AN ANALYSIS OF THE SUBJECT MATTER PREPARATION OF MATHEMATICS TEACHERS IN THE HIGH SCHOOLS OF NEWFOUNDLAND AND LABRADOR

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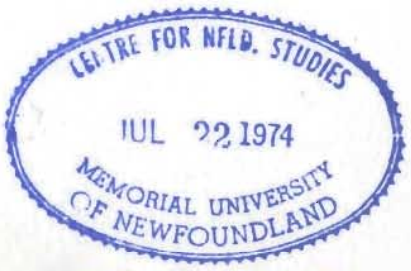
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AN ANALYSIS OF THE SUBJECT MATTER PREPARATION OF MATHEMATICS TEACHERS IN THE HIGH SCHOOLS OF NEWFOUNDLAND AND LABRADOR

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ABSTRACT

The study was concerned with determining the current status of the preparation of senior high school mathematics teachers in the province of Newfoundland and Labrador; and utilizing the information obtained to formulate appropriate in-service measures for these teachers.

Questionnaires were used to gather data on 335 teachers who were teaching at least one mathematics course in Grades X or XI during the fall term of the 1972-1973 school year. The questionnaires were used to gather information in three general areas: academic qualifications of teachers, interests and attitudes toward mathematics, and in-service activities. There were 271 useable questionnaires returned which represented a response rate of 80.9 per cent.

The respondents were classified according to the enrollment of the school in which they taught and, depending on their mathematics course background, as Type A, Type B, or Type C teachers. Since most of the data involved either the nominal or ordinal scales of measurement, the chi-square test was used frequently in testing hypotheses throughout the study.

It was found that 39 per cent of the teachers

were Type A (teachers with more than 24 semester hours of coursework recommended by CUPM for Level III), 17 per cent were Type B teachers (13 to 24 semester hours), and 44 per cent were Type C teachers (less than 13 semester hours). Only 40 per cent of the respondents had earned a major in mathematics, and 42 teachers had not earned a single semester hour of coursework in mathematics. Reasonable strengths in course background were indicated in the areas of algebra and analysis while serious gaps were found in the areas of geometry, probability and statistics, and computer mathematics. The fact that 71 per cent of the teachers had earned no credit in geometry was very alarming since geometry was a course taught by most teachers. The above findings serve as an indication of the critical shortage of well prepared mathematics teachers at the high school level in this province.

An analysis of teaching assignments revealed that many teachers have been misassigned. Only 27 per cent of the respondents were teaching exclusively high school mathematics courses, and many of the others were teaching one or more courses in totally unrelated areas.

The majority of the respondents indicated that they enjoyed teaching mathematics above all other subjects and did not consider that their lack of preparation was a handicap. However, the respondents showed little interest in membership in professional

organizations, reading of relevant professional publications, and taking additional courses.

In-service opportunities for high school mathematics teachers were limited to university sponsored on-campus courses. Sixty-three per cent of the teachers had taken at least one such course since they first began teaching, and 40 per cent of the 271 respondents had taken four or more courses. The respondents indicated that they considered university mathematics courses the most desirable type of in-service training, and felt that there was a need for more of these courses to be offered at the off-campus centers.

The major recommendations of the study include the following:

1. Since an essential ingredient of any program of in-service training is a realization of the need for such a program, it was recommended that all concerned be made aware of the great need for in-service training.
2. A Mathematics Consultant should be included as part of the staff of the provincial Department of Education, and whenever possible, school boards should also hire a Mathematics Consultant as part of their supervisory staff.
3. The provincial university should re-examine its course requirements for mathematics teachers and,

if possible, bring them in-line with the CUPM recommendations.

4. Teacher certification requirements and procedures should be re-examined with a view to improving them to insure that teachers will teach only subjects for which they are academically prepared.
5. In-service programs, especially in geometry, should be instituted as soon as possible. This could possibly be done as part of the off-campus program of Memorial University, and by making use of a group of well prepared teachers who teach mathematics at the high school level.
6. Personnel responsible for hiring and assigning mathematics teachers should try to ensure that
   (a) all new teachers hired have at least a major in mathematics and
   (b) that the best prepared teachers are used to maximum potential in teaching high school mathematics.

ACKNOWLEDGMENTS

The writer wishes to express his grateful appreciation to the many people who have contributed to the successful completion of this study. He is especially indebted to the high school mathematics teachers in Newfoundland for their cooperation in completing the questionnaires, and to his supervisor, Dr. G. K. Wooldridge, whose guidance, constructive criticism, and encouragement were paramount in bringing the study to completion.

The writer also wishes to thank the officials of the Department of Education for their assistance in obtaining necessary data, and Ms. Renée Daggett of Technical Typing for her efforts in the preparation of the final draft of the manuscript.

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CHAPTER I

INTRODUCTION

The state of preparedness of teachers to teach a given curriculum has always been an important concern for educators. For mathematics educators it took on added significance during the late fifties and sixties when it was realized that the mathematics being taught was not meeting the needs of a technological society. This awareness led to many major reforms designed to update the mathematics curriculum and bring it in line with the steadily increasing amount of available mathematical knowledge. Few areas have been left unchanged in the quest to improve mathematics programs. Courses of study have been revised, much new content has been added, textbooks have been improved, and much research has been done in mathematics education. However, the importance of the teacher must always be kept in mind.[1] New mathematics curricula are only as good as the teachers who try to teach the new ideas, concepts, theories and structures.

The sudden changes in the curriculum were the impetus for creation of guidelines and standards for the

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[1]William E. Haig, "Preparation of Senior High School Mathematics Teachers In South Dakota" (unpublished Doctoral dissertation, Indiana University, 1970), p. 2.

pre-service training of mathematics teachers. Efforts to implement new mathematics programs also made educators aware of the vast numbers of poorly prepared in-service teachers. Thus, much time and money was expended in the pre-service and in-service training of mathematics teachers. These measures produced varying degrees of success in the sixties. However, that is not enough. The growth of mathematics and its variety and depth of applications in our society has set a trend that is certain to continue, and "it is inevitable and proper that these changes will be reflected in the content of school mathematics. . ."[2] One of the criteria of success in coping with inevitable mathematics reform in the seventies will be how well prepared teachers are to handle these changes.[3]

This study was designed to investigate the degree of preparation of mathematics teachers in the senior high schools of Newfoundland and Labrador to teach present day mathematics and cope with inevitable changes in this decade.

STATEMENT OF THE PROBLEM

The purpose of the study was two-fold: (1) to

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[2]Committee on the Undergraduate Program in Mathematics, Recommendations on Course Content for the Training of Teachers of Mathematics (Berkeley, California: Mathematical Association of America, 1971), p. 4.

[3]Irving Adler, "Criteria of Success in the Seventies," The Mathematics Teacher, 65: 38-9, January, 1972.

determine the present state of preparedness of mathematics teachers in the senior high schools of Newfoundland and Labrador, and (2) to utilize information obtained to make recommendations for the pre-service training of teachers, and to formulate appropriate in-service measures to upgrade the mathematics background of teachers who are considered deficient.

Specifically, the purpose of the first part of the study was to determine:

(1) teacher preparation as evidenced by
   (a) the number of university level mathematics courses successfully completed,
   (b) the areas of mathematics covered by these courses,
   (c) the recency of these courses,
   (d) the undergraduate major(s) and minor(s),
   (e) the degree(s) held, and the year granted,
   (f) the field of graduate work,
   (g) the number of years teaching mathematics at the senior high level,
   (h) the Certificate or Licence held,
   (i) the number of mathematics courses completed since first began teaching;

(2) teacher attitude and interest toward mathematics as reflected in
   (a) membership in professional organizations,

(b) reading of relevant professional journals and publications,

(c) method of assignment to teach mathematics,

(d) satisfaction in teaching mathematics, and

(e) plans to take more mathematics courses in the future.

In the second part of the study specific aims were:

(1) to determine specific course deficiencies in the preparation of mathematics teachers,

(2) to determine the suitability of placement of mathematics teachers,

(3) to determine possible and most desirable types of in-service training, and

(4) to utilize the information gained in both parts of the study in the formulation of specific proposals on in-service education for mathematics teachers.

SIGNIFICANCE OF THE STUDY

During the last decade the mathematics curriculum in the secondary schools of Newfoundland and Labrador probably experienced more change and controversy than in any comparable period of time in the past. These changes were inspired by events that were happening elsewhere on the North American continent in the late fifties and

early sixties. Such highly-funded groups as the School Mathematics Study Group, the University of Illinois Committee on School Mathematics, the University of Maryland Mathematics Project, the Ball State Teachers College Experimental Mathematics Program and others, through the curriculum materials they produced, had a profound influence on the revision of mathematics programs by commercial publishers.[4] This influence is evident in textbooks used in the province's schools today.

Committees such as the Committee on the Undergraduate Program in Mathematics (CUPM) of the Mathematical Association of America, the Secondary School Curriculum Committee of the National Council of Teachers of Mathematics and others have made recommendations concerning the quantity and quality of coursework considered essential for teachers of mathematics in the secondary schools.[5,6] All groups have stressed the need for specific pre-service training and continuous in-service training.

This province has undergone the curriculum changes,

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[4]C. K. Bradshaw, "Mathematics Teaching in the Public Secondary Schools of the State of Nevada" (unpublished Doctoral dissertation, University of California, Berkeley, 1968), pp. 2-3.

[5]Committee on the Undergraduate Program in Mathematics, Recommendations for the Training of Teachers of Mathematics (Berkeley, California: Mathematical Association of America, 1961, 1966, 1971).

[6]Secondary School Curriculum Committee, "The Secondary School Mathematics Curriculum," The Mathematics Teacher, 52: 414-15, May, 1959.

but has it kept pace in preparing pre-service and in-service teachers according to guidelines deemed essential by such groups as the CUPM? This study is significant in that an attempt has been made to determine the current status of preparation of the province's mathematics teachers. A comparison of this information with the CUPM recommendations aided the researcher in assessing the perceived deficiencies in the preparation of mathematics teachers, and was useful in the formulation of plans to upgrade the background of these teachers.

A major problem in this province until recent years was that of securing enough teachers to staff the schools. Because there was such a problem of teacher supply, the quality of their preparation sometimes had to be ignored. Little or no consideration of background was, or could be, made in many instances. Many of the teachers hired during this time may still be teaching mathematics, and although it is possible that some of these teachers have since improved their background by appropriate in-service measures, it is probably unlikely that they have improved to a level deemed essential to handle today's curriculum. In view of the increasing supply of qualified mathematics teachers, it would seem desirable to identify such teachers, and if possible, to suggest ways of up-grading them to acceptable standards.

Mathematics programs are not static. They are

constantly being revised, rewritten and subjected to experimentation. Many proposals have been made, of which one of the most controversial is the Cambridge Report. In reference to their proposed curricula, the authors of the Cambridge Report made the following observation:

> It is characterized by a complete impatience with the present capacities of the educational system. It is not only that most teachers will be incapable of teaching most of the mathematics set forth in the curricula proposed here; most teachers would be hard put to comprehend it. . . Even the first grade curriculum embodies notions with which the average teacher is totally unfamiliar.[7]

The proposal of an equally ambitious group--the Secondary School Mathematics Curriculum Improvement Study (SSMCIS)--calls for a total reconstruction of the entire curriculum in order to present mathematics as an integrated body of knowledge. Such a curriculum would introduce into the school program topics such as matrices, differential equations, theory of probability and statistics and elementary numerical analysis. This material is now considered university level mathematics. The present goal is to gain one to one-and-a-half years advance in the study of mathematics in high school.[8]

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[7]The Report of the Cambridge Conference on School Mathematics, Goals for School Mathematics (Boston: Houghton Mifflin Company, 1963), p. viii.

[8]Howard F. Fehr, "The Secondary School Mathematics Curriculum Improvement Study Goals - The Subject Matter Accomplishments," School Science and Mathematics, 70: 281-291, April, 1970.

If the Cambridge Report, SSMCIS or similar proposals have any influence on the mathematics curricula of this province in the future, the necessity of having teachers with a solid background in mathematics will become even more urgent. The proposers ~~of~~ such changes stress that the preparation of the teachers is the key factor, since it is the teacher who is the central figure in the implementation of curriculum change. The present study is considered to be significant to the extent that it assesses the capability of today's teachers to teach the present curricula, and to cope with future revisions that appear inevitable. This information can then be used for the planning of pre-service and in-service programs for the mathematics teachers of the province.

LIMITATIONS

Although the problem of adequate teacher preparation exists at all levels of education, this study was limited to an investigation of the preparation of Grade X and XI (Senior High) mathematics teachers in the province of Newfoundland and Labrador. This limitation enabled the researcher to investigate the problem more thoroughly than would have been possible with a larger population.

The study was limited to an analysis of the academic preparation in mathematics. No consideration was given to training in methods, psychology of learning, etc., that

the teachers may have had. This kind of preparation was not omitted because it was regarded as unimportant, but rather because it was considered outside the scope of this particular study.

CHAPTER II

RELATED LITERATURE

The full significance of a study concerning the preparation of mathematics teachers cannot be appreciated without an overview of the vast amount of literature available on the development of contemporary mathematics and its impact on the pre-service and in-service training of mathematics teachers. This chapter attempts to do this by classifying the literature into three main categories:

(1) Changes in the Mathematics Curriculum

(2) Subject Matter Preparation of Mathematics Teachers - Recommendations and Guidelines

(3) In-service Education of Mathematics Teachers.

CHANGES IN THE MATHEMATICS CURRICULUM

The Curriculum Up to 1945

Before the turn of the century, the Committee of Ten in 1894, and the Committee on College Entrance Requirements in 1899 had influenced the establishment of a basic curriculum. This basic pattern that persisted for half a century had algebra and plane geometry (and some trigonometry in grade eleven) as the mathematics to be

studied in high school.[1]

One variation in this pattern--the creation of a general course in grade nine for the non-college bound--led to concern among educators. Establishment of such a course in grade nine eventually led to a removal of most of the algebra and geometry from the seventh and eighth grade curriculum, and a downward adjustment of the level of mathematics in subsequent courses. In addition to the weakening of the content in the 1930's, the mathematics educators had to contend with the general belief that mathematics beyond the general mathematics course was needed by very few people. Both these factors led to a decline in the number of people taking mathematics in colleges and universities, and there was a general deterioration of mathematics education. Calls for reorganization, and recommendations from the mathematics community went unheeded in the thirties and forties.[2]

Factors Leading to Change

There are many factors that contributed to the phenomenal changes in the past two decades. Bradshaw sees as the most prominent of these factors

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[1]C. K. Bradshaw, "Mathematics Teaching in the Public Secondary Schools of the State of Nevada" (unpublished Doctoral dissertation, University of California, Berkeley, 1968), pp. 11-12.

[2]Ibid., pp. 12-14.

> . . . the gradual recognition by the citizenry in general and by educators in particular that the mathematical literacy of the high school graduate was inadequate for living in this age of science and technology.[3]

People were finally beginning to listen to the opinions of the mathematics community on the direction mathematics should be taking. These opinions were many, and they all stressed one thing--the content of school mathematics was not right for a quickly growing technological society. The following comment by Saunders Maclane was typical of the discontent felt toward the content of mathematics courses:

> My subject is vacuous; the lively modern development of mathematics has had no impact on the content or on the presentation of secondary school mathematics. Algebra and geometry, as covered in schools, consist exclusively of ideas already well known two hundred years ago--many of them two thousand years ago. No matter how much better the teaching of these particular ideas to more and more pupils, their presentation leaves school mathematics in a state far more antiquarian than any other part of the curriculum.[4]

The Secondary School Curriculum Committee of the National Council of Teachers of Mathematics acknowledged the need for change to keep pace with expanding knowledge in the following statement:

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[3] Ibid., p. 14.

[4] Saunders Maclane, "The Impact of Modern Mathematics on Secondary Schools," The Mathematics Teacher, 49: 66, February, 1956.

> One of the distinct and important factors contributing to the great explosion of knowledge which has taken place during our life-span is the overall revolutionary advances in the uses of mathematics. . . The astonishing developments in the physical sciences are continually creating demands for new interpretation and uses of mathematics. Of possibly even greater significance in this revolution are the demands which are coming from new users of mathematics.[5]

The Commission on Mathematics of the College Entrance Examination Board, whose responsibility it was to reorganize the curriculum to meet the needs of the second half of the twentieth century, lobbied for revision this way:

> Mathematics is a dynamic subject, characterized in recent years by such impressive growth and such extensive new applications that these have far outrun the curriculum. Moreover, the traditional curriculum fails to reflect adequately the spirit of contemporary mathematics, which seeks to study all possible patterns recognizable by the mind, and by so striving has tremendously increased the power of mathematics as a tool of modern life. Nor does the traditional curriculum give proper emphasis to the fact that the developments and applications of mathematics have always been not only important but indispensable to human progress.
>
> In order that the school and college curricula meet the needs of mathematics itself and of its applications, there must be a change. A new program, oriented to the needs of the second half of the twentieth century and based on a dynamic conception of mathematics, is required. The national need for mathematical manpower, and a general feeling of dissatisfaction with the present state of affairs, support the early

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[5]Secondary School Curriculum Committee, "The Secondary School Mathematics Curriculum," The Mathematics Teacher, 52: 392, May, 1959.

introduction of such a new curriculum.[6]

Contemporary Mathematics

The strong demands for a new curriculum led to such a flurry of activity in the mathematics community during the sixties that it is commonly referred to as the "revolution in school mathematics."[7]

One pioneer in the field of experimentation with curriculum materials was the University of Illinois Committee on School Mathematics which began its work in 1951. From that time onward the pace of experimentation picked up, and major contributions towards building a new curriculum were made by the University of Maryland Project, the Boston College Mathematics Institute, the School Mathematics Study Group, the Greater Cleveland Mathematics Program, the Secondary School Mathematics Curriculum Improvement Study, the Comprehensive School Mathematics Project, the Madison Project, and a host of lesser known groups.[8] Dubish notes that out of all of these groups,

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[6]Commission on Mathematics, Program for College Preparatory Mathematics (New York: College Entrance Examination Board, 1959), p. 9.

