Fundamentals of Arithmetic (FOA); 2) Algebra, Trigonometry, Geometry (ATG); 3) Consumer (CON); and 4) Calculus and Above (CALC). The relationships vary among the three tables. In Table 26 (1979-80), teachers studying ATG tended to have the largest proportion of pupils passing the NCCT-M. This group of teachers was followed by that studying CON. However in Table 27 (1980-81), the largest proportion of pupils passing the NCCT-M was related to the group of teachers studying FOA. The next largest proportion was for teachers studying ATG. This pattern was repeated in Table 28 (1979-81).

Table 26

Predominant Type of Mathematics Compared with Numbers of Pupils Failing and Passing the Spring NCCT-M in 1979-81

	$N < 77$	$N \geq 77$
FOA	20	39
ATG	13	41
CON	14	34
CALC	34	57

Note. $X^2 = 3.043$ for $df = 3$, $p < .05$

Table 27

Predominant Type of Mathematics Compared with Numbers of Pupils Failing and Passing the Spring NCCT-M in 1980-81

	$N < 77$	$N \geq 77$
FOA	9	46
ATG	28	39
CON	31	30
CALC	25	38

Note. $X^2 = 15.692^a$ for $df = 3$, $p < .05$

[a] Significant since $X^2 \geq 7.89$.

Table 28

Predominant Type of Mathematics Compared with

Numbers of Pupils Failing and Passing

the Spring NCCT-M in 1979-81

	$N < 77$	$N \geq 77$
FOA	29	85
ATG	41	80
CON	45	64
CALC	59	95

Note. $X^2 = 7.259$ for df = 3, $p < .05$

To be significant at df = 3, $p < .05$, X^2 had to be equal to or greater than 7.81. The data for the year 1980-81 (Table 27) were the only data to show significance, with $X^2 = 15.692$. These data reflected that the least difficult level of mathematics (FOA) studied by the teacher tends to relate to the highest proportion of pupils passing the NCCT-M. Therefore, hypothesis $H_0(7)$, was rejected for only the school year, 1980-81.

The chi square test of data in Table 28 (1979-81) produced $X^2 = 7.259$, which was very close to 7.81. Although there is no significance, Table 28 (1979-81) does repeat the pattern seen in Table 27 (1980-81) -- teachers studying Fundamentals of Arithmetic tend to have the highest proportion of pupils passing the NCCT-M after remediation.

Variable 4: Semester Hours of Mathematics

In this group of tests, Tables 29-31 illustrate the relationships in hypothesis $H_0(8)$ which is as follows:

$H_0(8)$: The number of semester hours of mathematics formally studied by the teacher does not make a significant difference in the number of pupils passing the NCCT-M after remediation.

The categories of the independent variable are three: 1) 3-18 hours, 2) 21-36 hours, and 3) 42 + hours.

An analysis of the data in Tables 29-31 indicates a consistent pattern -- teachers studying 21-36 hours tend to yield the largest proportion of pupils passing the NCCT-M. This category roughly corresponds to the undergraduate degree in secondary mathematics. However, the pattern then becomes inconsistent. Tables 29 and 31 reveal the tendency of teachers studying 42 + hours to have the lowest proportion of pupils passing. Only in Table 39 (1980-81) does the data reflect a tendency for the group of teachers studying the least number of hours (3-18) to have the least number of pupils passing.

For degrees of freedom = 2, $p < .05$, there is significance only if X^2 equals or exceeds 5.99. Chi square tests of the data in Tables 30 and 31 produce significance -- Table 30 (1980-81): $X^2 = 7.320$ and Table 31 (1979-81): $X^2 = 8.332$. Therefore, hypothesis $H_0(8)$ can be rejected for 1980-81 and 1979-81. Data in Table 29 (1979-80) produced $X^2 = 5.952$ which, though not significant, is very close to 5.99.

Table 29

Semester Hours of Mathematics Compared with

Numbers of Pupils Failing and Passing

the Spring NCCT-M in 1979-80

	N < 77	N ≥ 77
3-18	39	96
21-36	7	26
42 +	35	49

Note. $X^2 = 5.952$ for df = 2, $p < .05$

Table 30

Semester Hours of Mathematics Compared with

Numbers of Pupils Failing and Passing

the Spring NCCT-M in 1980-81

	N < 77	N ≥ 77
3-18	67	90
21-36	5	25
42 +	21	38

Note. $X^2 = 7.320$[a] for df = 2, $p < .05$

[a]Significant since $X^2 \geq 5.99$.

Table 31

Semester Hours of Mathematics Compared with

Numbers of Pupils Failing and Passing

the Spring NCCT-M in 1979-81

	$N < 77$	$N \geq 77$
3-18	106	186
21-36	12	51
42 +	56	87

Note. $X^2 = 8.332^a$ for df = 2, $p < .05$

[a]Significant since $X^2 \geq 5.99$.

