A study of selected characteristics of the public secondary mathematics teachers of Montana
by Terrance Ralph Cypher

A thesis submitted in partial fulfillment of the requirements for the degree of DOCTOR OF EDUCATION
Montana State University


Abstract:
The purpose of the study was to delineate selected characteristics of the secondary mathematics teachers of Montana and to ascertain some of the needs felt by these teachers relative to their teaching. The results were compared with the results of two earlier studies in Montana and selected studies completed in other states.

The schools were divided into four categories by the number of students, 1-99 students, 100-399, 400-899, and 900 or more. Two-thirds of the mathematics teachers from each school size were randomly selected. This provided a sample of 353 teachers that taught at least one mathematics class in grades 9 through 12 in the Montana public schools during the 1976-77 school year. Data were collected in two ways. The first was the mathematics preparation of the teachers which was determined from the transcripts on file at the Certification Office of the State Office of Public Instruction or from the transcripts at the state colleges or universities. The second was from a questionnaire mailed to the teachers of which 255 usable questionnaires were returned.

Some results of the study of the surveyed mathematics teacher population were as follows: 12.3 percent of the teachers did not have an endorsement in mathematics; 10.6 percent had less than 15 credit hours of mathematics and 18.9 percent had fewer than 30 quarter hours of mathematics preparation; few met the CUPM recommendations for their teaching level; mathematics preparation of general mathematics teachers was significantly less than non-general mathematics teachers; many teachers had more than five classes per day; 64 percent of teachers had some type of extra curricular activity; 54 percent of the teachers had taken some type of NSF financed course; 23 percent did not plan to teach mathematics for the next five years; about 80 percent felt a need for a course guide for the high school mathematics | courses.

The following are some of the recommendations arrived at by the researcher: a full time mathematics supervisor should be employed by the State Office of Public Instruction; a set of course guides should be developed for secondary mathematics courses; an endorsement in mathematics by the State Office of Public Instruction should consider the mathematics courses taken as well as the total credit hours completed; in-service courses should be continued by the colleges and universities; a computer course should be required of mathematics majors and minors.

# A STUDY OF SELECTED CHARACTERISTICS OF THE PUBLIC SECONDARY MATHEMATICS TEACHERS OF MONTANA

by

TERRANCE RALPH CYPHER

A thesis submitted in partial fulfillment
of the requirements for the degree

of

DOCTOR OF EDUCATION

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December, 1977

# ACKNOWLEDGMENTS

The preparation of a thesis requires the support of many people. The response by the Montana high school mathematics teachers was greatly appreciated. The cooperation of the registrars of U of M, MSU, EMC, NMC, and WMC was invaluable.

I am also indebted to my graduate committee. Dr. Robert Thibeault, Chairman of the Department of Educational Services, and Dr. Adrien Hess, Professor of Mathematics, provided guidance and encouragement. I am also grateful for the assistance of professors Robert Van Woert, Eric Strohmyer, and Eldon Whitesitt.

The assistance of the State Office of Public Instruction, in particular, Dr. John Voorhis and Mr. Larry Thomas, is greatly appreciated.

Finally, to my wife and sons, my deepest thanks. Without your encouragement, none of this would be possible.

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# ABSTRACT

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# Chapter 1

## INTRODUCTION

American secondary education has gone through many changes since its founding. In the late seventeen hundreds and early eighteen hundreds the students generally came from the upper levels of society; this has given way to the current open door policy where all levels of society are represented (Butler, 1970:4). This has necessitated a primary philosophical change. The schools must now prepare those students that are college bound, those that are bound for a trade school, and those for which this is their last formal training. Nowhere is this change more apparent than in the field of mathematics.

In the early days of our country the need for mathematics was not great. Farmers needed little beyond the ability to add and subtract. Other occupations needed skills in measuring, changing of money and working with a few simple fractions. This simplicity has disappeared in the past two hundred years. We are now living in a much more complex society where people need a higher degree of mathematics literacy. Almost all people are faced with the problems of commerce, such as borrowing money, paying income taxes and property taxes, buying and selling stocks and bonds. We are also bombarded on all sides with statistical studies, and a person unversed in statistical methods cannot make intelligent decisions about these studies. As an example, consider the conflicting reports

on cancer research of today.

The Past Thirty-five Years

During World War II the high school mathematics program was found to be inadequate because of the deficiencies discovered among inductees into military training (Butler, 1970:27). A weakness in mathematics was also felt as a result of Sputnik. In the past thirty-five years many different committees and study groups have been formed to help alleviate the deficiencies in mathematics and science. The main emphasis of these committees and study groups has been on the curriculum of the schools from the grade schools through college.

In 1950 the National Science Foundation (NSF) was authorized by an Act of Congress. The Foundation had two functions: (1) support research and education through grants, and etc., and (2) the develop- of national science policy. The Foundation has had a significant effect on mathematics education by supporting summer and year long institutes for high school and college teachers. They have also supported in-service institutes for teachers from all levels, as well as for groups doing research on and development of materials for teaching.

In 1953 the Mathematical Association of America appointed the Committee on the Undergraduate Program (CUP). The committee was

"to consider the problems of making available in our society the values of modern mathematics "and" to attack the problem with broader scientific and cultural objectives than could be expressed through another mere study of curriculum revision." This committee was later dismissed so that a new committee with a broader program could be formed. This was the Committee on the Undergraduate Program in Mathematics (CUPM) which was formed in 1959 (Butler, 1970:32). The CUPM operated under a major grant from the NSF and has conducted extensive investigations through its specialized panels. From these investigations have come recommendations on teacher training where CUPM has suggested the types of courses that teachers need in order to teach elementary school mathematics, through Algebra 1 and through senior high school mathematics. The CUPM also issued a commentary on mathematics textbooks that could be used for the undergraduate preparation of elementary teachers. The CUPM has also issued recommendations on the undergraduate mathematics programs for engineers, physicists, research mathematicians, potential students of graduate mathematics, and other programs relying heavily on mathematics for their disciplines.

In 1956 the Board of Directors of the National Council of Teachers of Mathematics appointed the Secondary School Curriculum Committee to make a comprehensive and critical study of the curriculum and instruction of mathematics in secondary schools with relation to

the needs of contemporary society (Butler, 1970:31). The committee work was carried out by subcommittees appointed to undertake studies in each of the following areas:

1. The place of mathematics in a changing society and the implications of contemporary mathematics
2. The aims of mathematics education and the pedagogy of mathematics
3. The nature of mathematics taught in grades 7 to 12
4. How geometry should be introduced and developed
5. Content and organization of junior high school mathematics
6. Foreign mathematics programs
7. Adjustment of the mathematics program to students of average and below-average ability
8. Aids to teaching
9. The organization of the mathematics program
10. The administration of the mathematics program
11. Programs of instruction for the mathematically gifted pupil

The report of this committee was published in the May, 1959, issue of The Mathematics Teacher, pp. 389-417.

In the summer of 1963, a group of mathematicians and users of mathematics gathered in Cambridge, Massachusetts, under the auspices of Educational Services Incorporated and the National Science Foundation. The task of the conference was "exploratory thinking with a view to a long-range future (Educational Services, 1963:3)." The principal result of the conference was a curriculum for elementary schools K-6 and a curriculum for grades 7-12. The end result of this program would be a student comparable in mathematics to a three-year college student of today; that is, he would be expected to have the equivalent of two years of Calculus, and one semester each of Modern Algebra and

Probability Theory (Educational Services, 1963:11). An outgrowth of this first conference was a second one held in 1966 called the Cambridge Conference on Teacher Training which met at Pine Manor Junior College in Brookline, Massachusetts. This conference was attended by persons holding university positions or equivalent in pure or applied mathematics or statistics (Educational Development Center, 1967:11). From this group came the report titled "Goals for Mathematical Education of Elementary School Teachers."