[7]G. Baley Price, "Progress in Mathematics and its Implications for the Schools," The Revolution in School Mathematics (Washington, D.C.: The National Council of Teachers of Mathematics, 1961), p. 1.

[8]Eugene D. Nichols, The Continuing Revolution in Mathematics (Washington, D.C.: The National Council of Teachers of Mathematics, 1968), pp. 16-37.

it is the School Mathematics Study Group (SMSG) that has been the dominant influence in curriculum reform in mathematics, and has had the greatest influence on commercial publishers of new materials.[9] The researcher notes that the materials used in the Secondary Schools of this province were inspired by the work of the SMSG.

Despite the diverse goals and varying emphases of the many groups, there are many common elements present in the materials they developed. Such common elements are the result of the philosophy that

> Contemporary mathematics is characterized by: (1) a tremendous development quantitatively; (2) the introduction of new content; (3) the reorganization and extension of older content; and (4) renewed, increased, and conscious emphasis upon the view that mathematics is concerned with abstract patterns of thought.[10]

Adherence to this philosophy has resulted in programs that stress abstraction, logic, and rigor rather than problem solving.[11] The unifying themes in such programs are

> . . . sets, operations, properties of number systems, functions, logical deduction, inductive reasoning, generalization and measurement. . .

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[9]Roy Dubish, "Teacher Education," Mathematics Education: The Sixty-ninth Yearbook of the National Society for the Study of Education, Part I (Chicago: University of Chicago Press, 1970), p. 289.

[10]Commission on Mathematics, op. cit., p. 3.

[11]Morris Kline, "A Proposal for the High School Mathematics Curriculum," The Mathematics Teacher, 59: 322-330, April, 1966.

> Central to the new programs is the study of the structure of mathematics, that is, the study of the basic principles or properties common to all systems of mathematics.[12]

In the new programs courses are more compact than before. This has made room for the introduction of many new courses or topics in the senior high school. Bradshaw[13] reports a 1965 study which revealed that courses such as analytic geometry, calculus, probability and statistics, finite mathematics and linear algebra were not uncommon in the high schools of the twenty states surveyed.

Tomorrow's Mathematics

Robert B. Davis declared in 1967 that

> The 'new mathematics' revolution has not taken place, but--considering the pressures that are building up--it probably will, possibly within the next ten years. . .[14]

It appears that there is still change to come, and that the mathematics curriculum of the seventies and eighties will be greatly different from today's. The Cambridge Report outlines what is considered by many educators a realistic set of proposals for the future. The proposals call for the introduction of new subject matter into the

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[12]C. K. Bradshaw, op. cit., p. 20.

[13]Ibid., p. 21.

[14]Robert B. Davis, The Changing Curriculum: Mathematics (Washington, D.C.: Association for Supervision and Curriculum Development of the National Education Association, 1967), p. 1.

school curriculum so that at the end of high school, a student will have

> . . . a level of training comparable to three years of top-level college training today; that is we shall expect him to have the equivalent of two years of calculus, and one semester each of modern algebra and probability theory.[15]

The report goes on to point out that these proposals are long range, and in that context they cannot be considered unrealistic. Several possible course outlines are also suggested for attaining these goals.

Similar proposals[16] have been put forth by the Secondary School Mathematics Curriculum Improvement Study. In fact, some of the proposed courses have become a reality at the experimental stage in various locations in the United States.

Educators in this province cannot ignore such proposals. There is no doubt that what happens in the United States in the field of mathematics will influence what happens in Canada because, as Jones says, "As far back as the report of the Committee of Ten, Canadian educators have been influenced by developments in the

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[15]The Report of the Cambridge Conference on School Mathematics, Goals for School Mathematics (Boston: Houghton Mifflin Company, 1963), p. 7.

[16]Howard F. Fehr, "The Secondary School Mathematics Curriculum Improvement Study Goals - The Subject Matter Accomplishments," School Science and Mathematics, 70: 281-291, April, 1970.

United States."[17]

Conclusion

It is obvious that the contemporary philosophy of the nature of mathematics, the new content of today's curriculum, and the inevitable changes in the near future all have serious implications for the preparation of teachers of senior high school mathematics. The next section will consider some of these implications.

SUBJECT MATTER PREPARATION OF MATHEMATICS TEACHERS - RECOMMENDATIONS AND GUIDELINES

The Need for Subject Matter Preparation

As experimentation with the new curricula was completed, and more and more of the new materials became a part of the school mathematics curriculum, attention turned to the state of preparedness of the teachers to properly implement the new mathematics curriculum. All the various groups and individuals involved with the development of the new curricula emphasized that the objectives of the new programs could only be reached if

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[17]Philip S. Jones, "Present-Day Issues and Forces," A History of Mathematics Education in the United States and Canada: The Thirty-Second Yearbook of the NCTM (Washington, D.C.: NCTM, 1970), p. 463.

the teachers were adequately prepared in mathematics.

The Secondary School Curriculum Committee in making its recommendations stated that

> The most important single factor contributing to the effectiveness of any program of instruction is the teacher. As in any true profession, the competent teacher is characterized by scholarship in relevant knowledge. . .[18]

The Commission on Mathematics expressed its concern for having well-prepared teachers this way:

> More than any other single factor, the successful carrying out of the Commission's program depends on the teacher of high school mathematics. . . Schools must have teachers who are trained to teach the subject matter in the spirit of the twentieth century mathematics.[19]

Here the Commission stressed the kind of preparation it desired that teachers have:

> The teacher's greatest need, in order to be prepared to teach the new curriculum, is not methodology but subject matter. . . there is no substitute for a solid knowledge of the elements of the new mathematics.[20]

Fehr, the internationally known mathematics educator and director of the Secondary School Mathematics Curriculum Improvement Study, made the following comments concerning the subject matter preparation of teachers of mathematics:

A broad knowledge of mathematics in the teacher

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[18]Secondary School Curriculum Committee, op. cit., p. 414.

[19]Commission on Mathematics, op. cit., p. 50.

[20]Ibid.

> is essential if he is to plan his teaching so that his students will see how various aspects of mathematics are connected, so that the students can experience how mathematics grows from a cooperation between intuition and systematic reasoning, and how eventually mathematics becomes a set of general structures.
>
> A broad knowledge is also essential from the point of view that in the future there will always be a continuous revision of teaching methods and subject-matter content; and if the teachers have a narrow, closed orientation to the subject, a circumstance that has occurred in recent years in many countries, there will be a serious obstacle to the evolution of mathematics education. The day has passed when a teacher. . . can cease to study his subject. Teachers, throughout the whole of their professional career, must be actively engaged in the study of their subject. . .[21]

A lack of adequate preparation in academic subject matter is a handicap to a teacher. It makes his situation very difficult because he must struggle to learn the content as he tries to teach it to his students.[22] This type of teacher is described by McAulay:

> They must exert extra energy and time to prepare lessons in subjects in which their background is weak. The frustration thus generated is quickly passed on to their classes. The chief result is that little interest is created. . . and certainly little ability is determined among the students in these subject areas when the teacher himself

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[21]Howard F. Fehr, "Mathematics Education for a Scientific, Technological and Industrial Society," The Mathematics Teacher, 61: 670, November, 1968.

[22]Donald O. Nelson, "A Survey of Selected Characteristics of Alberta Mathematics Teachers" (unpublished Master's thesis, University of Calgary, Calgary, 1969), p. 13.

has little ability in their content.[23]

The whole issue of the need for subject matter preparation is perhaps best summed up by Diennes, who says that a teacher must be

> . . . first and foremost, a pedagogue. But he will not be able to be a pedagogue if he does not have a thorough grasp of the subject matter he is trying to pass on. . . .[24]

Recommendations and Guidelines

It has been illustrated in the preceding sections of this chapter that the period since 1960 was a time of change as far as the content of school mathematics was concerned. This period has also been characterized by many recommendations and guidelines for the improvement of teacher education. These recommendations have evolved from the discussions of committees and groups who were well informed about the problems associated with the teaching of mathematics, the training of teachers, and the characteristics of the mathematics programs in the schools.[25]

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[23]J. D. McAulay, "Training and Retraining of Mathematics and Science Teachers," Education Digest, 30: 29, September, 1965.

[24]Zoltan P. Dienes, "Comments on Some Problems of Teacher Education in Mathematics," The Arithmetic Teacher, 17: 263, March, 1970.

[25]P. S. Jones and A. F. Coxford, "Academic and Professional Preparation of Secondary School Mathematics Teachers," Review of Educational Research, 34: 322, June, 1964.

The Commission on Mathematics was one of the earliest groups to make specific course recommendations for prospective teachers of high school mathematics. The Commission's decision was that

> A sound teacher-education program can be developed around a major of 24 semester hours beyond the calculus. The Commission recommends that the major be earned by selecting from the following courses: differential equations, probability and statistics, modern algebra, geometry (other than Euclidean), advanced calculus, logic, history of mathematics, and theory of numbers.[26]

Similar recommendations were made by the Secondary School Curriculum Committee of the NCTM:

> In view of current curriculum demands, teachers of mathematics in grades seven through twelve will need to have competence in (1) analysis-trigonometry, plane and solid analytic geometry, and calculus; (2) foundations of mathematics - theory of sets, mathematical or symbolic logic, postulational systems, real and complex number systems; (3) algebra - matrices and determinants, theory of numbers, theory of equations, and structure of algebra; (4) geometry - Euclidean and non-Euclidean, metric and projective, synthetic and analytic; (5) statistics - probability and statistical inference; (6) applications - mechanics, theory of games, linear programming, and operations research.[27]

A noticeable absence in these earliest recommendations is mention of courses in computer mathematics. This is perhaps due in part to the fact that computers hadn't gained the place of prominence that they have in today's

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[26]Commission on Mathematics, op. cit., p. 57.

[27]Secondary School Curriculum Committee, op. cit., pp. 414-415.

society.

CUPM Recommendations. The recommendations that have emerged as one standard for the training of mathematics teachers are those of the Committee on the Undergraduate Program in Mathematics (CUPM) of the Mathematical Association of America. The influence of the CUPM has paralleled that of the SMSG according to Dubish:

> . . . Just as SMSG has been the dominant influence in curricula reform in mathematics, so has the CUPM been the dominant influence on the improvement of teacher preparation. Its recommendations for Levels I-III training have been widely endorsed. . . .[28]

In the original report published in 1961, and revised in 1964 and 1966, the CUPM made recommendations for the training of teachers at five specific levels: Level I (teachers of elementary school mathematics) to Level V (teachers of college mathematics). For teachers of high school mathematics (Level III), CUPM recommended the following courses: three courses in analysis, two courses in abstract algebra, two courses in geometry beyond analytic geometry, two courses in probability and statistics, a course in computer science, and two upper level electives.[29] A more complete description of the

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[28]Dubish, op. cit., p. 289.

[29]CUPM, Recommendations for the Training of Teachers of Mathematics (Berkeley, California: Mathematical Association of America, 1966), pp. 9-10.

Level III recommendations and the nature of the courses recommended is found in Appendix A.

The members of the CUPM stress that their proposals are only minimum standards which are applicable to teachers of all mathematics. In the introduction of the original report (1961) and in the revised reports (1964 and 1966), the Committee stresses that

> The recommendations are to be considered minimal for teachers in any educational program. . . .
>
> Ideally, a person preparing for teaching should meet, in addition to the minimal requirements set forth here, as many of the requirements for the next level as his college program permits.
>
> This report is meant as a guide for the preparation of people who will be teaching any mathematics whatsoever. The suggestions apply, within any level, to all people who teach any mathematics. The teacher who is assigned classes scheduled primarily for students of low aptitude is included in the recommendations.[30]

New recommendations[31] (which for level III are relatively unchanged) published in 1971 also stress the minimum nature and applicability of CUPM recommendations:

> The recommendations . . . are not motivated by a desire to meet the demands of any special program of mathematics education or the goals

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[30]CUPM, Recommendations for the Training of Teachers of Mathematics, A Summary (Berkeley, California: Mathematical Association of America, 1961), pp. 9-13.

[31]CUPM, Recommendations on Course Content for the Training of Teachers of Mathematics (Berkeley, California: Mathematical Association of America, 1971), pp. 17-18.

> of any particular planning organization. We consider our recommendations to be appropriate for any teachers of school mathematics, including teachers of low achievers.[32]

Impact of the CUPM recommendations. The CUPM recommendations have stimulated a great deal of interest in the preparation of teachers, and many studies and surveys have been done on the effect of these recommendations on the preparation of teachers of mathematics. In a 1966 study, Fisher found an appreciable increase in the required amount of coursework, especially in abstract algebra and analysis, from 1960 to 1965. Courses in probability and statistics were the least implemented of those recommended by the CUPM. Fisher's conclusion was that much had to be done before complete implementation of the Level III recommendations would be accomplished.[33]

Fisher's findings agree with those of a CUPM study conducted about the same time. The CUPM, in a survey of colleges and universities, found that the number of semester hours of mathematics required by all the institutions had increased up to the year 1966. The study also revealed that colleges were almost unanimous in attributing the significant changes in their teacher-

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[32] Ibid., p. 9.

[33] J. J. Fisher, "A Survey to Determine the Extent of Implementation of CUPM Recommendations," Dissertation Abstracts, 28: 1324-25, 1966.

training programs to the influence of the CUPM recommendations.[34]

Many reports of more localized studies are to be found in the literature on the CUPM recommendations. Easterday reported that only twenty-five per cent of Alabama's senior high school teachers had the training recommended by CUPM.[35] Smith found that approximately one-half of the high school mathematics teachers in Illinois had the recommended preparation by 1966.[36] Bradshaw, in a 1968 survey of Nevada's teachers of mathematics, determined that fifty per cent satisfied the Level III recommendations. Many teachers, he found, failed to meet the recommendations for geometry, computer mathematics and probability and statistics.[37] A study by Haigh found that only thirty-six per cent of South Dakota's senior high school mathematics teachers met, or exceeded, the CUPM Level III recommendations. The same course deficiencies as in Nevada were also noted

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[34]Committee on the Undergraduate Program in Mathematics, Eleven Conferences on the Training of Teachers of Elementary School Mathematics (Berkeley, California: MAA, 1966).

[35]K. E. Easterday, "Study of Mathematics Teachers in Alabama. Final Report," U.S. Department of Health, Education and Welfare, Office of Education, May, 1967, p. 40.

[36]Shelby D. Smith, "A Survey of Mathematics Teachers in Illinois," Dissertation Abstracts, 27: 2091, 1966.

[37]Bradshaw, op. cit., p. 199.

by Haigh.[38] In a 1969 survey, Nelson found that only twenty per cent of Alberta's high school teachers had the minimum course work recommended by the CUPM. Even more alarming, he noted, was the fact that approximately fifteen per cent of the teachers of high school mathematics had no background in university mathematics.[39]

Other recommendations. The American Association for the Advancement of Science (AAAS) offers two general guidelines for the preparation of teachers of high school mathematics. The AAAS recommends that the undergraduate program for secondary school mathematics teachers should include

(1) a major in mathematics of sufficient depth to make possible further study of mathematics at the graduate level in areas appropriate for teachers
(2) a substantial experience with the field of computing as it relates to mathematics and to the teaching of mathematics.[40]

The AAAS believes that the objectives of guideline (1) can be accomplished by adhering to the CUPM Level III

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[38] William E. Haigh, "Preparation of Senior High School Mathematics Teachers in South Dakota" (unpublished Doctoral dissertation, Indiana University, 1970), p. 117.

[39] Nelson, op. cit., p. 80.

[40] AAAS Commission on Science Education, and the National Association of State Directors of Teacher Education and Certification, Guidelines and Standards for the Education of Secondary School Teachers of Science and Mathematics (Washington, D.C.: AAAS, 1972), pp. 21, 26.

recommendations.[41]

The recommendations of the CUPM and others did not consider the teacher who teaches mathematics as a second subject. The AAAS did give some consideration to such teachers. For teachers who teach high school mathematics as a second subject (their major being in another area), the AAAS recommends four courses in analysis, a course in algebra, a course in geometry, and the other courses from supporting areas (sciences, symbolic logic, philosophy, psychology). The AAAS was quick to point out that it did not encourage the teaching of mathematics as a second subject and would rather see teachers in this category of limited training upgrade themselves as quickly as possible.[42]

Other recommendations have come from the American Association of Colleges for Teacher Education, the Joint Commission on the Education of Teachers of Science and Mathematics, and the National Association of State Directors of Teacher Education and Certification. However, since there is general agreement of their recommendations with those of the CUPM,[43] there is little need to discuss

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[41] Ibid., pp. 21-27.