Summaries

To summarize the data in Tables 20-31 by school year(s), Tables 32-34 were constructed. These tables revealed significance for some hypothesis in each school year(s).

Table 32 provides a summary of 1979-80. For this school year, tests of the data revealed that the grade level of certification of the teacher made a significant difference. Teachers not certified to teach grades 7-12 tended to have the largest proportion of pupils passing the NCCT-M after remediation. Approaching significance was the number of semester hours formally studied by the teacher. The tendency was for teachers studying 21-36 hours to have the largest proportion of pupils passing the NCCT-M.

A summary of tests of data for 1980-81 is given in Table 33. In this year, two variables were found to be significant -- the

Table 32

Summary of Numbers of Pupils Failing and Passing the NCCT-M for the School Year 1979-80

VARIABLE		N < 77	N ≥ 77	df	X^2
Subject	- Not Math	46	112	1	1.793
	- Math	35	59		
Grade	- Not 7-12	22	59	1	5.598[a]
	- 7-12	59	98		
Type	- FOA	20	39	3	3.043
	- ATG	13	41		
	- CON	14	34		
	- CALC	34	57		
Hours	- 3-18	39	96	2	5.952[b]
	- 21-36	7	26		
	- 42 +	35	49		

Note. $p < .05$

[a]Significant at df = 1, $X^2 = 3.84$.

[b]Significant at df = 2, $X^2 = 5.99$.

predominant type of mathematics and the number of semester hours of mathematics studied by the teacher. In the former, the teacher studying Algebra, Trigonometry, and Geometry tended to have the highest proportion of pupils passing. As in 1979-80, the school year 1980-81 revealed the tendency of teachers studying 21-36 hours to have the greater proportion of pupils passing the NCCT-M after remediation.

The data for the two-year period, 1979-81, are summarized in Table 34. As in Table 33 (1980-81), the variables showing significance were the predominant type of mathematics and the number of semester hours of mathematics. The latter indicates the same tendency shown in Tables 32 and 33 -- the largest proportion of pupils passing the NCCT-M was related to those teachers studying 21-36 hours of mathematics. In the former, there is a difference; during 1979-81, the tendency is for the teacher who studies Fundamentals of Arithmetic to thave the greater proportion of pupils passing the NCCT-M.

Table 35 summarizes the chi square statistics for tests of data in Tables 20-31. As indicated by this summary, subject area of certification was the only variable for which no significance was revealed. Grade level of certification was significant for only the school year, 1979-80. The variable, predominant type of mathematics, was significant only in 1980-81. It was the variable, semester hours of mathematics, that showed significance for two time periods, 1980-81 and 1979-81. Very near to, but not significant, was the statistic for 1979-80.

Table 33

Summary of Numbers of Pupils Failing and Passing the NCCT-M for the School Year 1980-81

VARIABLES		$N < 77$	$N \geq 77$	df	X^2
Subject	- Not Math	71	109	1	0.792
	- Math	22	44		
Grade	- Not 7-12	38	59	1	0.122
	- 7-12	55	94		
Type	- FOA	9	46		
	- ATG	28	39	3	15.692[a]
	- CON	31	30		
	- CALC	25	38		
Hours	- 3-18	67	90		
	- 21-36	5	25	2	7.320[b]
	- 42 +	21	38		

Note. $p < .05$

[a]Significant at df = 3, $X^2 = 7.81$.

[b]Significant at df = 2, $X^2 = 5.99$.

Table 34

Summary of Numbers of Pupils Failing and Passing the NCCT-M for the Two-Year Period 1979-81

VARIABLE		N < 77	N ≥ 77	df	X^2
Subject	- Not Math	117	221	1	0.050
	- Math	57	103		
Grade	- Not 7-12	60	132	1	1.880
	- 7-12	114	192		
Type	- FOA	29	85	3	7.259[a]
	- ATG	41	80		
	- CON	45	64		
	- CALC	59	95		
Hours	- 3-18	106	186	2	8.332[b]
	- 21-36	12	51		
	- 42 +	56	87		

Note. $p < .05$

[a]Significant at df = 3, $X^2 = 7.81$.

[b]Significant at df = 2, $X^2 = 5.99$.