The above paragraphs illustrate a variety of exploratory projects related to the improvement of mathematics curricula and courses. Many of these projects were supported by the National Science Foundation, but a number of them were supported by other means. Three projects that have had a marked influence on the mathematics curriculum are the CUPM, the University of Illinois Committee on School Mathematics (UICSM) and the School Mathematics Study Group (SMSG). The CUPM held many conferences around the country on different phases of mathematics and they have made recommendations on teacher qualifications at the different levels. The CUPM recommendations on college courses have been used by textbook companies to determine the level of their text. Participants in the SMSG project have written many texts on all levels of mathematics through the high school level. The UICSM project was one of the first of the groups to start writing textbooks to improve

the teaching of secondary mathematics. The UICSM texts were not available to the general public until 1958; before this the teachers that used the texts were required to receive training in the program before they could use them (NCTM, 1963:58).

## Mathematics Improvement Projects in Montana

There have been several efforts made to improve the teaching of mathematics in the state of Montana. The National Science Foundation has sponsored summer institutes at the University of Montana and at Montana State University. The University of Montana also held several summer institutes for college teachers. The NSF sponsored a project for writing of materials for low achievers in cooperation with the Butte school system. The NSF also made money available through a grant to the Superintendent of Public Instruction's Office for in-service courses to be taught at a number of locations around the state. Mathematics laboratory materials were developed by a group meeting in Columbus, Montana, in the summers of 1974 and 1975 with money furnished by ESEA Title III.

## Statement of the Problem

The problem of this study was to delineate selected characteristics of the Montana secondary school mathematics teachers and to ascertain some of the needs felt by these teachers relative to their

teaching of mathematics during the school year 1976-77. This study also incorporated data on the qualifications, professional activities, and teaching assignments of the mathematics teachers in Montana secondary schools.

Related Studies in Montana

Christman did a study in 1949-50 on other subject areas taught by mathematics teachers, and he also did some work with the qualifications of the mathematics teachers in Montana. Christman (1950:222-227) found 24 percent of the mathematics teachers taught only mathematics, 36 percent taught in two fields, 35 percent in three fields, and 4 percent in four fields, and one percent in five fields. The fields taught most frequently in combination with mathematics by the teachers of mathematics in Montana were found to be physical science, physical science and biological science, social studies, science and social studies, and science and physical education, in that order. He also found the average age of the mathematics teacher to be 40: the average for the women teachers was 46 years and for men was 38 years. The Christman study also found approximately 20 percent listed the master's degree as the highest degree held, but there were 2 percent of the teachers that did not hold a college degree. Fifty-one percent of the teachers of mathematics in Montana received their degree in Montana. A median of 12 years experience was found; only

3 percent had over 35 years while 13.7 percent had less than one year.

In 1970-71 VonKuster conducted a study on the opinions of the mathematics teachers in Montana that graduated in 1960 or after relative to their preparation programs for teaching secondary school mathematics. He considered only those teachers that graduated from a Montana college or university. The study included 159 Montana mathematics teachers (VonKuster, 1971:13-14). In this study 121 of the teachers had a mathematics teaching major and 29 a mathematics teaching minor out of the 159 teachers. This data could be misleading if taken by itself since some people were eliminated from the study because they had little college credit in mathematics or had their degrees from out of state (VonKuster, 1971:13,14,37). According to VonKuster (1971:77) many of the teachers would require the same number of mathematics courses as they had taken but would like to see history of mathematics, number theory, and other courses in the program instead of so much calculus; also a few suggested that computer programming courses be included in the mathematics teacher training program.

Related Studies in Other States

There have been a number of different studies in other states dealing with the characteristics of the mathematics teachers. A study by Bradshaw (1968:212) in Nevada found 52 percent of the teachers had fewer than 18 semester hours of mathematics credit and taught 38

percent of the mathematics students. He also found that 26 percent of the high school teachers had close to the approximate CUPM recommended mathematics preparation (see Appendix A). Regula (1965:187) found a similar situation in West Virginia where 31.7 percent of the secondary mathematics teachers had inadequate preparation on the basis of 18 semester hours of undergraduate preparation. His study also found 8.8 percent with no mathematics credit and 11.2 percent with from 1 to 11 semester hours of credit in mathematics. VanWoert (1969:92-93) found that the secondary mathematics teachers in Idaho that taught in the small schools had less preparation and more classes to teach than the mathematics teachers in the larger schools. A later study by Bertram (1971:23-124) of secondary mathematics teachers in Indiana found the median preparation of teachers to be 34.8 semester hours with 63.8 percent holding a master's degree. The better qualifications of the Indiana teachers could probably be attributed to the fact that 55.9 percent of the teachers had attended some type of NFS supported institute.

In the studies from Nevada and West Virginia it was found that approximately 20-25 percent of the teachers belonged to the National Council of Teachers of Mathematics (NCTM) but in Indiana 40 percent were members of NCTM (Bertram, 1971:129) (Bradshaw, 1968:203) (Regula, 1965-193).

In the studies from West Virginia and Nevada a high percentage of the teachers, 70 and 80 percent respectively, planned to take more college credit in the near future (Regula, 1965:191) (Bradshaw, 1968:204). In the study by Regula (1965:192) it was also found that only one-third of the mathematics teachers working on a master's degree were taking any courses in mathematics.

Need for and Benefit of the Study

There have been many study groups, textbook writing groups, and academic year and summer institutes in mathematics in the last twenty years with the objective of improving the teaching of mathematics, and there no doubt will be other efforts of this type in the future. At the present time when there does not appear to be a shortage of teachers of mathematics and when there are increasing budgetary problems, it seems that there is a need to consider the mathematical preparation, work load, and etc. of the teachers of mathematics in Montana, because the teacher probably has more effect than any one other factor on the mathematics attainment of students.

There are problems with the assignment of teachers in Montana schools. In the school year 1975-76 there were thirty teachers teaching mathematics without an endorsement in mathematics (Office of Public Instruction, 1976:3).

The report of the National Advisory Committee on Mathematical

Education (NACOME) states there is a need for more information on the preparation of mathematics teachers (Conference Board of the Mathematical Science, 1975:82,144). The teacher training institutions should benefit from this study by finding out what courses the teachers feel are necessary for the teaching of mathematics.

There have been several studies and reports made of secondary mathematics in Montana since 1968. A report of the meeting of the State Mathematics Study Committee recommended experienced, interested, and qualified teachers for the general mathematics classes (Office of Public Instruction, 1969a:19). The report further stated that the teachers should employ a laboratory approach, problem solving, and provide a variety of relevant instructional material.

In the spring of 1969 a "Survey on the Preparation of Secondary Mathematics Teachers" was made (Office of Public Instruction, 1969b: 1). The findings of this report indicated that 56.9 percent of the respondents wanted preparation in topology and 46 percent wanted preparation in complex analysis. However, the way the statement was stated may have been misleading. The statement was "The training that I received in preparing to become a secondary mathematics teacher was deficient in the areas checked." Some teachers may have checked these subjects even if they did not feel a need for them. In August of 1973 the Montana Commission on Mathematics Education sent a

questionnaire to junior high and senior high teachers. In this survey of 46 secondary teachers, 14 had 6 classes per day and the average number of preparations per day was greater than 4 (Allinger, 1974:5). Fifty percent of the teachers felt that the general mathematics course currently being taught in their district was either poor, inadequate, or in need of change (Allinger, 1974:5). This report also stated that mathematics teachers often graduated from college without knowing basic high school algebra and trigonometry (Allinger, 1974:8).