[42] American Association for the Advancement of Science, "Preparation for High School Science Teachers," Science, 131: 1028, April, 1960.

[43] J. A. Brown and J. R. Mayor, "The Academic and Professional Training of Teachers of Mathematics," Review of Educational Research, 31: 298, June, 1961.

them here.

Conclusion

. . . There is a great need for subject matter preparation of teachers of high school mathematics. There have been significant improvements made in teacher education in the past decade, and the CUPM has contributed in large part to such gains. However, it must not be allowed to stop there. Most writers agree that a lot still has to be done before it can be said that all of our mathematics teachers satisfy the minimum standards set by the CUPM.

IN-SERVICE TRAINING FOR MATHEMATICS TEACHERS

Need For In-Service Training

The introduction and implementation of new and modern programs of mathematics in the high schools, and the recommendations for the preparation of teachers, made in-service teachers aware of one thing: the nature of their pre-service training and teaching experience had left them with insufficient knowledge of contemporary mathematics, and consequently they couldn't function as effectively as they should with the new materials.[44] As a result of this awareness, in-service training (or retraining) of mathematics teachers became a vital concern for educators and

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[44]Merwin J. Lyng, "Factors Relating to a Teacher's Knowledge of Contemporary Mathematics," The Mathematics Teacher, 61: 695, November, 1968.

administrators. Representative of the importance attached to continuous in-service education is the following statement issued jointly by four leading professional organizations:

> Planning for a changing mathematics curriculum should provide for continuous in-service education of teachers in mathematics content. . . . The mathematics program not only has changed but will continue to change. The changing nature of the program results in a need for continuous in-service education. Teachers are increasingly recognizing that change is in the nature of current curriculum development, and that their tasks as teachers will constantly change in the years ahead.[45]

The vital need for in-service training of mathematics teachers is well documented in the literature. Jones and Coxford stress that

> In-service education is a continuing need for all mathematics teachers who are faced with increasing pressure to use new methods and materials. This need is particularly striking for those teachers whose preservice training was inadequate for their jobs. . . .[46]

With regard to the fact that there are large numbers of unprepared in-service teachers, Gager made the following comments:

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[45]National Council of Teachers of Mathematics, American Association of School Administrators, National Association of Secondary-School Principals, Association for Supervision and Curriculum Development; Report of the Joint Project on the Administration of Mathematics Programs, Administrative Responsibility for Improving Mathematics Programs (Washington, D.C.: National Council of Teachers of Mathematics, 1965), p. 11.

[46]Jones and Coxford, op. cit., p. 326.

> Of course, no teacher can teach what he does not know. Thus, for the in-service teacher it is the responsibility of all liberal arts colleges and teacher training institutions to make available to these teachers suitable planned mathematics courses. . . . All such offerings should emphasize the concepts and principles of mathematics and demonstrate their mathematical structure and relationships. Until teachers are trained to the point where they are very much aware of the fact that mathematics is a structure built from concepts, principles, and their relationships, the hope of secondary mathematics teachers using these essential components to establish understanding and insight into the powers of mathematics is almost nil.[47]

Even for adequately prepared in-service teachers, there is a need for continuous training if teachers are to deepen their education. They must remain in contact with colleges and universities, and supplement the training received while they were students.[48] A teacher must be continuously a student of his field; Smith goes so far as to suggest that

> No one can enjoy a full success in teaching a subject unless he, himself, is a student of that subject. The most vibrant teacher is often the most determined student.[49]

There is unanimous agreement among educators, writers, and developers of curriculum materials that

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[47]W. A. Gager, "Is Your College Giving Proper Training for Teachers of Secondary School Mathematics?" The Mathematics Teacher, 55: 493, October, 1962.

[48]Haigh, op. cit., p. 5.

[49]Lehi Smith, "Continual In-Service Education," The Mathematics Teacher, 61: 535, May, 1968.

continuous in-service training for mathematics teachers at all levels is vitally important. However, the little evaluative research that has been done in the area has been concentrated at the elementary school level. Because of this lack of empirical data, there is little to guide consultants and planners in organizing in-service programs for high school mathematics teachers. Many possibilities exist, but final decisions have to be made on what seems most feasible and expedient, and not on what empirical evidence says.[50]

The remaining literature concerning in-service education of high school mathematics teachers consists mainly of two types: (1) surveys of programs that have been or are being tried, and (2) suggestions of various groups and individuals concerning the composition of a successful in-service program. The remainder of this section is devoted to a brief overview of some of this literature.

National Council of Teachers of Mathematics

The National Council of Teachers of Mathematics (NCTM), more than any other single group, has assumed a leadership role in trying to keep in-service teachers

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[50]Bradshaw, op. cit., p. 30.

up to date with new developments in mathematics.[51,52,53] The periodicals, The Mathematics Teacher and The Arithmetic Teacher are the principal media through which the NCTM works. In addition, periodic publication of materials which describe the nature of new programs, reports which aid teachers in the evaluation and selection of texts, yearbooks which focus on methodology and content, journals on research in mathematics, and reports of national and local conferences have made the NCTM a major force in continuous in-service work.

The NCTM is also a useful instrument for overcoming "the inertia of teaching" as Adler calls it. In his view,

> There is an inertia of teaching that is difficult to overcome. Teachers tend to like their old textbooks and their old lesson plans the way some of us like our old shoes. Old shoes are so cozy and comfortable compared to new ones that haven't been broken in. . . .[54]

This situation is not confined to teachers who are poorly prepared, but to even the best prepared secondary school teachers of mathematics. Commenting on the role of the NCTM in overcoming this problem, and the importance of getting more of the teachers into the NCTM, Adler says

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[51] Ibid., p. 31.

[52] Adler, op. cit., p. 38.

[53] Julius H. Hlavaty, "Towards the Golden Jubilee Year 1970," The Mathematics Teacher, 61: 622, November, 1968.

[54] Adler, op. cit., p. 38.

> . . . the most powerful instrument we have for stirring teachers up professionally, for arousing their interest in professional improvement, and for providing the means for this improvement is the National Council of Teachers of Mathematics.
>
> The greatest single contribution that we can make to improve the preparation of high school teachers of mathematics during the next decade is to bring them all into the NCTM.[55]

National Science Foundation

One of the best examples of success in the field of in-service training of mathematics teachers is afforded by the work of the National Science Foundation (NSF) in the United States. The NSF is an agency of the Federal Government established in 1950 to advance scientific progress. This is accomplished by sponsoring research, supporting improvements in education and fostering scientific information exchange.[56]

The National Science Foundation offers grants that provide supplemental mathematics instruction for high school teachers through institutes that meet after school hours or on Saturdays. A typical in-service institute meets once a week for periods of two to four hours for a full academic year. Institutes, however, are not restricted to this type alone. Some are held in vacation periods or

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[55] Ibid.

[56] National Science Foundation, Guide to Programs (Washington, D.C.: National Science Foundation, 1968), p. iii.

irregularly, and are not restricted to a particular schedule format. These institutes enable mathematics teachers to obtain additional knowledge of subject matter and at the same time become familiar with changes in mathematics course content.[57] Since its conception in 1957, this program of institutes had grown until 14,000 to 15,000 teachers and supervisors were participating annually by the year 1968.[58]

The results of research studies indicate that the NSF institutes have been instrumental in the training of many high school mathematics teachers in the years since 1957. Easterday[59] reported that approximately 40 per cent of Alabama's high school mathematics teachers had attended an NSF institute by 1966. According to Bradshaw[60] over 70 per cent of the secondary school mathematics teachers in the state of Nevada had taken at least one course at an NSF institute. Haigh[61] determined that 40 per cent of South Dakota's high school mathematics teachers had taken advantage of the NSF programs to upgrade their mathematics

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[57] Ibid., p. 45.

[58] Haigh, op. cit., p. 40.

[59] Easterday, op. cit., p. 39.

[60] Bradshaw, op. cit., p. 209.

[61] Haigh, op. cit., p. 96.

background in the sixties. Alspaugh[62] found that over 60 per cent of Missouri's mathematics teachers had attended an institute sponsored by NSF. Bertram[63] determined that the improved subject matter competence of 60 per cent of Indiana's secondary school mathematics teachers was a result of their participation in NSF programs.

Researchers also report a more indirect benefit that comes from the NSF institutes. Teachers who are trained at these institutes are excellent potential sources of instruction for in-service programs in their local area. The use of these people as instructors helps lift the pressure placed on college and university staffs to supply instructors for in-service classes in mathematics.[64] Such use of these well-qualified secondary school teachers as instructors for in-service classes in mathematics met with approval and success among the teachers in Georgia[65] and Nevada.[66]

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[62]J. W. Alspaugh, "A Survey of Secondary Mathematics Programs in Missouri With Emphasis on Content, Procedures, and Preparation of Teachers," Dissertation Abstracts, 26: 5259, 1965.

[63]Charles J. Bertram, "Selected Characteristics of Mathematics Teachers in Indiana Public Secondary Schools" (unpublished Doctoral dissertation, Indiana University, 1971), p. 164.

[64]Haigh, op. cit., p. 42.

[65]Ibid.

[66]Bradshaw, op. cit., p. 196.

Other In-Service Activities

There is general agreement that the NSF institutes have been the main source of in-service training for mathematics teachers. However, many other smaller and lesser known projects, using a variety of techniques, are also reported. In addition to the NSF and other institutes, techniques used include faculty meetings, workshops, use of consultants, departmental or grade-level meetings, university and college courses, classroom visitations, action research, conferences and conventions, and provision of appropriate professional resources in the schools.[67]

The particular technique used varies from school system to school system depending on the local conditions. There are obviously many advantages and disadvantages to each technique, but as stated earlier in this section, research evidence on the merits of any particular technique is almost non-existent. What the research has shown is that the most common in-service measure for the training of mathematics teachers has been university sponsored programs consisting mainly of on-campus and off-campus courses.[68]

Memorial University of Newfoundland

Memorial University, the only university in the

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[67]Haigh, op. cit., p. 34.

[68]Ibid.

province, has been the major source of in-service training for Newfoundland teachers. Memorial's program has grown, and now it consists of a wide variety of summer and evening courses on-campus in St. John's, summer courses at Grand Falls and Corner Brook, and off-campus evening courses in twenty-eight centers throughout the province.[69] The overall expansion in the Summer Program has resulted in a large increase in the number of mathematics courses offered for credit. In 1964, only two mathematics courses, a first year course and an introductory calculus course, were offered to students attending the Summer Session, while in the 1973 Summer Session, six mathematics courses were being offered. The number of mathematics courses offered as part of the regular year Evening Courses Program has increased as well, but off-campus, CUPM type mathematics courses are almost non-existent.

The fact that 1800 students registered for off-campus courses in the past two years and 2863 students registered for summer courses is an indication of the large part played by Memorial University in providing in-service opportunities for all teachers of the province.[70]

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[69] Memorial University of Newfoundland, Extramural Studies, Off-Campus Courses, 1973-74, Foreword.

[70] Ibid.

Conclusion

The previous sections of this chapter cited several research studies which indicated that a large number of mathematics teachers have inadequate preservice training in terms of the CUPM recommendations. For this reason, continuous in-service education is vitally important. In-service training is also important if the better prepared teachers are to keep up with the inevitable changes in the field of mathematics. The work of the NCTM and organizations like the NSF should be given careful consideration when planning and organizing in-service programs for mathematics teachers because these organizations have been very effective in the area of in-service education for mathematics teachers.

SUMMARY OF RELATED LITERATURE

The review of literature in this chapter has centered on three main themes: (1) the changing mathematics curriculum, (2) the need for subject matter preparation and recommendations on what this preparation should be, and (3) the implications for in-service training in the attempt to ensure that all teachers have the recommended preparation.

It was shown that the recent changes in the mathematics curriculum require that teachers of mathematics have sound subject matter preparation. As a result, a

great deal of interest has been created in the training of teachers, and many groups have made recommendations and offered guidelines for the training of mathematics teachers. Studies have shown that the recommendations of the CUPM have emerged as a standard that has received widespread approval. Studies have also shown that many teachers lack the preparation recommended by the CUPM and this has led to the realization that if such teachers are to be trained to the minimum standard recommended by the CUPM, there is a vital need for continuous in-service education. Continuous in-service training is also necessary if the better prepared teachers are to keep current with happenings in the field of mathematics. The type of in-service training that has received greatest approval and contributed most to the up-grading of mathematics teachers is university or institute sponsored mathematics courses.

CHAPTER III

PROCEDURE

STATEMENT OF THE PROBLEM

The purpose of the study was two-fold: (1) to determine the current status of the preparation of mathematics teachers in the senior high schools of the province of Newfoundland and Labrador, and (2) to utilize information obtained to (a) make recommendations for the preservice training of mathematics teachers, and (b) formulate appropriate in-service measures to improve the background of the province's mathematics teachers.

DEFINITION OF TERMS

Some of the terms used in this study may be subject to various interpretations. The following terms are defined as they will be interpreted in this study:

Mathematics Teacher. Any teacher listed in the records of the Department of Education as having taught at least one mathematics class in Grade 10 or 11 during the 1972-1973 school year.

Preservice Teacher Training. The training a teacher receives from a recognized institution before being employed as a teacher.

In-Service Teacher Training. The training or retraining of a teacher which is going on or continuing while the teacher is employed. This training may take place after school hours, on weekends, during the summer, or during times when the teacher is on leave.

Level III Recommendations. The recommendations of the Committee on the Undergraduate Program in Mathematics (CUPM) for the minimal training program for senior high school mathematics teachers.

Mathematics Course. Any university-level course carrying a mathematics label, and requiring a semester to complete.

Semester Hour. One hour of coursework per week for one semester.

Type A Teachers. Mathematics teachers who have more than 24 semester hours of the coursework recommended by CUPM for secondary school mathematics teachers.

Type B Teachers. Mathematics teachers who have 13 to 24 semester hours of the coursework recommended by the CUPM.

Type C Teachers. Mathematics teachers who have less than 13 semester hours of the coursework recommended by CUPM.

Senior High School. Any school in which Grades 10 and 11 are taught. On the basis of the total enrollment, each school was classified as small (less than 199 students), medium (200-499 students), or large (more than 500 students).

STUDY POPULATION

The study population was limited to those teachers who were determined to be teaching at least one class in grade 10 or 11 mathematics at the beginning of the 1972-73 academic year. Since no list of the teachers fitting these descriptions was available to the researcher, the only way to determine the names of the teachers in the study population was to go through the "Day of Opening Notice" forms which teachers complete for the Department of Education. This form is completed on the first day of school, and at that time teachers are required to indicate as accurately as it is possible, how their teaching time is spent. A search of these records enabled the researcher to compile a list of 344 names of teachers meeting the above qualifications. Thus the tentative study population was 344.

HYPOTHESES AND OBJECTIVES

The first part of the study was involved with determining the current status of the preparation of senior high school mathematics teachers. Major hypotheses tested include:

1. Based on CUPM Level III recommendations, the preparation of mathematics teachers of large senior high schools exceeds the preparation of

mathematics teachers of small and medium senior high schools.

2. A majority of senior high school mathematics teachers in the province have had no university courses in one or more of the following areas of mathematics: analysis, abstract algebra, probability and statistics, geometry, and computer science.
3. A majority of the mathematics teachers have not had any mathematics training in the past four years.
4. A larger percentage of Type A than Type B or Type C teachers have completed courses since they began teaching.
5. A larger percentage of Type A than Type B or Type C teachers are members of the National Council of Teachers of Mathematics.
6. The majority of senior high school mathematics teachers do not subscribe to, or regularly read any professional mathematics publications.
7. Type A teachers express more enjoyment in teaching mathematics than do either Type B or Type C teachers.
8. The majority of mathematics teachers do not teach only mathematics.
9. A larger percentage of Type A than Type B or

Type C teachers teach only mathematics.

10. Based on CUPM Level III recommendations, older teachers are better prepared than younger teachers.
11. Type A teachers show a greater interest in future training in mathematics than do Type B or Type C teachers.
12. The majority of graduate work being done by mathematics teachers is not being done in mathematics.

The purpose of the second part of the study was to utilize the information obtained in the first part of the study to make recommendations regarding preservice programs and to formulate in-service measures to upgrade the mathematics background of mathematics teachers. Principal objectives in this part of the study were:

1. To determine specific courses where deficiencies in teacher preparation lie,
2. to determine the suitability of placement of mathematics teachers,
3. to determine possible and most desirable sources of in-service training for mathematics teachers, and
4. to utilize information gained from two parts of the study in the formulation of specific proposals on preservice and in-service education for mathematics teachers.

DATA NEEDED

Since very little information on the teachers in the study population was available to the researcher from other sources, it was necessary to solicit all information directly from the teachers. Data of the following type were collected:

1. The number of courses completed in the various areas of mathematics covered by the Level III recommendations.
2. The recency of completion of university mathematics courses and the number of courses completed since teaching career began.
3. The majors, minors, degrees and field of graduate work of the mathematics teachers.
4. The size and type of school in which the teachers teach.
5. The subjects currently being taught, the total amount of time spent teaching mathematics and the number of years of mathematics teaching experience.
6. Indication of the teachers' attitude toward future coursework, the teaching of mathematics, types of in-service, membership in professional organizations and reading of relevant professional materials.