Table 35

Summary of Chi Square Statistics for

Tests of Data in Tables 20-31

VARIABLE	TABLE	SCHOOL YEAR(S)	df	X^2
1 Subject Area	20	1979-80	1	1.793
	21	1980-81		0.792
	22	1979-81		0.050
2 Grade Level	23	1979-80	1	5.598[a]
	24	1980-81		0.122
	25	1979-81		1.880
3 Predominant Type	26	1979-80	3	3.043
	27	1980-81		15.692[b]
	28	1979-81		7.259
4 Semester Hours	29	1979-80	2	5.952
	30	1980-81		7.320[c]
	31	1979-81		8.332[c]

Note. $p < .05$

[a]Significant at df = 1, $X^2 = 3.84$.

[b]Significant at df = 3, $X^2 = 7.81$.

[c]Significant at df = 2, $X^2 = 5.99$.

Summary

The analysis of data using chi square and the resulting relationships between pupil performance on the NCCT-M after remediation and each of four teacher variables produced the following results:

$H_o(1)$:	1979-80	Not Rejected
	1980-81	Not Rejected
	1979-81	Not Rejected
$H_o(2)$:	1979-80	Not Rejected
	1980-81	Not Rejected
	1979-81	Not Rejected
$H_o(3)$:	1979-80	Not Rejected
	1980-81	Rejected
	1979-81	Not Rejected
$H_o(4)$:	1979-80	Not Rejected
	1980-81	Not Rejected
	1979-81	Rejected
$H_o(5)$:	1979-80	Not Rejected
	1980-81	Not Rejected
	1979-81	Not Rejected
$H_o(6)$:	1979-80	Rejected
	1980-81	Not Rejected
	1979-81	Not Rejected
$H_o(7)$:	1979-80	Not Rejected
	1980-81	Rejected
	1979-81	Not Rejected
$H_o(8)$:	1979-80	Not Rejected
	1980-81	Rejected
	1979-81	Rejected

The summary, conclusions, and implications for further study will be addressed in the following chapter.

CHAPTER V
SUMMARY, CONCLUSIONS, AND IMPLICATIONS FOR FURTHER STUDY

Introduction

The purpose of this study was to examine within the Secondary Remediation Programs in southeastern North Carolina, the relationship between pupil performance on the mathematics portion of the North Carolina Competency Test after remediation and each of four teacher variables -- subject area of certification, grade level of certification, predominant type of mathematics studied, and number of semester hours of mathematics formally studied after high school.

In this chapter, a summary of the study, conclusions of the findings, and implications for further study will be presented.

Summary

The purpose of this study was to determine whether any of four teacher variables (subject level of certification, grade level of certification, predominant type of mathematics studied, and number of semester hours of mathematics formally studied) made a significant difference in pupil performance on the NCCT-M after remediation. The sample included 16 public high schools in the Southeast Education Region of North Carolina. These schools were selected because they hired only one teacher of secondary remedial mathematics and because all nonhandicapped pupils failing the NCCT-M received remedial instruction from only those teachers. Data obtained for these schools included 16 teachers and 498 nonhandicapped eleventh-grade pupils.

Teacher variable data were obtained by questionnaire. These data provided the independent variables. Pupil performance data were procured from the Division of Research, State Department of Public Instruction. This data provided NCCT-M scores of individual nonhandicapped pupils for Fall 1979, Spring 1980, Fall 1980, and Spring 1981. Individual pupil gains in NCCT-M scores for each of 1979-80, 1980-81, and 1979-81 were compared with the particular mean gain; numbers of pupils having gains below or equal to or above the mean gains were used as dependent variables. Similarly, the numbers of pupils passing or failing the NCCT-M in the Spring after remediation were used as dependent variables.

In Part I of the analysis of data, the gains pupils made in their test scores between fall and spring testings of the NCCT-M were compared with each of the four teacher variables -- subject level of certification, grade level of certification, predominant type of mathematics, and number of semester hours of mathematics. A chi square test was conducted for each of the teacher variables for each of the school years, 1979-80, 1980-81, and the two-year period, 1979-81. Variables significant at the .05 confidence level were determined for each of these times.

In Part II, a similar comparison was made for the numbers of pupils passing the NCCT-M after remediation. For each of the teacher variables, a chi square test was conducted for each of the school years, 1979-80, 1980-81, and the two-year period, 1979-81. Variables significant at the .05 confidence level were determined for each of these times.

The findings based upon the analysis of data are as follows:

1. Certification of the teacher to teach mathematics does not make a significant difference in the gains in pupil scores on the NCCT-M after remediation.

2. Certification of the teacher to teach grades 7-12 does not make a significant difference in the gains in pupil scores on the NCCT-M after remediation.

3. The predominant type of mathematics studied by the teacher does not make a significant difference in the gains in pupil scores on the NCCT-M after remediation. Although there was significance for one school year, there was insufficient evidence to conclude that the predominant type of mathematics was a significant variable.

4. The number of semester hours of mathematics formally studied by the teacher does make a significant difference in the gains in pupil scores on the NCCT-M after remediation. This was based on the significance shown for the two-year period, even though the two individual school years did not indicate significance.