The present study was undertaken to see where Montana is at this time in the teaching of mathematics. It was also hoped that this study would be able to give direction to what might be needed to improve the teaching of mathematics in Montana.

General Questions to be Answered

This study answered a number of questions about the characteristics and assignments of the teachers of secondary mathematics in the state of Montana. A list of these questions includes:

1. What type of certification do the mathematics teachers possess?

2. What are the areas of endorsement of the mathematics teachers in Montana?

3. What is the mathematics preparation of the secondary

mathematics teachers in the state of Montana and how does their preparation compare to the 1971 CUPM level III recommendations?

4. Do the teachers of mathematics differ in their mathematics preparation between the four different size schools?

5. Where did the mathematics teachers of Montana receive their undergraduate degrees?

6. Do the teachers of general mathematics differ in their mathematics preparation between the different size schools? (The schools were divided into the class size of those from 1-99, 100-399, 400-899, 900 or higher. Preparation was defined as the quarter hours of mathematics of college algebra or above.)

7. Do the general mathematics teachers differ from other mathematics teachers in the number of years of experience within the three larger classes of secondary schools? (A general mathematics teacher is any teacher teaching at least one general mathematics class.)

8. Is there a difference in the mathematics preparation of the teachers that took their undergraduate degrees prior to 1966 and those that received their degree from 1966 through 1976?

9. What percent of the mathematics teachers of Montana are women?

10. Is there a difference in the total years of experience of

the teachers by the size of the school? Is there a difference in the years of experience at the present location of teachers by the size of school?

11. What is the average age of the mathematics teachers in Montana?

12. How many classes and different preparations per day do the mathematics teachers have? How much preparation time per day? Are there differences by the size of school?

13. How many student contacts do the teachers have per day and does this vary with size of the school? (A class of 24 students is 24 student contacts.)

14. How do the mathematics teachers compare with the CUPM Level II-J and Level III recommendations?

15. What are the extra-curricular activities that the teachers are assigned, and how much time is spent on them?

16. What types of courses do mathematics teachers take to renew their teaching certificates?

17. Do the mathematics teachers plan to take any more course work in mathematics?

18. Have the mathematics teachers attended NSF sponsored courses?

19. What mathematics courses do the mathematics teachers feel

are essential in order to teach secondary mathematics?

20. Do the mathematics teachers enjoy teaching mathematics, or would they rather teach a different subject?

21. When did the teachers of mathematics decide to become mathematics teachers?

22. Do the mathematics teachers plan to stay in mathematics teaching, teach a different subject, go into administration or leave the field of education?

23. Do the secondary mathematics teachers feel there is a need for course outlines to be furnished for the secondary mathematics subjects, and if so, who should be responsible for the outline?

24. Do the mathematics teachers feel a need for help in keeping up with new materials and programs being developed, and who do they feel should furnish this help?

25. To what professional mathematics organizations do the teachers belong and do they read the journals from these organizations?

26. How do the results of this study compare with Christman's study in 1949-50 and VonKuster's study in 1970-71?

General Procedures

In order to answer the above questions, data were collected in two ways. A questionnaire was developed to be filled out by the mathematics teachers of grades 9 through 12 in the Montana public

schools. The questionnaire was sent to two-thirds of the mathematics teachers in each class of school. The mathematics teachers were determined from a list of mathematics teachers of Montana compiled by the Mathematics Supervisor of the State Office of Public Instruction. A teacher was classed as a mathematics teacher if he taught one or more classes of mathematics in grades 9 through 12. A second form was developed to record information on the degrees held and mathematical training of the teachers in the sample. This information was obtained from the certification records in the Office of Public Instruction and from the registrars of the Montana colleges and universities. Due to the regulations on confidentiality of information, names could not be associated with this information.

The information received from these sources was then analyzed to answer the questions. Chapter 3 will give more detail on the procedure.

## Limitations

The study is limited to public school mathematics teachers as listed by the Science and Mathematics Supervisor of the Office of Public Instruction. The information on the mathematics training was limited to that obtainable from the Certification Office of the Office of Public Instruction and from the registrars of the Montana colleges and universities. Courses that teachers have taken since

they were last certified or courses taken at a college or university not listed in the certification may be missed by this method of data collection. It was felt that this would still give reliable information and the questionnaire would not take as long to fill out.

Definition of Terms

Secondary school mathematics. For the purpose of this study secondary school mathematics shall include all mathematics classes taught in the grades 9 through 12 including such courses as general mathematics, business mathematics, and vocational mathematics.

Mathematics teacher. For the purpose of this study a mathematics teacher is defined as a teacher teaching one mathematics class in grades 9 through 12 as listed in the report of mathematics teachers from the Office of Public Instruction.

General mathematics teacher. A general mathematics teacher is any teacher teaching at least one of the courses listed as general mathematics, business mathematics, vocational mathematics, or similar courses.

High school classification. The high schools are classed according to the student population as listed in Montana Education Directory, 1976-1977. The classes will be schools having from 1 to 99 students.

from 100 to 399 students, from 400 to 899 students, and 900 or more. The size of the school is for grades 9 through 12. Where a school is listed as either 7-12 or 10-12 in the Educational Directory the grades are considered to be equal in size.

# Chapter 2

## REVIEW OF RELATED LITERATURE

### Historical Background

In order to place the current status of mathematics teachers in Montana in proper perspective, one needs to look at the history of the development of the secondary mathematics program and the teacher education programs. For a more detailed account of the development of secondary mathematics the reader is referred to two books published by the National Council of Teachers of Mathematics. They are A History of Mathematics Education in the United States and Canada, the thirty-second yearbook of the NCTM and Readings in the History of Mathematics Education (Bidwell, 1970). There are many other sources; some of the secondary mathematics teaching methods books have chapters on the history of secondary mathematics. To name a few, there are Kinney and Purdy (1952), Fremont (1969), Butler, Wren, and Banks (1970) and the Thirty-third Yearbook of the National Council of Teachers of Mathematics (1970), Willoughby (1967).

The main function of the early schools of the colonies was to teach reading and writing so the students could read the Bible or be educated for the clergy. Arithmetic was taught only in those town schools where there were commercial interests.

According to Willoughby (1967:1-2) there were four different types of schools that provided the first formal education in the

colonies. One was the Dame School in which a few families would send their children to a neighborhood lady that would educate their children for a fee. A second type was the town school. The town school was imported from England and started out teaching both writing and arithmetic but later turned to reading, writing, and religion except in commercial towns. A third type of school was the Latin Grammar School, founded in 1635. The Latin Grammar schools were to train students in preparation for college. The main purpose of college at that time was to prepare ministers, so the Latin Grammar School concentrated mainly on classical subjects and religion. The fourth type of school in the early colonies was the college of which Harvard was the first. The colleges even though they mainly were for the training of ministers included the natural sciences, mathematics, logic, and ancient history, as well as the religious instruction.

The Latin Grammar School was the dominant school during the first part of the 1700's. They were publicly supported in New England but privately supported elsewhere (Kinney, 1952:18). The curriculum was mainly Latin and literature and some writing and later some arithmetic where the public demanded (NCTM, 1970a:18). The decline of the Latin Grammar schools was brought about by the need for a practical education by the growing middle class of people as well as the opposition to taxation and the American Revolution.