METHOD OF SECURING DATA

The size of the study population and the travel distances involved precluded the possibility of obtaining the needed information by personal contact. Thus, the researcher chose to collect the necessary data by using a questionnaire.

The questionnaire[1] used was a modified form of one used by Haigh[2] in a similar study in South Dakota. To ensure that the modifications had not caused any ambiguity of questions or confusion in the instructions, the questionnaire was submitted to a pilot group composed of graduate students. They were asked to comment on the time required for completion, the clarity of instructions, the wording of items, etc.. It was found that the time required for completion ranged from ten to fifteen minutes, and this was considered reasonable. Several suggestions for clarity of wording and improvement of format were received from the pilot group.

The questionnaire was then revised incorporating the minor changes suggested by the pilot group. As a final check the questionnaire was reviewed by faculty

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[1]See Appendix B.

[2]William E. Haigh, "Preparation of Senior High School Mathematics Teachers In South Dakota" (unpublished Doctoral dissertation, Indiana University, 1970), pp. 149-153.

members of the mathematics education department at Memorial University. Some minor changes were suggested and the questionnaire was revised accordingly. This final draft was accepted and printed for distribution to the study population.

DISTRIBUTION AND RETURN OF QUESTIONNAIRES

On November 20, 1972 the 344 questionnaires and accompanying letters of transmittal[3] were sent to the school addresses of the tentative study population. A stamped, self-addressed return envelope was enclosed with each questionnaire. Teachers were told that no names were necessary on the returned questionnaires since the researcher was only interested in the composite data on high school mathematics teachers. It was hoped that keeping it anonymous would contribute to a larger return.

At the end of two weeks, the number of returns had reached 208 or approximately 60 per cent of the original 344 mailed. Due to the rapidly approaching Christmas vacation, it was felt that a follow-up letter was necessary at this time. It was hoped that this follow-up letter would facilitate the quick return of the remaining questionnaires before the December break. The follow-up letter[4] was sent

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[3]See Appendix C

[4]See Appendix D.

to the head of the mathematics department in the school, or if there was no mathematics department, to the school principal. Those people were asked to remind the mathematics teachers in their schools (a list was supplied) to try and complete the questionnaire if they had not already done so.

On January 15, 1973, the researcher decided to proceed with the other phases of the study on the basis of questionnaires received up to that time. A total of 280 replies had been received at the close-off date. Four of the questionnaires had been returned undelivered and five were returned from teachers who were no longer teaching senior high school mathematics when they received the questionnaire. Thus, these nine teachers were deleted from the study population. Hence the final study population was fixed at 335. The 271 useable returns from the study population represented a return rate of 80.9 per cent. It was decided that this rate was sufficient for the purposes of the study.

ANALYSIS OF DATA

This study lies in the domain of descriptive research, and according to Borg,[5] the major purpose of

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[5]Walter R. Borg, Educational Research, An Introduction (New York: David McKay Company, Inc., 1965), p. 202.

this type of research in education is to tell "what is." For this reason, much of the data produced do little more than indicate the frequency of occurrence of some condition. However, a large part of the analysis of data was concerned with an examination of the interrelationships among certain conditions or events. Specifically, the major part of the analysis of data was concerned with (1) qualitative and quantitative comparisons between the courses taken by the mathematics teachers in the study population and the courses recommended by the CUPM for Level III, (2) differentiation in background of the teachers in the different size schools, and (3) differentiation in background of Type A, Type B, and Type C teachers. The chi-square test was used in testing all hypotheses involving these comparisons, and the level of significance was set at .05.

CHAPTER IV

FINDINGS OF THE STUDY

The purpose of this chapter is to present the findings resulting from the data collected by means of the questionnaire. This information will be presented in four main parts. Part one will be concerned with the school environment; part two will deal with the preparation of mathematics teachers; part three will be concerned with the interests and attitude toward mathematics teaching as expressed by the respondents; and part four will concentrate on in-service training of mathematics teachers.

SCHOOL ENVIRONMENT AND TEACHER DISTRIBUTION

To better understand some of the information about mathematics teachers that will be presented in the next sections of this chapter, it is necessary to know some things about the schools in which they teach. In particular, knowledge of organizational patterns, enrollment, and distribution of teachers in the different size and type schools should give depth to a study of the preparation of these teachers.

Patterns of Organization

There are two main organizational patterns of secondary schools in the province: (1) the five year central high school (Grades 7-11), and (2) the three year junior high school (Grades 7-9) followed by a two year senior high school (Grades 10, 11). This two year senior high school is usually referred to as a regional high school. A third, but rapidly disappearing pattern, is the all-grade school (k-11).

Question three on the questionnaire asked teachers to indicate the type of school in which they taught. It was found that 164, or about 61 per cent, taught in central high schools, and only 36 per cent taught in schools where only grades 10 and 11 are taught. Table 1 shows the complete distribution of teachers in the different type schools.

Table 1

Distribution of Teachers by School Type

Type of School	Number of Teachers	Per Cent
Regional High (Grades 10, 11)	98	36
Central High (Grades 7-11)	164	61
All-Grade (k-11)	9	3
Totals	271	100

School Size

A high degree of centralization of school services in this province in recent years has significantly reduced the number of small, all-grade schools, and produced some fairly large high schools. However, about 70 per cent of the teachers indicated that they were teaching in schools where the total enrollment is still less than 500. Table 2 summarizes the distribution of mathematics teachers in the different size schools in the province. Tables 1 and 2 indicate that the majority of the teachers were teaching in relatively small, central high schools. This means that they are probably required to teach a variety of subjects and grades, some of which they have little or no academic preparation to teach.

Table 2

Distribution of Teachers by School Size

School Enrollment	Number of Teachers	Per Cent
Less than 200 (small)	73	27
200 - 499 (medium)	116	43
More than 500 (large)	82	30
Totals	271	100

A thorough investigation into the relationships between the teachers' academic background in mathematics and the size

of the schools and the courses they teach will be made later in the study. However, the data cited above give a preliminary idea of the problem.

PREPARATION OF SENIOR HIGH SCHOOL MATHEMATICS TEACHERS

Undergraduate Majors and Minors

Since most recommendations for the preparation of high school mathematics teachers stipulate that, ideally, such teachers should not have less than a major in mathematics, question ten asked respondents to specify their majors and minors. A variety of majors and minors were reported, but for convenience of coding and analysis, they were grouped into eight categories.

It was very alarming to learn that only 40 per cent of the respondents had a major in mathematics, and another 45 per cent had no major at all or a major in a totally unrelated field (e.g. social studies, English). Table 3 summarizes the number of majors in the different fields of study.

Table 3

Undergraduate Majors of Mathematics Teachers

Field of Major	Number of Teachers	Per Cent
Mathematics or math-composite	109	40
Physical sciences	12	4
Biological sciences	7	3
Social studies	46	17
English	11	4
Other languages	6	2
Psychology	3	1
Non-mathematics composite	8	3
Other	13	5
No major	56	21
Totals	271	100

In an attempt to see if there were significant differences between the percentage of teachers in the different size schools who had majors in mathematics, the respondents were classified as mathematics or non-mathematics majors by school size. Table 4 illustrates this breakdown. It shows that 46 per cent of the teachers in the large schools had mathematics majors, but only 36 per cent of the teachers in the small schools had

mathematics majors. The researcher assumed the null-hypothesis that there was no significant difference in the percentage of teachers in the different size schools on the basis of mathematics or non-mathematics majors. The use of the chi-square test of significance showed no significant differences and thus, there was no basis for rejecting the null hypothesis.

Table 4

Distribution of Mathematics and Non-Mathematics Majors in the Different Size Schools

Undergraduate Major	Size of School							
	Small		Medium		Large			
	No.	%	No.	%	No.	%	Totals	
Mathematics	26	36	45	39	38	46	109	40
Non-mathematics	47	64	71	61	44	54	162	60
Totals	73	100	116	100	82	100	271	100

Hence, the number of mathematics majors as opposed to non-mathematics majors is not significantly higher in the larger high schools.

The recommendation of the American Association for the Advancement of Science (AAAS) is that secondary school mathematics teachers should have training in supporting

areas. It was suggested by the AAAS that study in philosophy, logic, symbolic logic, psychology, and all areas of science would be support to the mathematics teacher's background.[1]

Table 5 illustrates the undergraduate minors of the mathematics teachers responding to the questionnaire. Less than 25 per cent of the respondents had minors in supporting areas and 17 per cent indicated a minor in mathematics. Sixty-nine of the 271 teachers had no minor at all.

Table 5

Undergraduate Minors of Mathematics Teachers

Field of Minor	Number of Teachers	Per Cent
Mathematics or math composite	45	17
Physical sciences	51	19
Biological sciences	5	2
Psychology	8	3
Social studies	22	8
English	29	10
Other languages	8	3
Non-mathematics[a] composite	30	11
Other	4	2
No minor	69	25
Totals	271	100

[a]Most of these non-mathematics composites were in the areas of social studies and languages.

[1]See page 28.

Degrees Earned

Questions six, seven, and eight of the questionnaire asked the teachers to list the degrees they had earned. Nearly 64 per cent of the 271 respondents indicated that they held a Bachelor's degree in education. Most of these teachers also had another Bachelor's degree; the most common being the Bachelor of Arts held by 99 teachers and the Bachelor of Science held by 64 teachers. Table 6 reports the distribution of non-education bachelor's degrees held by the respondents.

Table 6

Distribution of Non-Education Bachelor's Degrees Held by Mathematics Teachers

Degree Held	Number of Teachers	Per Cent
Bachelor of Arts	99	37
Bachelor of Science	64	24
Bachelor of Commerce	3	1
Bachelor of Arts and Bachelor of Science	3	1
No Degree	102	37
Totals	271	100

The data from question eight showed that very few mathematics teachers held degrees higher than a Bachelor's. Only 9 per cent indicated that they had earned a Master's

degree or a graduate diploma. The most common of these degrees was the Master of Education held by 10 teachers and the Master of Arts held by 8 teachers. The distribution of non-Bachelor's degrees earned by mathematics teachers in the different size high schools is shown in Table 7.

Table 7

Distribution of Non-Bachelor's Degrees Earned by Mathematics Teachers in the Different Size Schools

Degree Earned	Size of School			Totals
	Small	Medium	Large	
Master of Arts	2	3	3	8
Master of Education	1	3	6	10
Master of Science	0	1	0	1
Master of Science and Doctorate	0	1	0	1
Graduate Diploma or Certificate	2	0	2	4
No Degree	68	108	71	247
Totals	73	116	82	271

A small increase in the number of teachers of mathematics holding Master's degrees can be expected in the near future. Approximately 20 per cent of the respondents replied that they had completed, or are

completing graduate work. However, only 4 teachers specified mathematics as their field of graduate study, so the acquisition of a master's degree by the other teachers will not necessarily mean an improvement in the academic mathematics background of the teachers. The most common field of graduate work reported by the mathematics teachers was education. Twenty-nine teachers or approximately half of those reporting their field of graduate work, specified areas in education (administration, curriculum development, educational psychology) as their field.

Some interesting results were obtained when mathematics teachers were classified as degree or non-degree teachers. Any teacher having at least one degree was classified as a degree teacher, and a teacher with no degree, a non-degree teacher. It was found that only 77 per cent of mathematics teachers were degree teachers. Further classification by size of school revealed that of the 61 non-degree teachers, only 13 per cent of them were teaching in large schools, but 46 per cent of them were teaching in small schools. Table 8 gives a summary of the number of degree and non-degree teachers in senior high schools in this province.

Table 8

Number of Degree and Non-Degree Mathematics Teachers in the Different Size High Schools

Classification of Teacher	Size of School			Totals
	Small	Medium	Large	
Degree	45	91	74	210
Non-degree	28	25	8	61
Totals	73	116	82	271

A chi-square test of the teachers in the different size schools on the basis of possession or non-possession of a degree revealed significant differences. Thus, the degree classification of teachers in larger schools was significantly better than the degree classification of the teachers in smaller high schools.

Period of Completion of Last Degree

Previous data indicated that very few (9 per cent) of the mathematics teachers responding to the questionnaire had completed higher than a Bachelor's degree. A study of the data in Table 9 helps explain the reason for this. Of the 271 respondents, 210 were teachers holding at least one degree. Fifty-one per cent of these mathematics teachers indicated that they had obtained their last degree since 1970, and only 9 per cent had earned their

last degree before 1965. As the table shows, the majority of degree holding teachers have only recently earned their last degree and consequently they have not had the time to pursue higher degrees.

Table 9

Period of Completion of Last Degree by High School Mathematics Teachers

Time Period	Number of Teachers	Per Cent
Since 1970	108	51
1965 - 1970	83	40
1960 - 1964	14	7
1950 - 1959	5	2
Before 1950	0	0
Totals	210	100

Classification by CUPM Recommendations

In 1966, the panel on teacher training of the Committee on the Undergraduate Program in Mathematics (CUPM) made recommendations for the academic preparation of senior high school mathematics teachers.[2] They recommended a minimum of 12 semester courses as follows: three courses in analysis, two courses in abstract

[2]See Appendix A.

algebra, two courses in geometry, two courses in probability and statistics, a course in computer science, and two courses in upper-level electives. Thus, the total coursework recommended is 36 semester hours.

Question twelve of the questionnaire asked teachers to indicate the number of semester courses they had completed in the areas of mathematics mentioned above. The semester hours equivalent for these courses was computed, and on the basis of this, teachers were classified into three categories. Type A teachers were those having more than 24 semester hours of the coursework recommended by CUPM; those who had 13 to 24 semester hours of the recommended coursework were classified as Type B teachers; and Type C teachers were those who had less than 13 semester hours of the recommended coursework. The results of this classification are shown in Table 10. It shows that almost half (44 per cent) of the mathematics teachers who participated in the study have from 0 to 12 semester hours (4 or less semester courses) of mathematics training. Thirty-nine per cent of the 271 teachers had backgrounds that put them in the Type A category.

Table 10

Number of Type A, Type B, and Type C Mathematics Teachers

Classification	Number of Teachers	Per Cent
Type A	105	39
Type B	46	17
Type C	120	44
Totals	271	100

Of the 105 Type A teachers, approximately 47 per cent had more than the minimum 36 semester hours of coursework recommended by CUPM. A breakdown of the Type C teachers revealed that 37 of the 120 teachers in this group had none of the coursework recommended by CUPM. This means that of the 271 respondents, slightly more than 13 per cent of them have no mathematics courses beyond an introductory first year course.

In an effort to see if the background of teachers in larger schools was significantly better than the background of teachers in smaller schools, the distribution of Type A, Type B, and Type C in the different size schools was investigated. Table 11 shows this distribution.

Table 11

Distribution of Type A, Type B, and Type C Teachers in the Different Size High Schools

Teacher Classification	Size of School							
	Small		Medium		Large		Totals	
	No.	%	No.	%	No.	%		
Type A	28	38	40	34	37	45	105	39
Type B	12	17	18	16	16	20	46	17
Type C	33	45	58	50	29	35	120	44
Totals	73	100	116	100	82	100	271	100

The table shows that in large high schools, a higher percentage than in small high schools are Type A teachers. The percentages of Type A teachers in large and small high schools are 45 and 38 respectively. Similarly, a smaller percentage of the teachers in large high schools than in smaller high schools are Type C teachers. A chi-square test was used to see if these differences among teachers in the different size schools were significant. The null-hypothesis assumed that there was no significant difference in the course background classification of teachers in the smaller schools and the course background classification of teachers in the larger schools. The value of chi-square was not

significant at the .05 level and there were no grounds for rejecting the null-hypothesis. This suggests that the course background classification of teachers in larger schools was not significantly better than the course background classification of teachers in the smaller high schools.

Recency of University Credits in Mathematics

The many new developments and changes in the high school mathematics curriculum in later years have made it clear that the recency of university credits in mathematics is a matter of great importance. Although it is possible for teachers to keep up-to-date through self-study, meetings, workshops and the like, it is unlikely that this happens very often. Thus, a necessary method of keeping current is by taking university level mathematics courses.[3]

In an attempt to determine the recency of such credits obtained by Newfoundland's mathematics teachers, the teachers were asked to indicate the period in which they last completed a university mathematics course. Table 12 illustrates the number of responses for each of the time periods included in question 13 of the questionnaire.

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[3]William E. Haigh, "Preparation of Senior High School Mathematics Teachers In South Dakota," (unpublished Doctoral dissertation, Indiana University, 1970), p. 78.

Table 12

Distribution of Mathematics Teachers According to Recency of Completion of Last University Mathematics Course

Time Period	Number of Teachers	Per Cent
Before 1965	38	14
1965 - 1967	36	13
1968 - 1970	93	35
Since 1970	104	38
Totals	271	100

As Table 12 shows, approximately 38 per cent of the respondents had completed a university course(s) since 1970, and another 35 per cent had completed course(s) during the period from 1968 to 1970. Thus, 73 per cent of the 271 teachers who replied to the questionnaire have had mathematics training in the past four years. Even more encouraging is the fact that only 38 teachers had not completed any courses since 1965.