5. Certification of the teacher to teach mathematics does not make a significant difference in the number of pupils passing the NCCT-M after remediation.

6. Certification of the teacher to teach grades 7-12 does not make a significant difference in the number of pupils passing the NCCT-M after remediation. There was insufficient evidence to conclude that the grade level of certification was a significant variable.

7. The predominant type of mathematics studied by the teacher does not make a significant difference in number of pupils passing the NCCT-M after remediation. Although there was significance for the school year, 1980-81, there was insufficient evidence to conclude that the predominant type of mathematics was a significant variable.

8. The number of semester hours of mathematics formally studied by the teacher does make a significant difference in the number of pupils passing the NCCT-M after remediation.

Conclusions

The findings of this research were reported in the previous chapter with each specific analysis. In addition, the acceptance or rejection of the null hypotheses was summarized in this chapter. The purpose of this section is to discuss the major conclusions of this research and to relate it to the findings of previous studies.

The conclusions of this research support earlier studies that have found there are various factors that affect pupil performance in mathematics remediation. Teacher certification, preparation, and qualification cannot be singled out as variables solely responsible for pupil success. Teacher expectations, perceptions, and interaction and behavior are a few of the various factors that can contribute to successful pupil performance.

In this study only one teacher variable, the number of semester hours of mathematics formally studied by the teacher, was found to be significant. This variable was significant as it related to the two dependent variables -- 1) gains in pupil scores and 2) numbers of pupils passing the NCCT-M. Teachers studying 21-36 semester hours of mathematics had the largest proportion of pupils who exhibited gains equal to or above the mean gains and who passed the NCCT-M after remediation. An examination of the data revealed that the proportion of pupils decreased as number of hours increased. This supports earlier studies that indicated a) there needed to be a sufficient number of semester hours of mathematics, and b) after a certain point, more pure mathematics is not the solution to more effective teaching.

In view of the state and national shortage of certified and qualified secondary mathematics teachers, the findings of this study are of importance. Although it is preferable to fill a secondary remedial mathematics teaching position with a certified secondary mathematics teacher, it is not always possible. However, it is possible to screen applicants with respect to the number of semester hours studied in mathematics. Certainly, there are many factors which determine the effectiveness of a teacher; yet, the findings of this study in conjunction with those of earlier studies support the importance of the teacher's background in mathematics. Thus, this variable should be a factor when employing teachers not certified in secondary mathematics to teach secondary remedial mathematics.

The final conclusions of this study are as follows:

1. There exists no evidence to support the conclusions that subject level of certification, grade level of certification, or predominant type of mathematics studied by a teacher makes a significant difference in pupil performance on the North Carolina Competency Test - Mathematics after remediation.

2. The variable, the number of semester hours of mathematics formally studied by a teacher after high school, does make a significant difference in pupil performance on the NCCT-M after remediation.

Implications for Further Study

Based upon the findings of this study, the implications for further study are as follows:

1. Further research is needed in determining what single teacher variables and combinations of teacher variables make significant differences in pupil performance on the NCCT-M after remediation. Other factors to be considered might be expectations, perceptions, interactions and behaviors, and attitude. These factors should be studied separately, in combination with each other, and in combination with the variables tested in this study.

2. A similar study should be conducted using a random sample of teachers and pupils from the entire state of North Carolina. The sample should be representative of the eight educational regions. The study should use as many teacher variables as can be reliably obtained. Teachers should be chosen from a population of all teachers providing instruction in secondary remedial mathematics to nonhandicapped juniors who have failed the NCCT-M.

3. A study should be conducted using a random sample of secondary remedial mathematics teachers who have studied 21-36 hours of mathematics. The sample should be representative of the eight educational regions in the state. As many other teacher variables as can be reliably obtained should be used.

4. Finally, a state-wide study should be conducted using a random sample of teachers of 7th grade mathematics, 8th grade mathematics, and General Mathematics. The sample should be representative of these three groups of teachers and of the eight educational regions in the state. In addition to the four teacher variables in this study, attitude, expectations, perceptions, interactions and behavior, methods, materials, size of school, and size of class should be studied. Such a study should examine the importance of these particular teacher variables and combinations of these variables in the pre-NCCT-M testing years where learning should occur before the fact of Competency Testing.