The resistance to the Latin Grammar schools led to the founding of the academy. The first academy appeared about 1750, but the extensive development and spread of the academy did not take place until the early 1800's (Anderson, 1962:27-32).

The aim of the academy was twofold. It was to prepare a student both for life and for college. The curriculum of the academy contained subjects such as mathematics, mechanical arts, and science. The mathematics of the academy was for its practical utility as well as its mental discipline. This is indicated in a speech given by Warren Colburn before the American Institute of Instruction in Boston, August, 1830. Colburn stated (Bidwell, 1970:24):

> Arithmetic, when properly taught, is acknowledged by all to be very important as a discipline of the mind; so much so that even if it had no practical application which should render it valuable on its own account, it would still be well worthwhile to bestow a considerable portion of time on it for this purpose alone. This is a very important consideration, though a secondary one compared with its practical utility.

The academies flourished during the mid 1800's and by 1859 there were more than 6,085 (Hahn, 1965:52). Many of the teachers in the elementary schools were trained in the academies. One drawback of the academy was that it was a private institution and not generally supported by taxes; thus the academies charged tuition and only those who could afford it were able to attend.

The decline of the academy started about the time of the Civil

War. The decline was brought on by three factors. First, the academies charged tuition (Anderson, 1962:30-31). Second, the academy strayed from the purpose of educating for both college and terminal education and the college preparatory curriculum began to dominate. Third, the denominational character of the academy was against it in a country that was to recognize a policy of separation of church and state.

The public high school first appeared in 1821 (Hahn, 1965: 62-64). One of the contributing factors to the establishing of public secondary schools was the expansion of manhood suffrage after 1800. Before this time the right to vote was restricted by church membership or a property qualification. The growth of the secondary schools was not only due to extensions of suffrage but also to the increased population and its concentration in cities. With these came pressures from the laboring classes. There were influential men such as Abraham Lincoln of Illinois, Thaddeus Stevens in Pennsylvania, and Daniel Webster in Massachusetts who declared that education was necessary for citizenship in a democracy (Hines, 1952:148-156).

The first public high school law was established in Massachusetts in 1827 (Hahn, 1965:79-80). This law set forth the type of school that each community was to provide depending on the number of households in the community. It was also Massachusetts that enacted

the first compulsory school law in 1852 (Hahn, 1965:70-71). There was resistance to the establishment of public schools supported by tax money as some felt all were being taxed for the benefit of a few. The resistance to tax support of secondary education culminated in the Kalamazoo Decision of 1872 where the court upheld the law for levying of taxes to support public secondary schools (Hahn, 1965: 75-78) (Hines, 1952:153).

In the period from 1870 to about 1892 there was a tendency for the curriculum of the secondary schools to expand in the number of and content of the courses offered. During this time there was no over all plan as to what courses should be in the secondary schools or what the function of the schools should be. Kandell (1930:460-461) states:

> Despite the repeated contention that college domination over the high school retarded its development, the actual facts, as indicated in the growth of subjects and courses offered, point to the contrary conclusion. It might even be argued that until the close of the nineteenth century the college entrance requirements alone saved the high schools from anarchy and chaos, in so far as they offered recognizable standards of attainment.

In the field of mathematics we find that arithmetic had moved from the academies and high schools to the elementary school by the end of the nineteenth century. Algebra and geometry meanwhile had moved into the high school. Algebra was required for college entrance to Harvard in 1820, to Yale and Princeton in 1847 and 1848 respectively. While geometry was made an entrance requirement to Yale in

1865, Princeton, Michigan, and Cornell in 1868, and Harvard required geometry and logarithims in 1870 (NCTM, 1970a:27-28). The algebra and geometry were in the enviable position of being wanted by two groups that at times were not in complete agreement, that is those college-bound students and those that were headed for the newly developed science and technology as well as the older fields of surveying and navigation.

The period from 1830 to 1890 saw the rise of formal teacher training. The first public normal school was founded in 1839 in Massachusetts under the leadership of Horace Mann. There was formal teacher training as early as 1832 at New York University, 1850 at Brown University, and 1860 at the University of Michigan (NCTM, 1970a: 30-31).

The mental discipline and drill procedures remained in mathematics into the early nineteen hundreds, but the "old copy book-show an example-practice" method of teaching was giving way to an inductive reasoning, and discovery-teaching process. There was at this a time of questioning of the goals and the methods used in teaching mathematics. A new psychological basis for learning and teaching was being sought.

The last half of the nineteenth century found the pressures building for reform in secondary education. These pressures were from

several different sources. One was the beginning of teachers' organizations. The National Teachers Association was founded in 1857 and in 1870 became the National Education Association (NCTM, 1970a: 34-35). Pressure was building from the colleges, citizens, and students because of the chaotic condition of the curriculum and the lack of articulation between the grade school and high school and between the high school and college. There was a high rate of drop-out in the high schools as indicated by Barker (1965:79-81). The students were forced to make an early choice of colleges because the entrance requirements were not standard (Willoughby, 1967:4-5).

Committee of Ten

The pressures mentioned led to the appointment of the Committee of Ten in 1892 by the National Education Association (Kandell, 1930: 472-476). The Committee organized conferences in many curricula areas and ten members were appointed to each conference. The report of the Committee was issued in 1893. One recommendation was that there should be no distinction in the curriculum for those planning to attend college and those not planning to attend. This was thought to simplify the program of the secondary school. The Committee pointed out that they did not feel that the secondary schools should exist for college preparation only, but that their main function was to prepare students who could profit from school to age eighteen for the

duties of life, as these people were considered vital to the welfare of our nation (Kandell, 1930:474-475).

The recommendation for mathematics by the Committee of Ten Subcommittee on Mathematics included such things as the elimination of topics in arithmetic that were difficult and of little value to the majority of students (Bidwell, 1970:131-141). The subcommittee also suggested a concrete geometry in the seventh and eighth grade. The subcommittee further recommended the study of algebra in the ninth grade and continued on in the tenth and eleventh grade courses with deductive geometry. For students not headed for college, but wanting to pursue a business career, the time alloted to algebra could be devoted to bookkeeping and commercial arithmetic. For those boys headed for scientific school, it was felt they would profit from higher algebra and trigonometry.

Committee on College-Entrance Requirements

The Committee on College-Entrance Requirements was set up by the National Education Association to bring about a better articulation between the secondary schools and the colleges. The Committee requested the Chicago Section of the American Mathematical Society to appoint a committee to cooperate with the National Education Association. The report of the Chicago Section was included in the report issued in 1899. Their recommendations were similar to those of the Committee of

Ten except that they recommended the shifting of some courses to lower levels. The Chicago Section also included some recommendations on teacher training (Bidwell, 1970:206-207). The recommendations stated, "The minimum attainment in mathematics should include analytic geometry, a first course in calculus, and the elements of the theory of equations (including determinants)." It was further recommended that the teachers be able to witness actual teaching and to hold discussion afterward and that beginning teachers be assigned to a more experienced teacher for guidance and consultation.

In the period from 1900 to 1940 we find many changes in the high school mathematics programs. The changes were due to the growth of professional organizations, committees studying the programs, and most importantly, the change in the high school student population. From Table 1, Page 28, it is evident that a much higher percent of the school age population were entering school. Thus we find the school serving not only those that were headed for college but those that would be leaving high school to enter the job market.