Table 13 reports the number of Type A, Type B, and Type C teachers who completed a university mathematics course prior to 1968 as opposed to the number of teachers in these categories who had completed a course in the period 1968-1972.

Table 13

Period of Completion of Last University Mathematics Course for Type A, Type B, and Type C Teachers

Period of Completion	Number of Type A Teachers	Number of Type B Teachers	Number of Type C Teachers	Totals
Prior to 1968	13	12	49	74
1968 to 1972	92	34	71	197
Totals	105	46	120	271

The percentages of the Type A, Type B, and Type C teachers who had completed courses during the period of 1968 to 1970 were 88 per cent, 74 per cent, and 59 per cent respectively. A chi-square test of these three groups on the basis of the two time periods described revealed significant differences.

Thus, the teachers with the higher CUPM course background classification indicated more recent completion of university-level mathematics courses than did those teachers with lower CUPM classification.

Certificate Standing of Mathematics Teachers

Every teacher who teaches in the public schools of this province must be certified under the Education (Teacher Training) Act, 1968. Upon approval of the Teachers' Certification Committee, a teacher is awarded a certificate to teach designated as Certificate I,

Certificate II, . . . or Certificate VII depending on the coursework and degree qualifications of the teacher. For example, a teacher who has completed (1) an approved Bachelor's degree and a specified number of courses in education or (2) forty semester courses for an approved four-year teacher education program with two courses in English and eight courses in education, would be awarded a Certificate IV. Completion of two Bachelor's degrees or one Bachelor's degree and another year of coursework would qualify a teacher for Certificate V provided the specified number of education courses were completed. A Certificate VII, the highest issued, is not awarded until a teacher has completed at least one Master's degree or Doctor's degree in addition to all other coursework and undergraduate degree requirements.[4]

The researcher regarded the Certificate standing of mathematics teachers as another indicator of the degree of preparation of these teachers. It would be expected that the majority of the respondents would have Certificate IV or higher since a previous finding indicated that 77 per cent of the teachers had earned at least one degree which is the basic requirement for Certificate IV.

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[4]Newfoundland Teachers' Association, "Teacher (Certification) Regulations, 1972," Handbook, 1972-73, (St. John's, Nfld.: The Newfoundland Teachers' Association, 1972), pp. 18-27.

Furthermore, it would be expected that the teacher's certificate would be related to the CUPM classification since higher CUPM classification means that teachers have completed more courses. Table 14 reports the Certificate standing of Type A, Type B, and Type C teachers. As expected a majority (83 per cent) of the respondents had at least Certificate IV standing. The percentages of Type A, Type B, and Type C teachers with Certificate IV or higher were 97 per cent, 94 per cent, and 68 per cent respectively. A chi-square test of these groups on the basis of Certificate standing revealed significant differences. Thus, teachers with higher CUPM classification hold higher Certificates than do teachers with lower CUPM classification.

Table 14

Certificate Standing of Type A, Type B, and Type C Teachers

Certificate	Type A		Type B		Type C		Totals	
	No.	%	No.	%	No.	%	No.	%
I	1	1	0	0	1	-	2	1
II	2	2	2	4	14	12	18	7
III	0	0	1	2	24	20	25	9
IV	15	14	15	34	21	18	51	19
V	44	42	13	28	33	27	90	33
VI	37	35	13	28	21	18	71	26
VII	6	6	2	4	6	5	14	5
Totals	105	100	46	100	120	100	271	100

A classification of teachers by Certificate and size of school in which they teach is shown in Table 15. The percentages of teachers in small, medium, and large high schools with Certificate IV or higher were 70 per cent, 84 per cent, and 96 per cent respectively. A chi-square test revealed that these differences were significant, and it was concluded that teachers in the larger schools have higher Certificates than do the teachers in the smaller schools.

Table 15

Certificate Standing of Mathematics Teachers in the Different Size High Schools

Certificate	Small Schools		Medium Schools		Large Schools		Totals	
	No.	%	No.	%	No.	%	No.	%
I	1	1	1	1	0	0	2	1
II	12	17	4	3	2	2	18	7
III	9	12	14	12	2	2	25	9
IV	15	21	24	21	12	15	51	19
V	27	37	30	26	33	40	90	33
VI	8	11	37	32	26	32	71	26
VII	1	1	6	5	7	9	14	5
Totals	73	100	116	100	82	100	271	100

These findings indicate that most mathematics teachers have met a minimum standard (Certificate IV) as far as certification is concerned. However, in the light of the findings that only 40 per cent of these teachers have majors in mathematics, and only 39 per cent are classified as Type A teachers, it appears that these certificates were awarded on the basis of something other than their mathematics preparation. Because higher Certificates mean higher pay, it is possible that teachers took any course(s) that would get them a higher Certificate, and paid no attention to whether these courses were considered useful and necessary for mathematics teachers. Thus, the conclusion that a mathematics teacher with Certificate IV or higher is adequately prepared to teach mathematics, is not necessarily justified.

Age of Respondents

A classification of Type A, Type B, and Type C teachers by age is shown in Table 16. The data indicate that the 271 respondents are a relatively young group. Twenty-four per cent of the mathematics teachers who replied to the questionnaire were under 25 years of age and another 54 per cent were in the 25 to 34 age group. Only 10 per cent indicated they were over 44 years old. Assuming that the respondents continue to teach mathematics until retirement, this means that 90 per cent of

them will be teaching mathematics for another 15 to 20 years at least. Thus, a study of their backgrounds to determine how adequately they are prepared to teach present mathematics courses and cope with inevitable changes in the years ahead assumes added significance.[5]

Table 16

Classification of Type A, Type B, and Type C Teachers by Age

Age Group	Type A		Type B		Type C		Totals	
	No.	%	No.	%	No.	%	No.	%
Under 25	31	30	11	24	22	18	64	24
25 - 34	65	61	22	48	60	50	147	54
35 - 44	4	4	8	17	21	18	33	12
Over 44	5	5	5	11	17	14	27	10
Totals	105	100	46	100	120	100	271	100

The percentages of Type A, Type B, and Type C teachers who were less than 35 years old were 91 per cent, 72 per cent, and 68 per cent respectively. A chi-square test revealed that these differences were significant, and it was concluded that the younger teachers have a higher

[5]C. K. Bradshaw, "Mathematics Teaching in the Public Secondary Schools of the State of Nevada" (unpublished Doctoral dissertation, University of California, 1968), p. 75.

CUPM course background classification than do older teachers.

Mathematics Teaching Experience

To support the contention that the population was a very young group, teachers were classified according to the number of years they had taught mathematics at the high school level. By allowing 4 to 7 years for completion of university training; and by assuming that teachers spent no time at other jobs, it is reasonable to predict that a teacher who reaches age 35 will have from ten to fifteen years of experience. The data in Table 16 indicate that 22 per cent of the 271 respondents were 35 years old or older, and the data in Table 17 indicate that approximately 25 per cent of the respondents have 10 or more years experience. This is further evidence that the mathematics teachers in this province are indeed a very young group.

A chi-square test of these three groups on the basis of years of mathematics teaching experience showed significant differences. As was expected, the younger, Type A teachers had significantly less experience than did the older, Type B and Type C teachers.

Table 17

Years of Mathematics Teaching Experience of Type A, Type B, and Type C Teachers

Years of Experience	Number of Teachers			Totals	
	Type A	Type B	Type C	No.	%
None[a]	22	11	11	44	16
1 - 3	31	6	29	66	24
4 - 6	24	10	27	61	23
7 - 9	15	4	13	32	12
10 - 12	6	6	15	27	10
13 - 15	2	3	4	9	3
More than 15	5	6	21	32	12
Totals	105	46	120	271	100

[a]First year of teaching mathematics.

INTERESTS AND ATTITUDES TOWARD MATHEMATICS

This part of the study attempted to assess the interests and attitudes of high school mathematics teachers toward mathematics and mathematics teaching. In this regard questions were asked relating to plans for future coursework, enjoyment of teaching mathematics, assignment to present teaching situation, membership in professional organizations, publications read, and sponsoring of high school mathematics clubs.

Findings in the previous section on "Teacher Preparation" indicate that only 39 per cent of the high school mathematics teachers who participated in this study could be classified as Type A teachers. This means that only 39 per cent of the teachers came close to having the 36 semester hours of coursework recommended by CUPM for high school mathematics teachers. Even the teachers who had degrees, and majors in mathematics fell short of the recommended coursework in terms of the quality of courses completed. In another part of this study, the researcher will attempt to formulate some realistic and appropriate in-service measures to upgrade the course backgrounds of these teachers. However, in order to do this it is first necessary to get some indication of the interests and attitudes of these teachers toward mathematics.

Plans for Future Coursework

The developments and changes that are taking place in the high school mathematics curriculum require mathematics teachers at this level to keep current with the happenings in their field. For most teachers, one of the best methods of doing this is by taking university level mathematics courses.[6]

Question 15 of the questionnaire attempted to

[6]Haigh, op. cit., p. 84.

determine the future plans of the study population for taking more mathematics courses. In response to the question, "Do you have definite plans to take more mathematics courses in the next two years?", 89 respondents indicated yes, 176 indicated no, and 6 made no response. Those figures indicate that only 33 per cent of the respondents intend to keep abreast of current and future happenings in mathematics by taking courses. A complete tabulation of the responses given by Type A, Type B, and Type C teachers is shown in Table 18.

Table 18

Plan of Type A, Type B, and Type C Teachers to Take More Mathematics Courses in the Next Two Years

Response	Type A		Type B		Type C		Totals	
	No.	%	No.	%	No.	%	No.	%
Yes	34	32	13	28	42	35	89	33
No	69	66	33	72	74	62	176	65
No Reply	2	2	0	0	4	3	6	3
Totals	105	100	46	100	120	100	271	100

The data show that the percentages of Type A, Type B, and Type C teachers who answered "yes" to the question were 32 per cent, 28 per cent, and 35 per cent respectively. A chi-square test revealed no significant differences in

the answers of the three groups. It appears that interest in taking more courses in mathematics in the next two years is not related to the present course background of the teachers. A possible reason for this apparent lack of interest in taking additional courses is that almost 40 per cent of the teachers have completed at least one course since 1970, and another 35 per cent have completed courses since 1968. These teachers possibly feel no urgent need to take further courses in mathematics.

Method of Assignment to Teach Mathematics

An indirect indicator of the degree of interest a teacher has in mathematics, and mathematics teaching is the method of assignment to the present teaching situation. In an effort to determine this, question 20 asked "At whose request are you currently teaching mathematics?". Possible responses were:

a. Mine. I was hired to teach mathematics.

b. Mine. I was teaching other subjects and requested to teach one or more courses in mathematics.

c. My administrator's. I was teaching (or hired to teach) other subjects and he assigned one or more mathematics courses to me.

d. Other (specify) _____

As was expected, the more qualified teachers (Type A) were all hired to teach mathematics, or requested

to do so after teaching other subjects. Most of the Type B teachers were also teaching mathematics at their own request with only 20 per cent indicating assignment by some other method. The finding that 34 per cent of the less qualified (Type C) teachers were not hired, or did not request, to teach mathematics appears to be an indication that these teachers are lacking interest in the subject as well as adequate coursework preparation. On the other hand, the fact that 66 per cent of Type C teachers are teaching mathematics at their own request is possibly an indication that these teachers wish to continue teaching mathematics, and will become better prepared to do so. However, in

Table 19

Responses of Type A, Type B, and Type C Teachers to Question 20 (At Whose Request Are You Currently Teaching Mathematics?)

Response	Type A		Type B		Type C		Totals	
	No.	%	No.	%	No.	%	No.	%
Mine (Hired)	94	90	29	63	49	41	172	64
Mine (Requested)	11	10	8	17	30	25	49	18
Assigned by Administrator	0	0	2	4	23	19	25	9
Other	0	0	7	16	18	15	25	9
Totals	105	100	46	100	120	100	271	100

light of a previous finding that only 35 per cent of Type C teachers plan on taking more mathematics courses in the next two years, it is unlikely that there will be significant improvement in the course background of these teachers in the near future.

Enjoyment in Teaching Mathematics

A more direct indication of the interest were the responses to Question 21. This question was stated on the questionnaire in the following way:

Do you enjoy teaching mathematics?

_____ a. No. I would prefer not to teach it.

_____ b. I dislike it somewhat but feel that with additional preparation in mathematics I would enjoy it.

_____ c. I enjoy teaching it, but prefer teaching other subjects.

_____ d. I enjoy it and prefer teaching it above all other subjects.

_____ e. Other (specify) _____

Of the 271 respondents, 214 indicated that they enjoyed teaching mathematics above all other subjects. This represents nearly 80 per cent of the teachers who replied, and is an impressive finding in view of the fact that less than 40 per cent of these teachers have close to the 36 semester hours of coursework recommended by the

CUPM for high school mathematics teachers. It appears that lack of adequate subject matter preparation did not determine the degree of enjoyment of teaching mathematics for these teachers. Only 4 of the teachers, all Type C teachers, indicated that they felt additional preparation in mathematics would help them enjoy teaching mathematics. Twenty-six teachers answered "other" to this question, and indicated that they could not make a choice because they enjoyed teaching several subjects equally well (twenty teachers), or because they had not taught other subjects and had nothing with which to compare (six teachers). Table 20 illustrates the responses given to question 21 by Type A, Type B, and Type C teachers. A chi-square test revealed no significant differences between the groups.

Membership in NCTM

The value of the National Council of Teachers of Mathematics as an instrument for the continuing professional development of mathematics teachers has been discussed in Chapter II of the present study. Because the NCTM is a leading professional organization for high school mathematics teachers, it would be expected that a large number of the respondents would be members. However, the information contained in Table 21 indicates that this is not the case. Of the 271 respondents, only 21 indicated membership in the NCTM. The percentages of

Table 20

Responses of Type A, Type B, and Type C Teachers to Question 21 (Do You Enjoy Teaching Mathematics?)

Responses	Type A		Type B		Type C		Totals	
	No.	%	No.	%	No.	%	No.	%
a	0	0	0	0	1	1	1	
b	0	0	0	0	4	3	4	2
c	4	4	3	7	19	16	26	10
d	95	91	37	80	82	68	214	79
e[a]	6	5	6	13	14	12	26	9
Totals	105	100	46	100	120	100	271	100

Key to responses: a. No. I would prefer not to teach it.

b. I dislike it somewhat but feel that with additional preparation in mathematics I would enjoy it.

c. I enjoy teaching it, but prefer teaching other subjects.

d. I enjoy it and prefer teaching it above all other subjects.

e. Other

[a]Other responses consisted of "Enjoy mathematics and other subject(s) equally well" (20 teachers), and "Enjoy it, but haven't taught other subjects to make comparisons" (6 teachers).

Type A, Type B, and Type C teachers who indicated that they were members of the NCTM were 12 per cent, 7 per cent, and 4 per cent respectively. The use of the chi-square test revealed that these differences were significant. Thus, a greater number of Type A than Type B or Type C teachers were members of the National Council of Teachers of Mathematics.

Table 21

Number of Type A, Type B, and Type C Teachers Who Are Members of the NCTM

Response	Type A		Type B		Type C		Totals	
	No.	%	No.	%	No.	%	No.	%
Yes	13	12	3	7	5	4	21	8
No	92	88	43	93	115	96	250	92
Totals	105	100	46	100	120	100	271	100

Membership in NTA Mathematics Council

In 1970, representatives of Newfoundland's mathematics teachers, under the sponsorship of the Newfoundland Teachers' Association, formed a provincial Mathematics Council that is now an affiliate of the National Council of Teachers of Mathematics. It was hoped that this Mathematics Council would be a vehicle for the improvement of mathematics education in this province.

Question 23 asked teachers to indicate if they were members of the NTA Mathematics Council. The responses of the 271 mathematics teachers indicate that the membership of the Council does not include very many high school mathematics teachers. Only 54 teachers indicated they were members, and most of the other teachers did not appear to know very much about the Council, or regard it as being very effective. It appears that the Council has not been very effective in publicizing its existence, objectives and accomplishments.

Mathematics Clubs

Question 22 asked respondents to indicate if they were the sponsor of a mathematics club in their school. Since only 8 teachers, or approximately 3 per cent of the respondents, indicated sponsorship of a mathematics club, it can be concluded that this is not an activity in which high school teachers in this province engage.

Professional Publications

In question 25 of the questionnaire, teachers were asked to indicate the professional publications in mathematics which they read, and to specify whether they subscribed, read regularly, or read occasionally. The data from this question were regarded as another indicator of the interest mathematics teachers have in keeping up-to-date with developments in their field. Three publications

were listed by title, and space was provided for teachers to list other titles that they read. Publications listed were The Arithmetic Teacher, The Mathematics Teacher, and School Science and Mathematics because it was felt that these would be the ones most likely to be read by mathematics teachers.

The reading habits of mathematics teachers with respect to the three publications listed are shown in Table 22. Fifty-two per cent of the respondents indicated

Table 22

Professional Publications Subscribed to and Read by Mathematics Teachers.