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APPENDICES

APPENDIX A

Letters to Remediation Teachers

DEPARTMENT OF PUBLIC INSTRUCTION

STATE OF NORTH CAROLINA
SOUTHEAST REGIONAL EDUCATION CENTER
612 COLLEGE STREET
JACKSONVILLE, NORTH CAROLINA 28540
AREA 919-455-8100

A. CRAIG PHILLIPS
STATE SUPERINTENDENT

CARLTON FLEETWOOD
DIRECTOR

January 18, 1982

MEMORANDUM

TO Remediation Teachers

FROM Anne Hathaway ah
Regional Mathematics Coordinator

SUBJECT Competency Test Remediation - 1979-80, 1980-81

I am conducting a study on competency test remediation for the school years 1979-80- 1980-81. This study will attempt to examine the relationships between pupil performance on the math portion of the competency test and several teacher variables.

In order to complete this study, I need your assistance. Enclosed is a questionnaire that I would appreciate your completing. Though I would like your name for initial purposes, your name and the school's name will not be used in the study. Moreover, the information will not be cited in such a way as to imply either name.

Please return the questionnaire in the enclosed envelope by Wednesday, February 3, 1982.

Thank you for your cooperation; it is most appreciated.

sc
Enclosure

DEPARTMENT OF PUBLIC INSTRUCTION

STATE OF NORTH CAROLINA
SOUTHEAST REGIONAL EDUCATION CENTER
612 COLLEGE STREET
JACKSONVILLE, NORTH CAROLINA 28540
AREA 919-455-8100

A. CRAIG PHILLIPS
STATE SUPERINTENDENT

CARLTON FLEETWOOD
DIRECTOR

February 5, 1982

MEMORANDUM

TO Remediation Teachers - 1979-80, 1980-81

FROM Anne Hathaway ah
Regional Mathematics Coordinator

SUBJECT Questionnaire - Remediation Teachers

Hopefully you received a short questionnaire from me several weeks ago. If you have not already done so, please complete it (another is enclosed for your convenience) and return it to my by Wednesday, February 24, 1982.

Your cooperation and assistance will be greatly appreciated as I very much need the information in order to complete the study.

sc
Enclosures

DEPARTMENT OF PUBLIC INSTRUCTION

STATE OF NORTH CAROLINA
SOUTHEAST REGIONAL EDUCATION CENTER
612 COLLEGE STREET
JACKSONVILLE, NORTH CAROLINA 28540
AREA 919-455-8100

A. CRAIG PHILLIPS
STATE SUPERINTENDENT

CARLTON FLEETWOOD
DIRECTOR

February 23, 1982

MEMORANDUM

TO Remediation Teachers - 1979-80, 1980-81

FROM Anne Hathaway *ah*
Regional Mathematics Coordinator

SUBJECT Questionnarie - Remediation Teachers

Hopefully you received a short questionnaire from me several weeks ago. If you have not already done so, please complete it (another is enclosed for your convenience) and return it to me by Wednesday, March 3, 1982.

Your cooperation and assistance will be greatly appreciated as I very much need the information in order to complete the study.

sc

Enclosure

APPENDIX B

Questionnaire

QUESTIONNAIRE - REMEIDATION TEACHERS

PLEASE COMPLETE THE FOLLOWING:

NAME:________________________________ SCHOOL:________________________

1. Grade Level(s) of Certification: ________________________________

2. Subject Area(s) of Certification: ________________________________

____

3. Number of semester hours earned in mathematics beyond high school. (Do not include inservice courses or conference workshops.)

_____ 3-6 _____ 21-24 _____ 39-42

_____ 9-18 _____ 27-36 _____ 42+

4. Predominant type of mathemtaics courses taken. (Check one)

_____ Foundations of Arithmetic _____ Consumer

_____ Algebra, Trigonometry, and Geometry _____ Calculus and Above

5. Check the most appropriate.

_____ I attended all 3 Phases of Remediation Inservice offered by the Division of Mathematics during the school year 1978-79.

_____ I attended only part of the 3 Phases in 1978-79.

_____ I attended none of the 3 Phases in 1978-79.

6. Check the more appropriate.

_____ I attended the Remediation Workshop in September, 1979.

_____ I did not attend the Remediation Workshop in September, 1979.

7. Give the approximate percentage of time spent during the school year remediating each of the competencies below:

_____ Fractions _____ Geometric Concepts

_____ Percents _____ Estimation

_____ Basic Processes _____ Probability and Statistics

Please return to: Anne Hathaway, Regional Mathematics Coordinator
Southeast Regional Education Center
612 College Street
Jacksonville, NC 28540

<u>PLEASE RETURN BY:</u> Wednesday, February 3, 1982

APPENDIX C

Letter to LEA Remediation Contacts

DEPARTMENT OF PUBLIC INSTRUCTION

STATE OF NORTH CAROLINA
SOUTHEAST REGIONAL EDUCATION CENTER
612 COLLEGE STREET
JACKSONVILLE, NORTH CAROLINA 28540
AREA 919-455-8100

A. CRAIG PHILLIPS
STATE SUPERINTENDENT

CARLTON FLEETWOOD
DIRECTOR

January 18, 1982

MEMORANDUM

TO LEA Remediation Contacts

FROM Anne Hathaway *ah*

SUBJECT Competency Test Remediation - 1979-80, 1980-81

I am conducting a study on competency test remediation for the school years 1979-80, 1980-81. This study will attempt to examine the relationships between pupil performance on the math portion of the competency test and several teacher variables.