On the following page is a part of a table from Hahn and Bidna (1965:84). From the table we see that the secondary school enrollment increased by twenty fold while the secondary school age population did not even double. This means the secondary school was faced with the problem of offering a curriculum to meet not only the

needs of the college bound but the needs of those that did not plan to attend college. The report published by the International Commission on the Teaching of Mathematics in 1911 indicated the secondary schools were not meeting this need.

TABLE 1

ENROLLMENT IN GRADES 9-12 IN PUBLIC AND NONPUBLIC SCHOOLS, COMPARED WITH POPULATION. 14-17 YEARS OF AGE: CONTINENTAL UNITED STATES, 1889-90 to 1955-56.

| School Year | Percent increase in enrollment over 1889-90 grades 9-12 and post-graduates. | Percent increase of population over 1889-90, 14 -17 years of age. | Number enrolled per 100 persons 14-17 years of age. |
|---|---|---|---|
| 1889-90 | | | 6.7 |
| 1899-1900 | 94.3% | 14.9% | 11.4 |
| 1909-10 | 209.9 | 34.8 | 15.4 |
| 1919-20 | 594.6 | 44.5 | 32.3 |
| 1929-30 | 1234.7 | 74.5 | 51.4 |
| 1939-40 | 1878.9 | 81.5 | 73.3 |
| 1949-50 | 1692.8 | 57.0 | 76.8 |
| 1955-56 | 2060.0 | 72.4 | 84.2 |

## The International Commission on the Teaching of Mathematics

Committee No. III of the International Commission on the Teaching of Mathematics found that the secondary mathematics curriculum was in general determined by college admission requirements (Bidwell, 1970: 331). This was true even where few of the secondary school graduates went on to college and where the school boards said they were not influenced by college requirements. The Committee found that every high school offered algebra and geometry for at least one year each, but only one-half offered algebra for an extra half year, and less than twenty percent offered algebra for two years. Some of the larger schools and some smaller ones especially preparing students for college taught one-half year each of solid geometry, and trigonometry and advanced algebra (Bidwell, 1970:346).

In the report of the International Commission a subcommittee of Committee III was Subcommittee 9. Their report was titled "Failures in the Technique of Teaching of Secondary Mathematics: Their Causes and Remedies" (Bidwell, 1970:348-360). In its report the Subcommittee listed the three general causes of failure of the secondary schools as the teachers, the pupils, and the organization of the schools.

The failure of the teachers was attributed to four things (Bidwell, 1970:352-54). First was the lack of professional preparation. It was pointed out that in New York State three years before

only 32.2 percent of the 4,668 secondary teachers were college graduates. Second was the lack of professional contact. The Subcommittee felt the lack of professional contact of teachers with others teaching in the same field was a major source of stagnation. Teacher organizations, meetings and reading materials would help to eliminate this stagnation. The third cause of failure was listed as overwork. The Subcommittee felt the practice of loading a teacher with three and four different preparations in subjects not in the teacher's field was indefensible and that teachers assigned more than twenty-five periods a week of required work could not accomplish this effectively. The fourth reason for failure was listed as the short and unstable tenure of office of the teachers. It was felt that there was too much changing of positions. A teacher needed a few years to settle into a position to do a good job. The Subcommittee felt that what was needed was better salaries, permanent appointment after a limited trial period, and a pension guarantee after a fixed term of service.

The Subcommittee listed three causes of failure attributed to the pupils (Bidwell, 1970:354-55). First was the lack of preparation. The Subcommittee found that many teachers emphasized the fact that the students were not prepared in the grade school to take the secondary mathematics courses. Either the students were not presented the material or the methods used did not produce retention. The second

cause of failure of the student was aimlessness. It was felt that too many students had no real purpose to keep them at work. Third was social diversions. The Subcommittee realized that students needed some time to relax and have fun, but they felt that there was too much emphasis on athletics of the grandstand type and that there were too many social functions.

The Subcommittee listed two causes of failure due to the high school organization (Bidwell, 1970:355-56). The first they called lack of symmetry. The Subcommittee felt the students had not learned to apply his mathematics to real life situations and what they had worked so long for was lost to them because it was not broad enough to be of any use to him. Second was the lack of thoroughness. Some subjects were not entered into far enough to be of any value or had a high rate of failure.

The Subcommittee had two recommendations (Bidwell, 1970: 359-60). The first dealt with organization of the school. They recommended that the secondary school start at the end of the sixth grade and be six years long. This would let certain subjects be spread over a longer period and have better coverage. The second dealt with the teacher preparation. The Subcommittee recommended that teachers have a broader foundation in their preparation. The teachers should have trigonometry, analytics, calculus, and

elementary mechanics. A familiarity with surveying and shopwork would be very desirable for the teachers. It was also felt there should be more expert supervision administered with a spirit of cooperation and inspiration.

National Organizations

During the time from about 1900 to 1920 there were three influential organizations formed that have had a significant influence on mathematics. The first to be organized was the Central Association of Science and Mathematics Teachers which organized April, 1903, and incorporated in July, 1928. At the present time this organization is the School Science and Mathematics Association (SSMA). The SSMA publishes nine issues a year of School Science and Mathematics. The SSMA is primarily interested in the teaching of elementary and the secondary science and mathematics curricula.

The next to organize was the Mathematical Association of America (MAA) (Butler, 1970:20-21). The MAA organized in December, 1915, and incorporated under the laws of Illinois in September, 1920. The purpose of the MAA was to improve instruction in collegiate mathematics. The MAA publishes several different journals mainly aimed at college teachers. They also have had a number of committees studying mathematics education at all levels. The MAA sponsors or helps sponsor conferences, meetings, mathematical research, and many

other activities for the benefit of mathematics education.

In spring of 1920, the National Council of Teachers of Mathematics (NCTM) was founded. It was incorporated under the laws of Illinois in 1928 (NCTM, 1970a:194-95) (Butler, 1970:21-22). The reason for the forming of the NCTM was, as pointed out by Austin, that the mathematics courses were being criticized and manipulated by people who knew very little about the mathematics curriculum (NCTM, 1970a:194-95). The MAA had appointed a committee to study the situation, but Austin stated, "The pity of it is that this work, wholly in the realm of the secondary schools, should have to be done by an organization of college teachers." The NCTM sponsors regional and state meetings for those interested in mathematics education as well as publishing The Arithmetic Teacher, The Mathematics Teacher, and the Journal for Research in Mathematics Education. The NCTM sponsors other publications such as a student paper, yearbooks, and other books and pamphlets. They also cooperate with other organizations in working toward better mathematics education.

The "1923 Report"

The first two decades of the twentieth century found an increase in the percentage of eligible secondary students enrolling in the secondary schools along with an increase in rate of failures and a decreasing enrollment in classical mathematics classes. There

was also a growing concern over individual differences and the domination of drill and formal manipulation in the mathematics classes. These factors led to a concern for the quality of the mathematics education by both educators and mathematicians.

This concern led the Mathematical Association of America to form, in 1916, the National Committee on Mathematical Requirements. The report of the Committee entitled The Reorganization of Mathematics in Secondary Education is many times called the "1923 Report." The original Committee had six mathematicians and three high school mathematics teachers. The work of the Committee was delayed by World War I. The work of the Committee, although funded by New York City Board of Education, tried to represent the entire country by soliciting advice and criticism from many different areas and then submitting the report to many concerned groups for comment and criticism (NCTM, 1970a:197-98). The first report was published in 1923. According to Bidwell and Clason (1970:361) the influence of this report continued until 1959, and the reason it did not produce more change was the inertia of education and the depression of the 1930's.