	Publication					
	Mathematics Teacher		Arithmetic Teacher		School Science and Mathematics	
	No.	%	No.	%	No.	%
Subscribe	35	13	4	2	2	1
Read regularly	12	4	4	2	5	2
Read occasionally	95	35	41	15	36	13
Do not read or no response	129	48	222	81	228	84
Totals	271	100	271	100	271	100

that they either subscribed to The Mathematics Teacher or read it regularly or occasionally. This finding was anticipated since The Mathematics Teacher is published by the NCTM, and written specifically for secondary school mathematics teachers. The Arithmetic Teacher was read by 19 per cent of the respondents, and School Science and Mathematics by 16 per cent of the teachers.

Teachers were asked to list any other publications of a mathematical nature that they read. However, only a handful of teachers responded in this section of question 25. The American Mathematical Monthly, Scientific American, and the NCTM publication, Journal of Research in Mathematics Education were each mentioned twice.

Table 23 shows a classification of the reading habits of Type A, Type B, and Type C teachers with regard to The Mathematics Teacher. The data reveal that the percentages of Type A, Type B, and Type C teachers who did not read this publication were 38 per cent, 39 per cent, and 61 per cent respectively. A chi-square test of these groups on the basis of reading or non-reading of The Mathematics Teacher revealed significant differences. It was concluded that the teachers with the higher CUPM classification indicated a significantly higher degree of interest in this publication than did the teachers with lower CUPM classification.

Question 26 asked teachers if any of the publications

discussed in relation to Table 22 were available in their schools. The responses to this question provide a possible explanation of why such a small percentage of mathematics teachers read these publications: many teachers do not subscribe themselves, and 58 per cent of the respondents indicated that none of them were available in their schools.

Table 23

The Reading Habits of Type A, Type B, and Type C Teachers with Respect to The Mathematics Teacher

Response	Type A		Type B		Type C		Type D	
	No.	%	No.	%	No.	%	No.	%
Subscribe	18	17	8	17	9	8	35	13
Read regularly	5	5	3	7	4	3	12	4
Read occasionally	43	41	17	37	35	29	95	35
Do not read or no response	39	37	18	39	72	60	129	48
Totals	105	100	46	100	120	100	271	100

IN-SERVICE TRAINING OF SENIOR HIGH SCHOOL MATHEMATICS TEACHERS

The need for continuous in-service training is of paramount importance for mathematics teachers. Haigh makes the case for in-service this way:

> The extent to which innovations and exemplary practices make in-roads into high schools will depend on the kind and quality of in-service education programs that are provided. To continue to learn on the job is a professional necessity for mathematics teachers. Therefore, in-service education for these teachers must receive increased attention as a means to meet the demands being placed upon today's teachers.[7]

This section attempts (1) to analyse in-service activities that have contributed to the improved preparation of mathematics teachers, (2) to determine any specific deficiencies in the academic preparation of mathematics teachers, and (3) to identify possible sources and methods of in-service training.

Mathematics Courses Taken While Teaching

One of the best indicators of the degree to which mathematics teachers in this province have participated in in-service training is the number of university level mathematics courses they have completed since they first began teaching. This information was solicited from the teachers in question 14 which asked them to indicate the number of semester courses they had completed while teaching. A

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[7]Haigh, op. cit., p. 93.

summary of the number of courses taken by Type A, Type B, and Type C teachers is shown in Table 24. An inspection of the data in this table will show the extremes that are characteristic of in-service activity for mathematics teachers. On the one hand, over 40 per cent of the respondents have taken only one course, or no courses at all, since they began teaching. At the other extreme, it is

Table 24

Number of Mathematics Courses Taken by Type A, Type B, and Type C Teachers Since Teaching Career Began

Number of courses	Type A		Type B		Type C		Totals	
	No.	%	No.	%	No.	%	No.	%
None	45	43	15	33	39	33	99	37
One	4	4	2	4	7	6	13	5
Two	7	7	4	9	29	24	40	15
Three	3	3	3	6	6	5	12	4
Four	8	8	5	11	26	22	39	14
Five	2	2	1	2	3	3	6	2
Six	7	7	3	7	10	8	20	7
Seven	3	3	2	4	0	0	5	2
Eight	2	2	5	11	0	0	7	3
Nine or more	24	23	6	13	0	0	30	11
Totals	105	100	46	100	120	100	271	100

noted that approximately 40 per cent of the respondents had taken 4 or more courses, and 30 of the teachers in this group had taken 9 or more courses since they first began teaching.

Type A and Type B teachers were quite active in terms of number of courses taken. Twenty-eight per cent of the 105 Type A teachers, and 27 per cent of the 46 Type B teachers had completed 7 or more courses while in service. In terms of number of teachers taking courses, Type B and Type C teachers were the most active. The data in Table 24 indicate that 67 per cent of Type B and Type C teachers took some courses, but only 57 per cent of Type A teachers took at least one course. If the 271 respondents are taken as a group, then the data in Table 24 show that 63 per cent of that number took at least one mathematics course since they began teaching. Thus, it is possible that many of these teachers have reached their present level of academic preparation in mathematics by taking courses while teaching.

It is unlikely that the sole motivation for taking additional courses in mathematics was interest in the subject per se. Such factors as salary increments that go with gaining a higher Certificate by taking additional courses must be considered. Nevertheless, the findings discussed in the previous paragraphs indicate that a real effort has been made in the upgrading of the mathematics

background of over 60 per cent of the respondents. However, the fact that still only 39 per cent of the teachers (the Type A teachers) have backgrounds that approximate minimal CUPM recommendations, indicates the great need for the continuation of these efforts.

Other In-Service Activity

It appears from the answers given to question 27, (Has the school board you are now teaching with sponsored any in-service training in senior high school mathematics in your school district in the past two years?), that very little has been done at the school district level in the way of in-service training for mathematics teachers. Only twenty teachers indicated the occurrence of any in-service activity at the school district level, 182 teachers answered "no" or omitted the question, and 69 teachers indicated that they were not aware of what had happened in the past two years. Ten of the teachers who answered "yes" specified workshops as the type of in-service training, seven teachers reported committee meetings and three teachers did not specify.

Teaching Assignments

If in-service measures are to be effective in improving mathematics training, they must be related to the mathematics courses the teachers teach. Thus, it is necessary to know something about the courses that are

taught, and the teaching loads of the teachers responsible for teaching these courses. This information was obtained from the teachers through questions 16, 17, and 18 of the questionnaire.

The responses of the teachers to the question concerning the mathematics courses taught indicated that the main courses taught in the high schools of Newfoundland were algebra, geometry, trigonometry, and general mathematics. One hundred fifty-three of the 271 respondents taught grade ten algebra, 154 taught geometry in grade ten, 59 teachers taught general mathematics in grade ten, 144 taught grade eleven algebra, 125 taught a combined geometry-trigonometry course in grade eleven, 49 taught grade eleven general mathematics, and 10 teachers were involved in teaching business oriented mathematics courses to grade ten and eleven students. These figures show two things: (1) most teachers teach algebra or geometry, and (2) many teachers teach more than one mathematics course. Thus, it would be hoped that these teachers would have preparation in many areas of mathematics.

The data just cited indicate that a large number of teachers were involved in teaching a single course (154 taught geometry in grade ten, 153 taught algebra in grade ten). The data in Table 25 indicate that the major reason for this was that 27 per cent of the respondents were teaching only high school mathematics; the other 73 per

cent of the teachers taught other subjects in addition to high school mathematics. Thus, more teachers were required because only one teacher in every ten was teaching exclusively grade ten or eleven mathematics. The percentages of Type A,

Table 25

Responses of Type A, Type B, and Type C Teachers to Question 16 (Are You Now Teaching Any Subjects Other Than Grade Ten or Eleven Mathematics?)

Responses	Type A		Type B		Type C		Totals	
	No.	%	No.	%	No.	%	No.	%
Yes	69	66	34	74	96	80	199	73
No	36	34	12	26	24	20	72	27
Totals	105	100	46	100	120	100	271	100

Type B, and Type C teachers who were teaching exclusively high school mathematics were 34 per cent, 26 per cent, and 20 per cent respectively. A chi-square test of these groups on the basis of whether or not they taught courses other than high school mathematics revealed significant differences, and it was concluded that a larger percentage of Type A than Type B or Type C teachers were teaching only high school mathematics.

A further investigation revealed that 70 per cent of the sixty-nine Type A teachers who taught other courses were teaching (1) mathematics in lower grades, or —

(2) science. The 34 Type B teachers and the 96 Type C teachers who taught outside the area of high school mathematics, specified a wide variety of other courses. Twenty-three per cent were teaching mathematics in lower grades, 16 per cent were teaching science, 31 per cent were teaching two or more non-mathematics courses, and the remainder specified other courses such as religion, foreign languages, art, music, social studies, and English.

In a previous section of this chapter (p. 53) the fact that the majority of mathematics teachers were teaching in relatively small, central high schools was briefly discussed. At that time it was felt that because most of the schools were relatively small and contained five grades (central high schools), many of the teachers might be required to teach a variety of subjects and grades even if their preparation for such assignments were inadequate. In an attempt to see if this was actually the case, teachers in the different size schools were classified on the basis of what part of their total teaching time was allotted for high school mathematics courses. The data which are shown in Table 26 indicates that the percentages of teachers in small, medium, and large schools who taught high school mathematics on a full-time basis were 14 per cent, 15 per cent, and 53 per cent respectively. On the other hand, the percentages of teachers in the small, medium, and large high schools who were involved in teaching

high school mathematics for less than half their total teaching time were 49 per cent, 43 per cent, and 11 per cent respectively. In both cases, chi-square test revealed that these differences were significant. Thus, as was

Table 26

Distribution of Teachers in the Different Size Schools According to Time Spent Teaching High School Mathematics

Per cent of total teaching time	Size of School						Totals	
	Small		Medium		Large			
	No.	%	No.	%	No.	%	No.	%
0 - 24	4	6	14	12	4	5	22	8
25 - 49	32	43	36	31	5	6	73	27
50 - 74	17	23	35	30	16	20	68	25
75 - 99	10	14	14	12	13	16	37	14
100	10	14	17	15	44	53	71	26
Totals	73	100	116	100	82	100	271	100

expected, teachers in the smaller schools spent less time teaching high school mathematics courses than did teachers in the larger schools.

The information contained in Table 27 indicates that the percentage of total teaching time that is spent teaching high school mathematics varies according to teacher type. The percentage of Type A, Type B, and Type C teachers who were involved in teaching high school

mathematics for more than half their total teaching time were 76 per cent, 67 per cent, and 55 per cent respectively. The use of the chi-square test showed that these differences were significant, and it was concluded that the teachers with the better mathematics background taught more classes of high school mathematics.

Table 27

Distribution of Type A, Type B, and Type C Teachers According to Time Spent Teaching High School Mathematics

Per cent of total teaching time	Type A		Type B		Type C		Totals	
	No.	%	No.	%	No.	%	No.	%
0 - 24	3	3	2	4	17	14	22	8
25 - 49	22	21	13	29	38	32	73	27
50 - 74	32	31	8	17	27	22	67	24
75 - 99	12	11	11	24	14	12	37	14
100	36	34	12	26	24	20	72	27
Totals	105	100	46	100	120	100	271	100

The finding that 76 per cent of the more qualified, Type A teachers were involved in teaching high school mathematics for more than half their total teaching time is an indication that these teachers were being utilized to near maximum potential. However, the fact that 67 per

cent of Type B teachers, and 55 per cent of Type C teachers were teaching high school mathematics for more than half their time is cause for concern. It means that the teaching loads of 96 poorly prepared teachers consisted mainly of high school mathematics. This serves as an indication of the shortage of well qualified senior high school mathematics teachers in this province.

Strengths and Weaknesses of Mathematics Background

In order to formulate appropriate in-service measures for high school mathematics teachers, it is necessary to know the strengths and weaknesses of their mathematics background. In an attempt to determine any strengths and weaknesses, question 12 asked teachers to list the number of semester courses they had completed in specific areas of mathematics. Respondents were asked to list all first year courses separately since it was felt that this would make it easier for them to categorize their courses. However, for purposes of classifying teachers by number and kind of courses taken, these first year courses were ignored. This was done because in relation to the CUPM recommendations which were used in this study, such courses are considered part of high school mathematics and thus, a prerequisite for all other mathematics courses. By eliminating these first year courses, the researcher was able to determine the number of semester courses

completed in the areas of algebra, analysis, geometry, probability and statistics, and computer science. The mean number of semester hours earned in each area was computed for all teachers, and for teachers in the different size schools. These means were then compared with the minimum semester hours recommended by CUPM in each of the areas of mathematics. The results are shown in Table 28.

The information in Table 28 indicates that the mean number of semester hours earned by all teachers in all five areas of mathematics is less than that recommended by CUPM. The mean number of semester hours earned by the 271 respondents in higher algebra was 5.43, and this is fairly close to the six semester hours recommended by CUPM. Similarly, the mean of 8.85 semester hours accumulated in analysis approximates the minimum nine semester hours recommended by CUPM. Teachers in large high school had earned a mean of 6.14 semester hours of algebra, and a mean of 9.77 semester hours of analysis. Thus, the 271 respondents, and particularly those in the large high schools can be considered to have reasonably strong backgrounds in algebra and analysis.

The mean number of semester hours earned by the respondents in the areas of geometry, probability and statistics, and computer mathematics were 1.65, 2.12, and 1.03 respectively. Since these are well below the minimum recommended by the CUPM, it is obvious that the major

Table 28

Comparison of Mean Number of Semester Hours Earned in Algebra, Analysis, Geometry, Probability and Statistics, and Computer Mathematics with the CUPM Recommendations

Subject Area	Mean Number of Semester Hours				Semester Hours Recommended by CUPM
	Size of School			All Teachers	
	Small	Medium	Large		
Higher Algebra	5.14	5.12	6.14	5.43	6.00
Analysis	7.89	8.87	9.77	8.85	9.00
Geometry	1.64	1.50	1.90	1.65	6.00
Probability and Statistics	1.64	2.51	2.00	2.12	6.00
Computer Mathematics	1.25	1.11	0.69	1.03	3.00

weaknesses in the mathematics background of the respondents were in the areas of geometry, probability and statistics, and computer mathematics. The fact that geometry was determined to be a very weak area is disturbing because the majority of teachers teach geometry in grades ten or eleven.

The CUPM also recommended that teachers of high school mathematics should have completed six semester hours of upper class electives. The mean number of semester hours of upper class electives earned by the respondents was 2.09 and, as for other areas of mathematics, is well below the CUPM recommendation.

The distribution of total semester hours in each of the six areas of mathematics covered by the CUPM Level III recommendations is shown in Table 29. The cumulative totals in each area indicate that 114 teachers lacked the CUPM recommendation of six semester hours of algebra; 143 teachers did not have the CUPM recommended nine semester hours of analysis; 213 failed to have the recommended six hours of geometry; 196 did not have the six semester hours of probability and statistics; 215 failed to meet the recommended three semester hours of computer mathematics; and 204 teachers did not have the six semester hours of upper class electives recommended by CUPM.

A further investigation of the distribution of

Table 29

Distribution of Total Semester Hours in Algebra, Analysis, Geometry, Probability and Statistics, Computer Mathematics, and Electives

Semester Hours	Areas of Mathematics											
	Algebra		Analysis		Geometry		Probability[b]		Computer[c]		Electives	
	No.	Cum. No.[a]	No.	Cum. No.	No.	Cum. No.	No.	Cum. No.	No.	Cum. No.	No.	Cum. No.
0 - 2.99	82	82	72	72	193	193	168	168	215	215	179	179
3 - 5.99	32	114	23	95	20	213	28	196	25	240	25	204
6 - 8.99	89	203	48	143	51	264	68	264	26	266	50	254
9 - 11.99	15	218	13	156	0	264	1	265	4	270	4	258
12 - 14.99	43	261	54	210	7	271	5	270	1	271	13	271
15 or more	10	271	61	271	0	271	1	271	0	271	0	271

[a]Cumulative number of teachers

[b]Probability and Statistics

[c]Computer Mathematics

total semester hours in the six areas of mathematics revealed that 30 per cent of the 271 respondents had earned no credit in algebra; 27 per cent had no courses in analysis; 71 per cent were without a course in geometry; 62 per cent had no credit in probability and statistics; 79 per cent had completed no courses in computer mathematics; and 66 per cent had none of the recommended electives. This part of the investigation also revealed a startling fact: 42 teachers of high school mathematics had completed none of the coursework recommended by CUPM, and 5 of these teachers had not completed even a first year course.

Preferred Types of In-Service Training

Mathematics teachers were given an opportunity to express their opinions regarding the type of in-service training they preferred. Table 30 summarizes the responses of 254 teachers who answered the question on what they considered the most desirable type of in-service training. Summer courses were preferred by 78 teachers and evening courses by another 74 teachers as most desirable types of in-service training. Saturday courses, correspondence courses, and television courses were mentioned by a small number of teachers.

The respondents also indicated that there was a great need for Memorial University to offer mathematics

courses at the off-campus centers. Over two hundred teachers indicated that they felt there was a need for such courses.