In order to complete this study, I have sent to selected teachers, who worked with remediation during the school years 1979-80, 1980-81, a questionnaire (see enclosure) to be completed and returned to me by Wednesday, February 3, 1982. The teacher's and the school's names will not be used in the study; and the data will not be cited in such a way as to imply either name. Your encouragement in this effort will be greatly appreciated.

Thank you.

sc
Enclosure

APPENDIX D

Application for Permission to Obtain and Use Competency Test Data

PROPOSAL FOR USE OF RESEARCH DATA FILES*

DIVISION OF RESEARCH

NORTH CAROLINA STATE DEPARTMENT OF PUBLIC INSTRUCTION

RALEIGH, NORTH CAROLINA 27611

Name of Applicant: Harriet Anne Hathaway

Position: Regional Mathematics Coordinator

Address: Southeast Regional Education Center
612 College St.
Jacksonville, N. C. 28540

Telephone: 455-8100 ,

Title of Proposal: Effects of Teacher Variables on Secondary Pupil Test Performance After Remediation

How Will The Proposed Research Be Funded? Personal Funds

Efforts will be made by the Division of Research staff to assist researchers in use of the data files consistent with the methods utilized in sampling and data collection.

1. Give a brief description of your research objectives and procedures. Cover such topics as major comparisons and/or hypotheses to be tested, supplemental data acquisition (if any), general statistical techniques (such as analysis of variance) to be used for the analyses, and expected/desired generalization space. Attach a more detailed explanation of your plan of research.

See Attached Enclosures

2. How do you plan to disseminate your research results?

Through the Division of Mathematics, the North Carolina Council of Teachers of Mathematics, the National Council of Teachers of Mathematics, and a dissertation.

*Research Data Files refer to information collections presently maintained by the Division of Research consisting of survey forms, data cards, or magnetic tapes.

RESTRICTIONS AND CONSTRAINTS

The Division of Research encourages maximum utilization of our data files within the following constraints of laws and departmental policy.

1. Federal law prohibits release of personally identifiable data.
2. No further data collection in conjunction with this study should be made of school systems or individuals whose records are contained in the data file.
3. Data files of the Division of Research cannot be released until the initial report based upon the data is presented to the State Board of Education.
4. Involvement of time of Division of Research staff must be arranged in accordance with existing priorities.
5. Release of data is contingent upon approval of an application providing sufficient description of the proposed use of the data.
6. No commercial use is to be made of data received from the Department of Public Instruction.
7. Utilization of the data files beyond the scope of the approved analysis is prohibited.

GUIDELINES FOR USE OF DIVISION OF RESEARCH DATA FILES

Upon approval of application for research data files, the user agrees to:

1. Provide an appropriate medium (e.g., magnetic tapes or disk) for receiving the research data file.
2. Identify those variables contained on the Division of Research data file of specific interest to the user.
3. Provide to the Division of Research, State Department of Public Instruction, Raleigh, North Carolina 27611, a copy of any report based on these data at least five working days prior to its release.

Upon approval of application for a research data file, the Department of Public Instruction agrees to:

1. Provide the user with oral and written documentation concerning the data source, logic of the data gathering, generalization space and the input format of the data file.
2. Copy the components of the data file relevant to the proposed research onto the medium provided by the user.

GUIDELINES FOR USE OF DIVISION OF RESEARCH DATA FILES (continued)

. . . .

I am aware of the guidelines and restrictions for use of the research data file and agree to abide by them.

Signature of Applicant Harriet Lynne Hathaway Date 1/15/82

Signatures of Approval

Chairperson, Research Steering Committee ______________________

Director, Division of Research ______________________

Assistant State Superintendent for Research ______________________

REVIEW PROCEDURE

Members of the staff of the Division of Research will review proposals submitted for use of research data files. These reviews will examine: 1) acceptable matching of problem and generalization space to research data file contents, 2) acceptability of proposed analytical procedures for the sampling methodology used to obtain the research data files, and 3) compliance with data restrictions and constraints. Approval of the Director of the Division of Research and the Assistant Superintendent for Research is required before data can be released. Proposal writers should receive notice of action within 30 days of submission of the requisite information. Rational for approval/disapproval will be provided to the proposal writer.