The Committee set forth three aims of the secondary school mathematics as practical or utilitarian, disciplinary, and cultural (Bidwell, 1970:387-458). They stated these were not necessarily mutually exclusive. The Committee went on to outline what they felt

should be the program of a 6-3-3 system or a 8-4 system. The Committee made the following statements about the college entrance tests in algebra and geometry (Bidwell, 1970:433):

> An effort should be made to devise questions (in algebra) which will fairly test the candidate's understanding of principles and his ability to apply them while involving a minimum of manipulative complexity.
>
> The examination in geometry should be definitely constructed to test the candidate's ability to draw valid conclusions rather than his ability to memorize an argument.

The Committee felt that a good teacher would produce good results under most programs and a poor teacher would not get good results under any program (Bidwell, 1970:399-401). A common practice during this time was to place as a mathematics teacher anyone that did not have a class that hour since it was felt all a teacher had to do was follow the book. The committee deplored this practice. They felt that teachers must be well trained in mathematics but requirements must not be so high that people are not attracted into teaching. The requirements must not be so restrictive that a student could not get into mathematics teaching even if he made a choice of this field late in his college career.

## The Joint Commission

In 1933 the Mathematical Association of America appointed a Commission to Study the Place of Mathematics in Secondary Education. Later the Commission was incorporated into a Joint Commission of the

Mathematical Association and the National Council of Teachers of Mathematics. The first report of the joint commission is the Fifteenth Yearbook of the National Council of the Teachers of Mathematics, printed in 1940. In this final report the Commission undertook to define the place of mathematics in the educational program. They then organized a mathematical program for grades 7 to 14 in terms of the major mathematical fields which would provide for continuity of development and flexibility of administration (NCTM, 1940:53).

The Joint Commission deplored the fact that the amount of mathematics needed in order to obtain a license to teach mathematics was low; in some states no mathematics needed to be taken in college and even where some was required the regulation could be filled in a year or a little more (NCTM, 1940:193). The Commission went on to say that a teacher should be a master of trigonometry and have calculus (NCTM, 1940:196-97). They stated that the study of mathematical statistics and mathematical theory of finance was important. They also stressed history of mathematics as being a worthwhile study. The commission felt the mathematics teachers needed a course where the mathematics was applied such as physics, chemistry, or astronomy.

The Commission laid out the courses they felt a person teaching mathematics should have and what a full time mathematics teacher should have (NCTM, 1940:201-2). They felt all mathematics teachers

should have the following courses: (a) courses that include complete treatment of college algebra, analytic geometry, and 6 semester hours of calculus; (b) a course that critically examines Euclidean geometry, introduces projective geometry and non-Euclidean geometry for 3 semester hours; (c) for 6 semester hours there should be courses in advanced algebra including theory of equations, mathematics of finance, and statistics; (d) a course in the history of mathematics. For the full-time mathematics teacher the following were also necessary: (a) six semester hours of advanced calculus and differential equations; (b) three semester hours of additional work in geometry such as projective or descriptive geometry; (c) three semester hours in algebra such as modern algebra; (d) at least one of the following: physics, chemistry, or astronomy.

The Commission on Post-War Plans

During World War II the inadequacy of the secondary school mathematics program came to light when the men inducted into the service were found to be lacking in mathematical background. In February 1944 the NCTM appointed the Commission on Post-War Plans for the purpose of setting forth an effective secondary mathematics program for the post-war period. The Commission printed reports in The Mathematics Teacher in both 1944 and 1945. The second report set forth the program recommended by the Commission for grades 1 to 14

(Reeve, 1945:195-221).

The Commission set forth what it considered to be the dual responsibilities of the secondary school (Reeve, 1945:195):

> (1) To provide sound mathematical training for our future leaders of science, mathematics, and other learned fields, and (2) to insure mathematical competence for the ordinary affairs of life to the extent that this can be done for all citizens as a part of a general education appropriate for the major fraction of the high school population.

The report went on to list thirty-four theses that were arrived at by the whole Commission from their collective experience, pedagogical literature, and what was advocated by leaders in mathematics education. The following are the theses dealing with secondary mathematics teachers (Reeves, 1945:218-223):

> Thesis 26. The teacher of mathematics should have a wide background in the subject he will be called upon to teach.
> Thesis 27. The mathematics teacher should have a sound background in related fields.
> Thesis 28. The mathematics teacher should have adequate training in teaching of mathematics, including arithmetic.
> Thesis 29. The courses in mathematical subject matter for prospective mathematics teachers should be professionalized.
> Thesis 30. It is desirable that a mathematics teacher acquire a background of experience in practical fields where mathematics is used.
> Thesis 31. The minimum training for mathematics teachers in small high schools should be a college minor in mathematics.
> Thesis 32. Provision should be made for the continuous education of teachers in service.
> Thesis 33. Mathematics teachers need to give careful consideration to the possibilities of multi-sensory aids.
> Thesis 34. The resourceful teacher of mathematics should be given competent guidance in the production, selection, and use of slide films.

The Status of Secondary Mathematics in 1950

During this period it was difficult to tell how successful the mathematics instruction was in the secondary schools since there was no central administration of secondary school mathematics. Kinsella (1965:12-14) stated that educational evaluation was another obstacle to appraisal of instructional results. There were many tests to check a student's mathematical skills or factual knowledge, but an instrument to check on his understanding of what his abilities, attitudes, and appreciations were rare and of uncertain validity. It may be that some of these characteristics cannot be ascertained or judged by standardized tests.

Kinsella (1965:13-14) pointed out that in 1950 the situation in secondary mathematics was not satisfactory to many individuals or groups. Some of the complaints were the following: there were not enough students required to take mathematics courses for graduation from high school; the superior student was taught the same as everyone else; the emphasis was on manipulation and memorization instead of meaning and understanding; the general mathematics course was a dumping ground for those not able to take algebra; the proof was used in geometry only; and the mathematics was taught as a series of numerous mechanical operations instead of being unified into a few large concepts.

Trends in Secondary Mathematics Teacher Education

Schumaker (1961:413-422) made a study of the trends in the education of secondary school mathematics teachers. He stated that in 1920 the mathematics requirements for prospective teachers seldom went beyond calculus. Most programs at that time required college algebra, trigonometry, analytic geometry, differential and integral calculus, history of mathematics, some work in foundations of algebra and geometry, applications of mathematics, methods course, and practice teaching. The median for the major was 24 semester hours and for the minor was 12 semester hours.

Schumaker found that in the period from 1920-21 to 1957-58 the median requirement for a major went from 24 semester hours to 27, while in the minor the median required hours went from 12 to 18. From a table of the percentage of institutions requiring various courses in 1920 and 1957 there was at least a 10 percent increase from 1920 to 1957 in both differential and integral calculus, college geometry, and elementary statistics. In 1920 no institution required elementary statistics, but in 1957 there were 10 percent that required it. During this same period there was a marked drop in the number of institutions requiring solid geometry. The drop was from 16 percent requiring solid geometry to 5 percent. Schumaker stated that the most notable change in the secondary school offerings was

general mathematics being offered as an alternative to algebra.

A study by Johnson (1975:3) found that for senior high teachers the mean number of semester hours for majors was 33.28 semester hours. He also found the five courses required most often were elementary calculus, abstract algebra, geometry, linear algebra, and probability and statistics. Another rather shocking finding was that out of about 400 schools that filled out his questionnaire on the training of secondary teachers, 66 indicated they were not familiar with the CUPM recommendations and 147 were not familiar with the 1963 Cambridge Conference Goals for School Mathematics.