Table 30

Mathematics Teachers' Preference of Type of In-Service Training

Type of Training	Number of teachers Showing preference
Correspondence courses in mathematics	19
Television courses in mathematics	33
Summer university courses in mathematics	73
Saturday courses in mathematics which would meet in a nearby location	28
Weekday evening courses in mathematics which would meet in a nearby location	74
Other[a]	27

[a]Other responses included:

"Go back to university for a year."

"Coursework not the answer."

"In-service training needed in more than academic subject matter."

NONRESPONDENTS

The findings of this study must be interpreted with the realization that they are based on the responses

of 81 per cent of the study population. It is possible that the answers of the nonrespondents would not correspond closely to the answers of the respondents, and the study would be biased in favour of one of the groups. Because the questionnaire was anonymous, and because there was very little data available to the researcher from sources other than the teachers themselves, no attempt could be made to determine the degree and direction of bias in this study.

In similar studies,[8,9] it has been determined that a strong bias exists in favour of the better prepared teachers. If this is the case in this study, then the findings show a more favourable picture of the mathematics preparation of high school mathematics teachers than would have been obtained with a 100 per cent response rate. Thus, the negative findings of this study assume added importance. If the bias exists in favour of the less prepared teachers, then the answers of the 65 better prepared nonrespondents would have shown, to some degree, a more favourable picture than was obtained from the answers of the 271 respondents. However, the 81 per cent who responded to the questionnaire, are even with the limitations mentioned above, a meaningful sample.

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[8]Haigh, op. cit., p. 114.

[9]Bradshaw, op. cit., p. 65.

SUMMARY

This chapter has presented an analysis of the responses to questionnaire items concerning (1) school environment, (2) preparation of mathematics teachers, (3) attitudes and interests toward mathematics and mathematics teaching, and (4) in-service training of mathematics teachers. The major findings will be summarized in Chapter V and recommendations based on these findings will be presented there.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this chapter is to present (1) a summary of the major findings revealed by an analysis of the data collected by means of the questionnaire, (2) the conclusions reached on the basis of these findings, and (3) recommendations directed toward overcoming some of the problems identified in (1) and (2).

SUMMARY

Purpose of the Study

This study was concerned with determining the current status of the preparation of senior high school mathematics teachers in the Province of Newfoundland and Labrador, and utilizing the information obtained to formulate appropriate in-service measures for these teachers.

Study Population

During the fall term of the 1972-73 school year, questionnaires were sent to 344 teachers who were listed in the records of the provincial Department of Education as teaching at least one course in grade ten or eleven mathematics. Nine teachers were later deleted from the

study population when it was learned that they did not meet the requirements for participation in this study. Thus, the final study population was fixed at 335 teachers. Responses were received from 271 of the teachers, and this return rate of 80.9 per cent was considered sufficient to allow the completion of the other phases of the study.

School Environment

Organizational patterns. Two main organizational patterns of secondary schools were noted: (1) the five year Central High School (grades 7-11), and (2) the three year Junior High School (grades 7-9) followed by a two year Regional High School (grades 10, 11). A relatively unimportant pattern noted was the All-Grade (K-11) School. It was found that 61 per cent of the respondents were teaching in Central High Schools, 36 per cent were teaching in Regional High Schools, and 3 per cent were teaching in All-Grade Schools.

School size. Schools with a total enrollment of more than 500 students were classified as large high schools, those schools with an enrollment of 200 to 499 students were classified as medium size schools, and any school with an enrollment of less than 200 students was classified as a small high school. The data from the questionnaire revealed that 30 per cent of the respondents

taught in large high schools, 43 per cent of the teachers taught in medium size schools, and 27 per cent in small high schools.

Preparation of Senior High School Mathematics Teachers

Undergraduate majors and minors. Forty per cent of the 271 respondents reported mathematics or a mathematics composite as their undergraduate major. Over 20 per cent had no major at all, and the remainder reported majors in a wide variety of fields. The number of mathematics majors as opposed to non-mathematics majors was not significantly greater in the larger high schools.

The American Association for the Advancement of Science (AAAS) recommended that the minors of high school mathematics teachers be in supporting areas (philosophy, logic, psychology, all areas of science) because this would lend support to the background of the teacher. Responses indicated that 17 per cent had a minor in mathematics, and 25 per cent of the teachers had minors in areas that could be considered as supporting areas for mathematics.

Degrees earned. Seventy-seven per cent of the respondents indicated that they had earned at least one degree. The most common degree reported was a Bachelor's in education which was held by 64 per cent of the teachers.

In addition, ninety-nine teachers had earned a Bachelor of Arts, and sixty-four teachers held a Bachelor of Science degree. Only 9 per cent of the 271 respondents reported their highest degree to be a Master's or Doctor's degree. When teachers were classified as degree teachers or non-degree teachers, it was found that there was a significantly greater number of degree teachers in the larger high schools than there was in the smaller high schools.

Period of completion of last degree. The majority of degree teachers have had little time to pursue higher degrees because they have only recently earned their last degree. Fifty-one per cent of the 210 degree teachers indicated that they had earned their last degree since 1970, and forty per cent had earned their last degree in the period from 1965 to 1970.

Graduate work. Fifty-four teachers reported that they had completed, or are now completing graduate work. Twenty-nine teachers specified education as their field of graduate work, four teachers specified mathematics, and the others named a wide variety of areas.

Classification by CUPM recommendations. The CUPM Level III recommendations[1] were used as guidelines to

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[1]See Appendix A.

classify the respondents as Type A, Type B, or Type C teachers. Mathematics teachers who had completed more than 24 semester hours of the coursework recommended by CUPM were classified as Type A teachers; those who had 13 to 24 semester hours of the coursework recommended by CUPM were classified as Type B teachers; and those teachers who had zero to 12 semester hours of the coursework recommended by the CUPM were classified as Type C teachers. The percentages of mathematics teachers classified as Type A, Type B, and Type C teachers were 39 per cent, 17 per cent, and 44 per cent respectively. A chi-square test revealed that the course background classification of teachers in the larger high schools was not significantly better than the course background classification of teachers in the smaller high schools.

Recency of university credits in mathematics. The recency of completion of university courses in mathematics is an indicator of how well teachers are keeping abreast of new developments in mathematics. It was found that 73 per cent of the 271 mathematics teachers had completed courses in the period of time from 1968 to 1972. The percentages of Type A, Type B, and Type C teachers who had completed mathematics courses in the time period from 1968 to 1972 were 88 per cent, 74 per cent, and 59 per cent respectively. A chi-square test of these groups on

the basis of taking courses from 1968 to 1972 as opposed to taking mathematics courses prior to 1968 revealed significant differences in favour of the teachers with the higher CUPM course background classification.

Certificate standing of mathematics teachers. The Education (Teacher Training) Act (1968) of Newfoundland gives the Teacher Certification Committee the authority and responsibility of certifying all teachers who teach in the public schools of this province. Teachers are awarded a Certificate to teach designated as Certificate I, Certificate II, . . . or Certificate VII depending on the coursework and degree qualifications of the teacher. The certificate standing of mathematics teachers was regarded as another indicator of their depth of preparation. The percentages of Type A, Type B, and Type C teachers who had Certificate IV or higher were 97 per cent, 94 per cent, and 68 per cent respectively. A chi-square test revealed that a larger percentage of Type A than Type B or Type C teachers hold Certificate IV or higher. A chi-square test also showed that the Certificate standing of teachers in the larger high schools was significantly higher than the Certificate standing of teachers in the smaller high schools. It was felt that the relatively high Certificate standing of the teachers (as a group) had been attained on the basis of courses

other than mathematics.

Age of respondents. It was found that the 271 respondents were a relatively young group. Twenty-four per cent of them were under 25 years old and another 54 per cent were in the 25 to 34 age group. Only 10 per cent of the respondents were more than 44 years old. The percentages of Type A, Type B, and Type C teachers who were less than 35 years old were 91 per cent, 72 per cent, and 68 per cent respectively. A chi-square test showed that the younger teachers had a higher CUPM course background classification than did the older teachers. It was noted that since the majority of the respondents were relatively young, they had many years of teaching ahead of them. Thus, a study of their preparation to teach mathematics assumes added significance.

Mathematics teaching experience. The number of years of mathematics teaching experience of the respondents supports the contention that they are a relatively young group. Seventy-five per cent of the respondents had less than 10 years of mathematics teaching experience and 40 per cent had less than four years experience. The younger, Type A teachers had significantly less mathematics teaching experience than did the older, Type B and Type C teachers.

Interests and Attitudes Toward Mathematics

In order to make proposals for in-service training, it was necessary to get some indication of the interest and attitudes of teachers toward mathematics and mathematics teaching.

Plans for future coursework. Only thirty-three per cent of the respondents indicated that they had definite plans to take more mathematics courses in the next two years. This was regarded as an indication that only one-third of the mathematics teachers in the high schools planned to keep abreast of current and future happenings in mathematics by taking more university mathematics courses.

Method of assignment to teach mathematics. An indirect indicator of the interest a teacher has in a particular subject is whether or not it was the teacher's wish to teach that subject. Eighty-two per cent of the respondents reported that they were hired to teach mathematics, or that they requested to do so after teaching other subjects. Only 18 per cent of the teachers indicated that they had been assigned to teach mathematics even though they had not requested the assignment.

Enjoyment in teaching mathematics. Nearly 80 per cent of the 271 respondents indicated that they enjoyed

teaching mathematics above all other subjects. This seems rather startling in light of the fact that only 40 per cent of the respondents had a major in mathematics, and only 39 per cent (Type A teachers) had close to the 36 semester hours of coursework recommended by CUPM for high school mathematics teachers. Only 4 teachers felt that this lack of preparation prevented them from enjoying the teaching of mathematics.

Membership in NCTM. Membership in organizations related to one's teaching field provides another means for professional growth of teachers. Since the National Council of Teachers of Mathematics (NCTM) is a leading professional organization for mathematics teachers, it was expected that many of the respondents would be members. It was disappointing to note that only 8 per cent of the respondents had membership in the NCTM. A chi-square test revealed that a larger number of Type A than Type B or Type C teachers were members of the NCTM.

Membership in NTA Mathematics Council. The Mathematics Council of the Newfoundland Teachers' Association (NTA) is a provincial organization for mathematics teachers at all levels. It was found that many teachers werenot even aware of the existence or purposes of this Council. Only 20 per cent of high school mathematics teachers indicated that they were members of the

Mathematics Council.

Mathematics Clubs. Respondents were asked to indicate if they sponsored a mathematics club in their school. Only 8 teachers stated that they were engaged in this activity.

Professional publications. Mathematics teachers were asked to list any professional publications in mathematics which they read. Almost 50 per cent of the respondents failed to indicate a single publication which they subscribed to or read. Fifty-two per cent of the mathematics teachers indicated that they subscribed to or read occasionally The Mathematics Teacher, 19 per cent of the teachers indicated The Arithmetic Teacher, and 16 per cent indicated School Science and Mathematics. A chi-square test revealed that the teachers with the higher CUPM course background classification showed a significantly greater degree of interest in The Mathematics Teacher than did the teachers with lower CUPM classification.

In-Service Training of Senior High School Mathematics Teachers

If well prepared teachers are to remain up-to-date, and if poorly prepared teachers are to improve their backgrounds in mathematics to an acceptable standard, there is a great need for planned programs of in-service education for all mathematics teachers. The data produced

in this section provided basic information which was used to make proposals for in-service education for mathematics teachers.

Mathematics courses taken while in service. In-service activity, as measured by the number of mathematics courses taken since teaching career began, has been characterized by extremes in this province. Thirty-seven per cent of the respondents have taken no courses, 40 per cent of the teachers have taken four or more courses, and 11 per cent have taken nine or more courses since they first began teaching. These findings indicate that a great effort has been made by teachers to improve their mathematics background, but since there are still many teachers who have nothing close to the CUPM recommended background, these efforts must continue.

Other in-service activity. Only 20 teachers indicated the occurrence of any in-service activity at the school district level. The most common type of in-service training specified by these 20 teachers was workshops.

Teaching assignments. The mathematics courses taught most frequently by the respondents were algebra, geometry, trigonometry, and general mathematics. Grade X algebra was taught by 153 teachers, Grade X geometry

was taught by 154 teachers, Grade X general mathematics by 59 teachers, Grade XI algebra by 144 teachers, a combined geometry-trigonometry course in Grade XI was taught by 125 teachers; and Grade XI general mathematics was taught by 49 teachers. This data indicated that most teachers were teaching more than one course; the most common being algebra and geometry.

Only 27 per cent of the 271 respondents were teaching exclusively grades X or XI mathematics. The other 73 per cent taught one or more courses in areas other than high school mathematics. A chi-square test revealed that a larger percentage of Type A than Type B or Type C teachers were teaching only high school mathematics courses.

It was found that the size of the school was a determining factor in whether or not teachers taught courses other than high school mathematics. The percentages of teachers in small, medium, and large high schools who taught only high school mathematics courses were 14 per cent, 15 per cent, and 53 per cent respectively. This indicates that possibly the organizational patterns in the smaller schools dictate that teachers must teach other courses in order to make up full class loads.

A further investigation of the class loads of mathematics teachers in high schools revealed that the percentages of Type A, Type B, and Type C teachers who

were teaching high school mathematics courses for more than half their total teaching time were 76 per cent, 67 per cent, and 55 per cent respectively. This means that the class loads of many poorly prepared teachers consisted mainly of high school mathematics courses. This is an indication of the shortage of well qualified mathematics teachers at the high school level.

Strengths and weaknesses of mathematics background. It was found that the 271 respondents have reasonably strong backgrounds in algebra and analysis; but are very weak in geometry, probability and statistics, and computer mathematics. The above conclusions were based on the following findings: (1) 114 teachers did not meet the CUPM recommendation of six semester hours of algebra; (2) 143 teachers did not meet the CUPM recommendation of nine semester hours of analysis; (3) 213 teachers did not meet the CUPM recommendation of six semester hours of geometry; (4) 196 teachers did not meet the CUPM recommendation of six semester hours of probability and statistics; and (5) 215 teachers did not meet the CUPM recommendation of three semester hours of computer mathematics. Further investigation of the distribution of total semester hours earned by the respondents revealed that 42 teachers of high school mathematics had not completed any of the coursework recommended by the CUPM.

The fact that geometry was determined to be a weak area is very alarming because geometry is one of the mathematics course most frequently taught in Newfoundland high schools. The finding that 42 teachers have absolutely no background in mathematics is equally alarming. Both findings serve to point out the urgent need for in-service training in all areas of mathematics, especially geometry.

An investigation of the mean number of semester hours earned by teachers in the different size schools revealed no consistent patterns. Only in the areas of algebra and analysis was the mean number of semester hours earned by teachers in the large high school significantly greater than the mean number of semester hours earned by teachers in the smaller high schools. The mean number of semester hours earned by the teachers in the large high schools in algebra and analysis also exceeded the CUPM recommendation for algebra and analysis.

Preferred types of in-service training. Summer university mathematics courses and weekday evening courses were indicated most frequently by the respondents as the most desirable types of in-service training. Correspondence courses, Saturday courses, and television courses ranked low as desirable types of in-service training. Over 200 of the respondents indicated that there was a need for Memorial University to offer mathematics courses at the

off-campus centers.

CONCLUSIONS

1. There is a critical shortage of well prepared senior high school mathematics teachers in Newfoundland. This shortage is evidenced by the findings that (a) sixty per cent of the teachers did not have a major in mathematics, (b) sixty-one per cent of the respondents had earned less than 25 semester hours of mathematics credits, (c) forty-two teachers had not earned a single semester hour of mathematics credit, (d) only four teachers had completed, or were completing, graduate work in mathematics, (e) the majority of the teachers lack preparation in one or more of the areas of mathematics, and (f) seventy-one per cent of the high school mathematics teachers had earned no credit in geometry, a course that the majority of them taught.
2. The shortage of adequately prepared teachers was evidenced in all size schools. Only in a few instances was it found that the teachers in the larger high schools were better prepared than the teachers in the smaller high schools.
3. There are serious gaps in the mathematics background of the majority of the teachers in all

areas of mathematics, especially geometry, probability and statistics, and computer mathematics. As a result of these gaps, very few teachers have the exact background that is recommended by the CUPM for teachers of high school mathematics. Furthermore, only 39 per cent of the teachers, the Type A teachers, can be considered to have backgrounds that even approximate the background recommended by the CUPM.

4. As a group, the better prepared, Type A teachers had the following characteristics: (a) they were all teaching mathematics at their own request, (b) they were the youngest teachers, and consequently the least experienced, (c) they had higher Certificate standing than the other groups, (d) they showed more interest in the NCTM and its publications than did the poorly prepared teachers, (e) they had more recently completed university training in mathematics than the other groups, and (f) they all enjoyed teaching mathematics.
5. The number of teachers with inadequate background in mathematics is not likely to decrease soon because the majority (67 per cent) of the teachers have indicated that they do not intend to take mathematics courses in the near future.
6. The majority of the respondents have shown little

professional orientation toward mathematics through membership in professional organizations and reading professional publications.