Purpose

The purpose of this study is to investigate within the Secondary Remediation Programs in North Carolina, the relationship between pupil performance on the mathematics portion of the North Carolina Competency Test after remediation and each of five (5) teacher variables — grade level(s) of certification, subject area(s) of certification, number of semester hours studied in mathematics, type of mathematics studied, and amount of time spent remediating certain competencies.

Specific Questions

To be addressed in this investigation are several specific questions:

1. Is there evidence of a correlation between pupil performance on the mathematics portion of the North Carolina Competency Test and the teacher's grade level(s) of certification?
2. Does there exist a correlation between pupil performance on the mathematics component of the North Carolina Competency Test and the teacher's subject area(s) of certification?
3. Does the number of semester hours of mathematics studied by a secondary remedial mathematics teacher correlate to pupil performance on the mathematics portion of the North Carolina Competency Test?
4. Does the type of mathematics studied by a secondary remedial mathematics teacher correlate to pupil performance on the mathematics portion of the North Carolina Competency Test?
5. Does the amount of time spent remediating a particular competency correlate to the pupil's performance on that objective on the mathematics portion of the North Carolina Competency Test?

Each of these questions is to be examined for each of the school years 1979-80, 1980-81, and then across the two-year span.

Scope of the Study

The following is an outline of the study:

I. Chapter I: Introduction

II. Chapter II: Review of the Literature

  A. Introduction

  B. Secondary Remedial Mathematics Programs

    1. General

    2. Competency Test Related

  C. The Secondary Remedial Mathematics Student

    1. Characteristics

    2. Pupil Performance

  D. The Secondary Remedial Mathematics Teacher

    1. Perception of Self

    2. Teacher Expectations

    3. Interaction and Behavior with Students

    4. Training and Qualifications

      a. Pre-service

      b. In-service

III. Chapter III: Procedure

  A. Introduction

  B. Selection of Sample

    1. Population

      a. Public School Students in the Southeast Region of North Carolina

      b. Secondary Remedial Mathematics Teachers in the Southeast Region of North Carolina

2. Sample

   a. Approximately 25 Public Schools in the Southeast Region of North Carolina

   b. Approximately 25 Secondary Remedial Mathematics Teachers in the Southeast Region of North Carolina

   c. Approximately 1600 Students in the Southeast Region of North Carolina

3. Selection

   a. Students: All students taught by a selected teacher.

   b. Teachers: Those employed in only those schools hiring one state-funded mathematics remediation teacher.

C. Data Collection

1. Pupil Data

   a. SDPI

   b. Scores

      1. First Testings: 1979, 1980 - total mathematics scores and specific objective scores to be used as pre-test scores to show similarity of students in sample.

      2. Last Testings: 1980, 1981 - total mathematics scores and specific objective scores to be used as pupil performance data (dependent variable) for correlation.

2. Teacher Variable Data

   a. SDPI

   b. Regional Mathematics Coordinator

   c. System Level Supervisor or Principal

   d. Teacher - Questionnaire

D. Measurement of Relationships

1. Correlational Study

SUPPLEMENTAL DATA ACQUISITION
(REMEDIATION TEACHERS)

PLEASE COMPLETE THE FOLLOWING:

NAME: ______________________________

1. Grade Level(s) of Certification: ______________________

2. Subject Areas(s) of Certification: ______________________

____

3. Number of semester hours earned in mathematics beyond high school. (Do not include inservice courses or conference workshops.)

   ___ 3-6 ___ 21-24 ___ 39-42

   ___ 9-18 ___ 27-36 ___ 42+

4. Predominant type of mathematics courses taken. (Check one.)

   ___ Foundations of Arithmetic ___ Consumer

   ___ Algebra, Trigonometry, and Geometry ___ Calculus and Above

5. Check the most appropriate.

   ___ I attended all 3 Phases of Remediation Inservice offered by the Division of Mathematics during the school year 1978-79.

   ___ I attended only part of the 3 Phases in 1978-79.

   ___ I attended none of the 3 Phases in 1978-79.

6. Check the more appropriate.

   ___ I attended the Remediation Workshop in September, 1979.

   ___ I did not attend the Remediation Workshop in September, 1979.

7. Give the approximate percentage of time spent during the school year remediating each of the competencies below:

   ___ Fractions ___ Geometric Concepts

   ___ Percents ___ Estimation

   ___ ___ Probability and Statistics

<u>Expected/Desired Generalization Space</u>

The general statistical techniques to be used include analysis of variance and possibly multiple linear regression. Hopefully, the results of these tests will be positive correlation coefficients for each of the hypotheses to be tested. Such results would pertain to three specific areas.