College Entrance Examinations Board (CEEB)

The Mathematics Examiners of the CEEB felt an increasing concern about the curriculum they were testing. They wondered if they were really testing what the schools were teaching and, if they were, was this what the schools should be teaching; therefore, in 1955 the CEEB appointed the Commission on Mathematics. Their report was then issued in 1959 in booklet form.

The Commission presented a nine-point program for college-capable students, (CEEB, 1959:III):

(1) Strong preparation, both in concepts and in skills for college mathematics at the level of calculus and analytic geometry.
(2) Understanding of the nature and role of deductive reasoning in algebra, as well as in geometry.

(3) Appreciation of mathematical structure ("patterns")--for example, properties of natural, rational, real, and complex numbers.
(4) Judicious use of unifying ideas-sets, variables, functions, and relations.
(5) Treatment of inequalities along with equations.
(6) Incorporation with plane geometry of some coordinate geometry, and essentials of solid geometry and space perception.
(7) Introduction in grade 11 of fundamental trigonometry--centered on coordinates, vectors, and complex numbers.
(8) Emphasis in grade 12 on elementary functions (polynomial, exponential, circular).
(9) Recommendation of additional alternative units for grade 12: either introductory probability with statistical applications, or an introduction to modern algebra.

The Commission took the position that calculus was still in general a college level course but students should enter college ready to take the calculus course. They further emphasized the role of the teacher in that any curricular change must be accompanied by effective meaningful teaching with emphasis on mathematical power and understanding. The Commission went on to outline the courses they felt should be taught (CEEB, 1959:36-47).

The Commission made some recommendations on the pre-service education of the mathematics teachers (CEEB, 1959:54-58). They felt that students made the decision to go into teaching in the latter part of high school or the first part of college so the first years should be watched for spirit and content. The spirit of the Euclidean geometry should be that it is just a special case of a more general geometry and time should also be spent on non-Euclidean geometry, topology, and the elements of differential geometries. It was felt

that the topics that had been in a theory of equations course that were needed would be better covered in other courses. The Commission felt that the major should be 24 semester hours past the calculus and should include such subjects as: differential equations, probability and statistics, modern algebra, geometry (other than Euclidean), advanced calculus, logic, history of mathematics, and theory of numbers. The Commission also felt that graduate courses for secondary teachers should not be the same as for the regular graduate students but should emphasize a broad understanding of the elementary aspects of the field studied.

New Mathematics Programs

Starting in 1952 with the University of Illinois Committee on School Mathematics (UICSM) the next ten years saw a number of programs start with the objective of improving the secondary school mathematics program. Support for these programs came from several sources. Some came from the universities that sponsored the writing projects, but mostly the support came from the National Science Foundation, Carnegie Foundation, and the U.S. Office of Education (Kinsella, 1965:26-27). In 1963 the NCTM published an analysis of eight of the new mathematics projects (NCTM, 1963:6-66).

Wooten (1965:VI) indicated that there were similarities between the different groups in that most discovered the best way to

change secondary teaching was to provide a model. They provided this model in the form of sample texts. The groups also were alike in that they tried to have collaboration between subject matter experts and experts in teaching at the proper grade level.

Criticism of the Educational System

Kline (1973:22-23) and Muller (1975:51-52) indicated that they felt the policy that everyone could and should be educated was an impossible dream if schools were to maintain reasonable standards. Both men also brought out the fact that they felt there was a lack of highly qualified instructors. The shortage of teachers for a number of years meant that some positions were filled with people without proper qualifications. It then becomes difficult to fill these positions with qualified teachers when qualified teachers become available. The book by Kline (1973) is on mathematics and the article by Muller (1975:50-52) is on education in general. The two publications emphasize almost the same points: the difference in students, motivation, and teacher qualifications.

Kline (1973:119-147) lamented the fact that the mathematics had broken away from science, and he pointed out the need for this connection. Kline also pointed out that very few of the students in public school would be mathematicians so their education should be broad rather than deep. He felt that the new programs in mathematics

were becoming too theoretical and thus did not have the natural motivation provided by the sciences.

In an expression of criticism of the direction the mathematics curriculum was taking, the following was stated (Kline, 1973:112): "Mathematics, reacting to the dominance of education by professional educators who may have stressed pedagogy at the expense of content, may now stress content at the expense of pedagogy and be equally ineffective." The memorandum from which the above quote was taken was signed by seventy-five mathematicians and published in The Mathematics Teacher of March 1962 and in The American Mathematical Monthly of March 1962.

The April 1966 issue of The Mathematics Teacher contained two articles on the new high school mathematics curriculum. One article by Kline (1966:322-30); the other by Zant (1966:331-34) in which he answered Kline's criticism. Zant (1966:332) pointed out that by this time one should realize that telling a high school teacher what should be taught without providing the text material was useless. He also challenged Kline to put his ideas in a textbook (Zant, 1966: 334).

Selected Studies of Mathematics Teachers

Three state study. Due to a lack of information on the qualifications of mathematics teachers, the United States Office of Education along

with the NSF instituted a study in the states of Maryland, New Jersey, and Virginia. In this study a mathematics teacher was defined as any teacher teaching one mathematics class. The study found 7.1 percent or 57 out of the 799 mathematics teachers had no college credit in mathematics (Brown, 1959:5). Most of these teachers taught general mathematics and most had only one class. There was no one teaching full time in mathematics that did not have some college mathematics. Sixty-one percent of the mathematics teachers had taken calculus or a more advanced mathematics class. New Jersey was high with 83.8 percent having calculus or more while Virginia had only 43.5 percent. The average number of semester hours of calculus or above was 14.7 hours. The average semester hours of mathematics for mathematics teachers was 23 while for those teaching both mathematics and science the average mathematics preparation was 17.3 semester hours (Brown, 1959:29). About 50 percent of the mathematics-sciences teachers had no calculus (Brown, 1959:47). In this study the average class size was 28 and the average number of pupils per day was 145.2 but went as high as 182 (Brown, 1959:31). The highest degree had been earned in the last seven years by 43.8 percent of the mathematics teachers (Brown, 1959:7). It was also found that about one half of the teachers had taken their degree out of the state in which they taught (Brown, 1959:8).

A national study. In the spring of 1961 a survey was conducted by the American Association for the Advancement of Science and the National Association of State Director of Teacher Education and Certification. In this study which was supported by the NSF, there were 1280 teachers classified as mathematics teachers and 502 classified as science mathematics teachers (NSF, 1963:1). Sixty-three percent of the mathematics teachers were men, and half of them were less than 35 years old and one-fourth were over 45 years of age (NSF, 1964:4). Over half had received their degree in the last ten years and about one-fourth before 1940. Seventy percent of the science and mathematics classes were taught by teachers devoting full time to that area while only six percent were taught by teachers that devoted most of their time to fields outside of science or mathematics (NSF, 1963:5). Forty-four percent of the teachers of grade 9 through 12 taught 5 classes per day (NSF, 1963: 7). The teachers averaged 22.3 hours per week teaching, 17.7 per week for preparation, paper grading, and study halls, and 4.4 hours per week for such things as lunch room, ticket taking, bus duty, and class sponsor (NSF, 1963:29). Of the 1280 mathematics teachers 19 held associate degrees while 38 percent had master's degrees (NSF, 1963:30). In the mathematics classes for grades 9 through 12 it was found that 11 percent were taught by teachers with less than 9 semester hours of college mathematics, 12 percent by teachers with 9-17 hours

and 45 percent by teachers with 30 or more hours. In the sample 18 percent had completed at least one summer institute (NSF, 1963:32).