7. In-service opportunities for high school mathematics teachers were found to be limited to university on-campus courses. No evidence was found of a planned program of in-service at the school district level.
8. A great deal of misassignment of teachers was noted. It was found that only 27 per cent of the respondents were teaching exclusively high school mathematics. This means that some of the better prepared teachers were teaching other subjects, and less qualified teachers had to be brought in to teach the mathematics courses that could have been taught by qualified teachers if they hadn't been assigned to other areas.
9. The majority of the teachers were found to be teaching in relatively small (enrollment less than 500), central high schools (grades 7-11).
10. The majority (80 per cent) of the teachers indicated that they enjoyed teaching mathematics above all other subjects. Only 4 teachers considered that their lack of preparation prevented them from enjoying mathematics teaching.
11. The respondents are a relatively young group.

Thus, whatever training they have is recent, and their experience has been with teaching modern mathematics.

12. The majority (73 per cent) of the teachers have completed mathematics courses in the past four years, and 63 per cent have taken at least one course since they first began teaching. This is an encouraging finding because it indicates that most teachers have shown some interest in trying to improve their mathematics background.

13. The degree qualifications and Certificate standing of the respondents is relatively high in relation to the amount of mathematics coursework completed. This leads to the conclusion that these degrees and Certificates were awarded on the basis of other, non-mathematics coursework, because it was found that the majority of the mathematics teachers had several degrees and high certificates, but little academic mathematics training.

RECOMMENDATIONS

The summary in the first part of this chapter has served the first purpose of the study--to determine the current status of the preparation of senior high school mathematics teachers in Newfoundland and Labrador. The recommendations which follow will be directed toward the

second purpose of the study--to formulate appropriate in-service measures to improve the preparation of senior high school mathematics teachers in this province.

1. It is recommended that all concerned--high school mathematics teachers, school administrators, school board officials, Department of Education officials, Newfoundland Teachers' Association, Memorial University--be informed of the great need for in-service training programs for high school mathematics teachers. An essential ingredient of any program of in-service training is a realization of the need for such a program. This study has shown that there are many poorly prepared high school mathematics teachers in the province's schools, and that a real need for in-service programs does exist.
2. It is recommended that in-service training in algebra and geometry be initiated as soon as possible. It was found that training in these areas is very essential because most teachers teach algebra and geometry at the high school level. Teachers in these areas must be made aware of how limited their preparation is, and of the importance of upgrading. If in-service measures to up-grade these teachers cannot be provided at the school district level, then some form of assistance should be provided to allow them to get the necessary training at

a university.

3. It is recommended that a Mathematics Consultant with responsibility for secondary school mathematics be included as part of the staff of the provincial Department of Education. It is also recommended that school boards, whenever possible, should hire a Mathematics Consultant as part of their supervisory staff. These consultants should be individuals who have (a) a sound background in all areas of mathematics, (b) knowledge of current trends and happenings in mathematics education, and (c) experience in the teaching of mathematics at the high school level. Such people could provide the necessary guidance and leadership in organizing and operating successful programs of in-service training for high school mathematics teachers.
4. It is recommended that Memorial University through its division of Extramural Studies, offer mathematics courses particularly in algebra and geometry, at its off-campus centers. This could possibly be done by making use of the ETV facilities and/or the well qualified teachers referred to in the next recommendation.
5. It is recommended that teachers who have above average mathematics preparation be trained and utilized as instructors and directors of in-service

training programs in their local school districts. This study has shown that some highly trained teachers, teachers with from 50 to 75 semester hours of mathematics, are teaching in the high schools of this province. Such teachers are a potential source of instructors for localized programs of in-service.

6. It is recommended that small study groups be formed in areas where location and distance make it impossible for teachers to take formal courses during the school year. These study sessions could serve to help teachers up-date their preparation and also stimulate some interest in the reading of relevant professional publications.

7. It is recommended that all schools which are large enough should have a Mathematics Department, and as the head of that department, a well qualified mathematics teacher. This person in addition to organizing and administering the high school mathematics program could possibly assist in the hiring and assigning of mathematics teachers and try to ensure that qualified mathematics teachers are used to maximum potential. The department head could also be a leader and organizer of in-service activities, leading discussions, organizing study sessions, encouraging teachers to keep informed and up-to-date by organizing and maintaining a library of

professional mathematics materials in the school, keeping teachers informed on curriculum reform, and most of all, acting as a liaison between the school and the other levels of education in the province.

8. It is recommended that high school mathematics teachers have access to the publications of the National Council of Teachers of Mathematics (NCTM). Such NCTM publications as The Mathematics Teacher are a valuable resource for the teacher who wishes to keep current with happenings in the field of mathematics and they should be available to teachers in all schools.

9. It is recommended that all high school mathematics teachers be well informed on all matters relating to high school mathematics and high school mathematics teachers. Keeping teachers well informed should be one of the main functions of the NTA Mathematics Council.

10. It is recommended that teachers who have limited preparation in mathematics but wish to continue teaching mathematics should up-grade their mathematics background as soon as possible. If they refuse to up-grade, then they should be replaced as soon as more qualified teachers are available to fill their positions.

The final group of recommendations are not directly concerned with in-service training but have considerable relevance in that they suggest improvements in other areas that would do much to reduce the number of unprepared mathematics teachers and thus reduce the need for in-service measures.

11. It is recommended that a real effort be made by personnel responsible for assigning mathematics teachers in high schools to see that the well qualified teachers are used to maximum potential in teaching mathematics. This study has shown that many teachers have been misassigned. Highly qualified mathematics teachers have been assigned to teach in other areas, and because there was such a limited number of qualified teachers, other less prepared teachers had to be assigned to teach high school mathematics courses. It would appear that the number of poorly prepared teachers who teach high school mathematics could be reduced by re-assigning them to areas for which they are more qualified and replacing them by the qualified teachers who are teaching in other areas.
12. It is recommended that the 42 teachers who have not earned a single credit in mathematics be replaced. This can probably be done by adopting more careful assignment practices as discussed in

the previous recommendation.

13. It is recommended that personnel responsible for hiring mathematics teachers do all in their power to see that all high school mathematics teachers hired in the future have at least a major in mathematics.

14. It is recommended that Memorial University re-examine its course requirements for mathematics majors, and if necessary change them to ensure that a prospective teacher who completes a mathematics major will have as a minimum, the training recommended by the CUPM. This study has shown that many teachers, even those with a major in mathematics, lack sufficient coursework in all areas of mathematics, especially geometry, probability and statistics, and computer mathematics. This is primarily a result of the fact that many of the courses in algebra and analysis, and all courses in geometry and probability-statistics are optional courses, and courses in computer mathematics cannot be used to fulfill the requirements of a mathematics major. If these requirements for a mathematics major were brought more in-line with the recommendations of the CUPM, it would reduce the number of inadequately prepared mathematics teachers entering the teaching force. Changes in the

requirements might also mean that more mathematics teachers would qualify for, and participate in, graduate programs following their undergraduate training.

15. It is recommended that Teacher Certification requirements and procedures be re-examined with a view to improving them and ensuring that teachers will teach only in areas for which they are academically prepared. Under the present certification system a teacher is not certified as a teacher of a particular subject but is certified as a teacher who will be assigned to teach some subject by an administrator in a school. Thus, a teacher can end up teaching a subject for which he has no preparation. Some kind of Certification or Accreditation system should be adopted that would ensure that teachers of mathematics meet a minimum standard such as that recommended by the CUPM before they are Certified to teach mathematics.

Suggestions for Further Research

While this study was concerned with the subject matter preparation of mathematics teachers and its implications for in-service education, there are other areas of concern which came to light during the course of

the study that might be considered appropriate for further research. The researcher offers the following suggestions:

1. The study produced evidence of a great deal of misassignment of teachers in relationship to mathematics instruction. A study of the specific causes of such misassignment and of ways to remedy it could prove to be very useful.
2. This study was only concerned with senior high school mathematics teachers. A study of the subject matter preparation of mathematics teachers at other levels (elementary and junior high school) would be desirable because it would provide a complete picture.
3. An investigation into the possibility of adopting some kind of accreditation system in this province should be undertaken. Such a system would ensure that teachers teach only in areas for which they are prepared.

Concluding Remarks

This study has shown that a majority of senior high school mathematics teachers in Newfoundland are not adequately prepared to teach mathematics. They lack sufficient coursework in most areas of mathematics and in most cases do not meet the minimum recommendations of the CUPM. This is a serious situation and immediate, well-

planned in-service measures are necessary if the background of teachers is to be upgraded to even minimum standards.

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APPENDICES

APPENDIX A

RECOMMENDATIONS FOR LEVEL III

(Teachers of high school mathematics)

Prospective teachers of mathematics beyond the elements of algebra and geometry should complete a major in mathematics and a minor in some field in which a substantial amount of mathematics is used. This latter should be selected from areas in the physical sciences, biological sciences, and from the social studies, but the minor in each case should be pursued to the extent that the student will have encountered substantial applications of mathematics.

The minimum requirements for high school mathematics teachers should consist of the following:

(A) Three courses in analysis.

(B) Two courses in abstract algebra. The courses should include linear algebra as well as the study of groups, rings, and fields.

(C) Two courses in geometry beyond analytic geometry. These courses should be directed at a higher understanding of geometry of the school curriculum.

(D) Two courses in probability and statistics.

(E) In view of the introduction of computing courses in the secondary school, a course in computer science is highly recommended.

(F) Two upper-class elective courses. A course in the applications of mathematics is particularly desirable. Other courses suggested are introduction to real variables, number theory, topology, or history of mathematics. Particular attention should be given to laying groundwork for latter graduate study.[1]

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[1]Committee on the Undergraduate Program in Mathematics, Recommendations for the Training of Teachers of Mathematics (Berkeley, California: Mathematical Association of America, 1966), pp. 9-10.

APPENDIX B

QUESTIONNAIRE

Check the appropriate blank, or answer as otherwise indicated.

1. Age: under 25 ___; 25-34 ___; 35-44 ___; 45 or over ___.

2. Sex: male ___; female ___.

3. Type of school: Regional H.S. ___; Central H.S. ___; All-grade ___.

4. Total enrollment of the school: Less than 200 ___; 200-499 ___; 500 and over ___.

5. What is your present teaching certificate: I ___; II ___; III ___; IV ___; V ___; VI ___; VII ___.

6. Please list any Education (Bachelor) degree(s) you now hold.

   _____

7. Please list other Bachelor degree(s) you hold.

   _____

8. Please list any other degrees or diplomas not mentioned in number (6) or (7). _____

9. (a) In which year did you receive your last degree? _____.

   (b) This degree was obtained: In Newfoundland ___; Outside Newfoundland ___.

10. Please specify: (a) academic undergraduate major(s) _____.

    (b) academic undergraduate minor(s) _____.

11. If you have done graduate work, specify the field (e.g. mathematics)

    _____

12. Please list the number of courses you have completed in each of the following areas of Mathematics. "Course" refers to ONE semester of work. For example, if you have completed a full year course in Geometry, count it as TWO courses in Geometry. If you have trouble in classifying a course, please list it in category "h".

SUBJECT AREA	NUMBER OF COURSES
(a) FIRST-YEAR COURSES	_____
(b) HIGHER ALGEBRA. Includes Modern Algebra, Linear Algebra, Algebraic Structures.	_____
(c) ANALYSIS. Includes Analytic Geometry and Calculus, Calculus, Differential Equations, Advanced Calculus, Vector Analysis, Real Variables, Complex Variables, Calculus of Variation, Fourier Series, Metric Structures.	_____
(d) GEOMETRY. Includes Projective Geometry, Differential Geometry, Euclidean and Non-Euclidean Geometry, Topology.	_____
(e) PROBABILITY AND STATISTICS. Includes only those courses in Probability and Statistics taught by Mathematics Departments.	_____
(f) COMPUTER SCIENCE. Includes courses in Computer Mathematics and Computer Programming.	_____
(g) ELECTIVES. Theory of Equations, History of Mathematics, Number Theory, Numerical Analysis, Foundations of Mathematics, Set Theory, Logic.	_____
(h) OTHERS (specify any not included above) _____	

13. When did you last complete a university course in Mathematics?
Before 1965 ___; 1965-67 ___; 1968-70 ___; since 1970 ___.

14. How many SEMESTER courses in Mathematics have you completed since you first began teaching? ____

15. Do you have definite plans to take more Mathematics courses in the next TWO years? Yes ___; No ___.

16. Are you now teaching any subject(s) other than Grade X or XI mathematics? Yes ___; No ___.

17. If the answer to (16) is "yes", list the other subject(s) and the grade(s) to which you teach it.

SUBJECT(S)	GRADE(S)

18. Please indicate the percentage (approximate) of your teaching time spent on the following?

GRADE X	PER CENT	GRADE XI	PER CENT
Algebra	___	Algebra	___
Geometry	___	Geometry and Trigonometry	___
General Mathematics	___	General Mathematics	___
Other Mathematics courses (Specify)	___	Other Mathematics courses (Specify)	___
_____		_____	
_____		_____	

19. How many years have you taught Mathematics in Grades X or XI?
First time ___; 1-3 years ___; 4-6 years ___; 7-9 years ___; 10-12 years ___; 13-15 years ___; more than 15 years ___.

20. At whose request are you teaching mathematics?

___ Mine. I was hired to teach mathematics.

___ Mine. I was teaching other subjects and requested to teach one or more courses in mathematics.

____ My administrator's. I was teaching (or hired to teach) other subjects and he assigned one or more mathematics courses to me.

____ Other (specify) _____

21. Do you enjoy teaching mathematics? (Check one)

____ No. I would prefer not to teach it.

____ I dislike it somewhat but feel that with additional preparation in mathematics I would enjoy it.

____ I enjoy teaching it but prefer teaching other subjects.

____ I enjoy it and prefer teaching it above all other subjects.

____ Other (specify) _____

22. Are you the sponsor of a Mathematics Club in your school? Yes ___; No ___.

23. Are you a member of the Mathematics Council of the Newfoundland Teachers' Association? Yes ___; No ___.

24. Are you a member of the National Council of Teachers of Mathematics (NCTM)? Yes ___; No ___.

25. Please check the professional publications which you read and specify the frequency.

PUBLICATION	SUBSCRIBE	READ REGULARLY	READ OCCASIONALLY	DO NOT READ
Arithmetic Teacher	___	___	___	___
Mathematics Teacher	___	___	___	___
School Science and Mathematics	___	___	___	___
Other(s) (Specify)				
_____	___	___	___	___
_____	___	___	___	___

26. Are any of the publications mentioned in (25) available in your school? Yes ___; No ___.

27. Has the school board you are now teaching with sponsored in-service training in senior high school mathematics in the past TWO years?

Yes ___; No ___; Don't know ___.

28. If "yes", please specify the nature of the in-service training.

_____

_____

_____

29. Which of the following do you consider the most desirable type of in-service training? (Check only one)

___ Correspondence courses in mathematics.

___ Television courses in mathematics.

___ Summer university courses in mathematics.

___ Saturday courses in mathematics which would meet in a nearby location.

___ Weekday evening courses in mathematics which would meet in a nearby location.

___ Other (specify) _____

_____

_____

_____

30. Have there been any university mathematics courses (other than those offered on-campus at Memorial) offered in your area in the past TWO years?

Yes ___; No ___; Don't know ___.

31. Do you feel that there is a need for university mathematics courses to be offered in your area?

Yes ___; No ___.

APPENDIX C

LETTER OF TRANSMITAL

November 20, 1972

Dear Mathematics Teacher:

The attached questionnaire will give information to be used for a Master's thesis concerning the preparation of senior high school mathematics teachers in Newfoundland. Your responses are necessary because your experience with mathematics will contribute significantly to an analysis of some of the problems in the area of high school mathematics education.

The study is concerned with (1) determining the current status of the preparation of mathematics teachers in the senior high schools of Newfoundland, and (2) utilizing the information obtained to formulate realistic programs of in-service education in mathematics. It is hoped that this study will lead to some recommendations which could improve the mathematics program in the province.

It will be appreciated if you can find the time to complete the questionnaire as soon as possible, and return it in the stamped, self-addressed envelope enclosed. The questionnaire is anonymous, and none of the information can be associated with an individual or a school. The only interest of the researcher is in the composite data.

I wish to thank you in advance for your participation in the study and, also, express my appreciation for the time you devote to the consideration of the questionnaire. Your prompt return of the questionnaire will contribute to early completion of other phases of the study.

Sincerely yours,

Fred N. Denty

Enclosures

APPENDIX D

FOLLOW-UP LETTER[1]

December 2, 1972

Dear _____:

About two weeks ago a questionnaire was sent to the grade X and XI mathematics teachers in your school. This questionnaire will give information to be used in a study concerning the preparation of high school mathematics teachers in the province. To date, the overall return has been very favourable, but it would be desirable to have near 100 per cent return before tabulating the results and drawing conclusions.

Because of the nature of the study, it was considered advisable to have the questionnaire anonymous. Thus there is no way of knowing who did, or did not return the questionnaire. It is in this connection that I solicit your help and cooperation. Would you please mention the questionnaire to the teachers involved from your school (the names are listed below) and ask them to take a few minutes of their time to complete and return the questionnaire if they haven't already done so? If they have returned it, please express my sincere thanks to them for their valuable assistance in the completion of this study.

Thank you for your cooperation.

Sincerely yours,

Fred N. Denty

_____ _____

_____ _____

_____ _____

_____

[1]This letter was addressed to the Head of the Mathematics Department or the Principal of the school.