First is the hiring of teachers. In seeking to employ effective educators in secondary remedial mathematics, one must determine those qualifications which most consistently correlate to effectual remediation and positive pupil performance and which are not detrimental to pupil progress. Second, the inservice given to the remediation teachers by the Division of Mathematics and/or the local school system may or may not necessitate change in its focus. The third area is money for remediation since it is directly related to the number of failures and for inservice so that continuous professional growth and development of the teacher can be maintained.

If the results indicate negative correlations or no correlations, they would still have implications for the hiring of teachers and the inservice provided the remediation teachers by the Division of Mathematics. Hiring teachers certified in areas other than 7-12 Mathematics might be desired. Rather than knowledge of mathematics, knowledge of student growth and development may be the desired focus of inservice for teachers remediating secondary remedial mathematics students. Therefore, though positive correlation coefficients are desirable, non-positive correlation coefficients are viewed as having implications for secondary remedial mathematics programs.

APPENDIX E

Approval to Obtain and Use Competency Test Data

D E P A R T M E N T O F P U B L I C I N S T R U C T I O N

STATE OF NORTH CAROLINA RALEIGH

March 24, 1982

Ms. Anne Hathaway
Regional Mathematics Coordinator
Southeast Regional Education Center
612 College Street
Jacksonville, North Carolina 28540

Dear Anne:

Your request for data has been approved after review by a staff member. His comments are included for your consideration.

I am asking Kenny Hobby to call you and decide on just what data you wish to secure and how will be the simplest way to provide it. Dr. Inman suggested a print-out by teacher to avoid the problems of matching teacher names from your survey with our data set.

I will leave the final decision on what you get with you and Mr. Hobby.

Best wishes on your study.

Sincerely,

Wm. J. Brown

Bill Brown
Special Assistant for Research

BB:aw

Enclosure

cc: Mr. Kenny Hobby

DEPARTMENT OF PUBLIC INSTRUCTION

STATE OF NORTH CAROLINA RALEIGH

January 19, 1981

M E M O R A N D U M

TO: Bill Brown

FROM: Bill Inman WI.

SUBJECT: Harriet Anne Hathaway's Research Proposal: Effects of Teacher Variables on Secondary Pupil Test Performance after Remediation

It is evident that Ms. Hathaway is an intelligent, logical person who has given a lot of thought to her research proposal. She is proposing to correlate five teacher characteristics with student scores on the North Carolina Competency Test to determine what part those characteristics play in determining the scores. The research design is that of a field study. Ms. Hathaway proposes that substantive administrative decisions be based on the results.

The procedures advocated by Ms. Hathaway, when applied to a broad array of administrative problems, would seem to have the potential of remaking administrative decisionmaking. It was believed by many people some 15-20 years ago to have that potential, particularly when enhanced by the computerization of sophisticated statistical techniques. Unfortunately, the method is in almost complete disrepute as a result of the two decades of experience with it. Only when it is employed in an experimental setting, with randomization of variables, does it live up to its expectations. But the main focus of interest in its use was in dealing with a multiplicity of variables, and this almost always precludes the use of a true experimental design.

The basic problem with Ms. Hathaway's design--and thousands of designs like it--is the inability to specify a complete model. For example, the independent variable, Semester Hours of Mathematics, must be correlated with dozens, perhaps hundreds, of other variables that have the potential of correlating with the dependent variable. For example, one would assume that success in mathematics courses would encourage one to take more math courses. General intelligence (as well as application, etc.), then, could be associated with Semester Hours of Mathematics. If Semester Hours of Mathematics correlates with remediation success, is it because of the additional education, or simply because of greater general intelligence applied to the problem of teaching? There is no way of telling from the study design. If teachers who would not normally take more math courses are given more math courses, would it improve their teaching? The design cannot answer that question.

Even if the model could be completely specified, there is no assurance that covariance techniques could handle the mix of variables, fallibly measured, that mother nature has chosen to bestow on Ms. Hathaway's design. The odds are highly against it. Ms. Hatnaway has not indicated a sensitivity to these problems.

I suggest that Ms. Hathaway scale down her expectations regarding the conclusions of her study. The results will be descriptive at best. To infer otherwise would be gratuitous. Taken merely as description, the study should advance the state of knowledge and perhaps suggest an experimental study on which decisions could be made.

It is not clear to me just what data Ms. Hathaway desires to access in our files (see "Data Collection") or how she proposes to access it. We could print out all of the scores at the schools of interest and she could come by and pick out the ones of interest. Matching would be a much bigger job.

"SDPI" is listed under "Teacher Variable Data." At one place, "Perception of Self" and "Teacher Expectations" items are listed. Apparently, more data-gathering is involved than the enclosed "Supplemental Data Acquisition" form and the student test scores. I am not clear whether any of it concerns our files.

WCI/sjn