West Virginia Study. A study of 899 mathematics teachers in West Virginia was made during the school year of 1963-64 by Regula. In this study Regula (1965:186-89) defined 18 semester hours of college mathematics as adequate training. Under this criteria Regula found that 31.7 percent of the mathematics teachers had inadequate backgrounds, 8.8 percent had no college mathematics credits, and 11.2 percent had from one to eleven semester hours of mathematics. About 26 percent of the mathematics classes were taught by teachers with inadequate preparation. Of the people with inadequate backgrounds about half of them had been teaching more than ten years. There were 36.8 percent of the secondary teachers that had 30 or more semester hours of mathematics, and the median was 25 semester hours for all secondary teachers. About 44 percent of the secondary teachers had a master's degree, but only 4.2 percent had the master's in mathematics, and only 21 others had any credits in mathematics in their graduate program.

Regula (1965:191-94) also surveyed the teaching preferences, plans, and professional organizations of the mathematics teachers. In general the teachers expressed a low preference for general mathematics. The first and second year of algebra were the highest followed

by plane geometry in the preferred courses. Of the teachers teaching mathematics about 71 percent indicated they preferred to teach mathematics over any other subject. There were 50 percent of the teachers with less than 18 semester hours credit that planned to teach mathematics for the next five years and 75 percent of those with 30 or more hours planned to continue to teach mathematics. Seventy percent indicated they planned to take more college classes in the next five years, and about 58 percent said that they intended to take more mathematics. About one third of the 194 people working on a master's degree indicated there was some mathematics included. The membership in the NCTM was higher (28.8 percent) among the teachers that had more than 24 semester hours of mathematics than among those with less than 24 hours (12.2 percent).

The Nevada Study. During the school year 1964-65 Bradshaw (1968:191-204) conducted a study of junior and senior high school mathematics teachers in the State of Nevada. Bradshaw defined a major as 30 semester hours that included calculus and a minor as 18 semester hours. All others were classified as unqualified. Using this criteria Bradshaw found 31 percent with a major, 17 percent with a minor, and 52 percent unqualified. It was also found that 38 percent of the students were taught by unqualified instructors. Bradshaw defined a full load as four or more classes per day. Using this criteria he found 82

percent of the mathematics majors taught full time in mathematics; 50 percent of the minors; and 21 percent of the unqualified taught full time in mathematics. Bradshaw found that 37 percent had their master's degrees but there were four people that did not have a degree. Only 29 percent of the teachers had earned a degree in Nevada. The teachers were on the average a young group as over 50 percent were less than 35 years old while only 20 percent were 45 or older and only 24 percent had 10 or more years of experience. It was found that 22 percent of the teachers were women. It was further observed that the teachers with majors made their decision to be a mathematics teacher either in high school or college, but 11 percent of them did not make the decision until after they entered a non-teaching field. Bradshaw found that almost three fourths of the mathematics classes taken after graduation were taken in NSF sponsored courses. Twenty-one percent said they receive The Mathematics Teacher, The Arithmetic Teacher, or School Science and Mathematics, but only 11 percent said they read one of them regularly while 34 percent said they read one of the three occasionally. Less than 20 percent belong to the NCTM.

The Missouri Study. The Missouri Study took place during the 1967-68 school year and included a random sample of 250 mathematics teachers from the junior and senior high schools (Reys, 1969:933-37) (Kerr,

1969:781-90). There were 233 usable returns. The teachers were classified as either rural, suburban, and urban. The total mean semester hours for all teachers was about 36; for the rural it was 32.25, suburban 44, and for the urban 39.8 hours. It was found that 35 percent had attended one or more NSF institutes but over 50 percent had not taken any graduate work in either mathematics or education. Nearly 29 percent held a master's degree. Less than 40 percent of the teachers belonged to any professional organization dealing with mathematics and less than 50 percent regularly read a professional mathematics journal.

The Indiana Study. During 1970 Bertram (1971:121-31) conducted a study of 493 mathematics teachers in Indiana. At least one teacher from every school was contacted. All of the teachers in the study group had a bachelor's degree, 62.8 percent had a master's degree, and 25 percent had work above their master's degree. The average mathematics credits in the undergraduate degrees was 32.6 semester hours and an average of 15.5 semester hours of graduate mathematics. Two thirds of the respondents had taken a graduate course in the last three years but there were 7.8 percent that had taken no credit in the last ten years. There were 77.5 percent men in the study. The median age of the rural teachers was 32.5 while for the urban it was 38.1 years. Two thirds of the teachers had less than ten years experience at

their present position and almost one-half had five or less at their present position.

The NSF had a marked affect as indicated by the fact about 56 percent of the respondents had taken some type of NSF program, about 14 percent had attended a one-year long institute while about 39 percent had attended at least one summer institute. Forty percent of the teachers were members of NCTM and about 54 percent said they read The Mathematics Teacher and 16 percent said they read The Arithmetic Teacher. Over 70 percent of the teachers planned to continue to teach mathematics; about 4 percent planned to go into school administration; 5.3 percent planned to go into higher education teaching; 3.4 percent planned to go into another field of teaching, and 12.2 percent planned to leave the field of education.

## Chapter 3

## DESIGN OF THE STUDY

The problem of this study was to delineate certain characteristics and determine certain needs felt by the mathematics teachers of Montana. This chapter will outline the procedure followed to meet these objectives.

### School Population

The 1975-76 Montana Education Directory was used to determine the population of the schools. Some schools in the directory were listed as grades 7-12 or 7-9. When schools were listed in this way the students were considered to be equally divided among the different grade levels. The number of students in grades 9-12 were then calculated. If there were two high schools 10-12 in a town, then the ninth grade students were assumed to be equally divided between the two high schools. The number of mathematics teachers was determined for school size 1-199, 200-499, 500-999, and 1000 and above. The number of mathematics teachers was also determined for school size 1-99, 100-399, 400-899, and 900 and above. The latter was decided upon as the classification to use, as this divided the teachers more evenly and especially did not make the smaller classification so large. The large size schools still had the largest number of teachers. This was not considered a disadvantage because of the way

in which the high school population was divided as is indicated in Table 2 below. In order to more accurately describe the teachers in the different size schools it was decided to use a stratified sample with two thirds of the teachers being selected for the sample from each category listed in the table.

TABLE 2

ENROLLMENT AND NUMBER OF MATHEMATICS TEACHERS IN MONTANA SCHOOLS GRADES 9-12 IN 1976-77

| School size | No. of schools | No. of teachers | % of schools | % of teachers | No. of students | % of total students |
|---|---|---|---|---|---|---|
| 1-99 | 67 | 94 | 39.2% | 17.5% | 3960 | 6.9% |
| 100-399 | 72 | 156 | 42.1 | 29.1 | 13842 | 24.3 |
| 400-899 | 18 | 76 | 10.5 | 14.2 | 10880 | 19.1 |
| 900 + | 14 | 211 | 8.2 | 39.3 | 28390 | 49.7 |

Drawing of the Sample

A listing of all the mathematics teachers in the public schools of Montana was obtained from the Science and Mathematics Supervisor of the Office of Public Instruction. The Montana Education Directory 1976-77 was used to determine the size of each school in order to classify the schools into one of the four classifications as given in Table 2, page 54.

The sample for the 1-99 size school was drawn as follows: It was decided to roll a die and if a 1 or 2 appeared, the first person listed in that size school was left out; if a 3 or 4 appeared, the first person was in the sample but the second person was left out, and if a 5 or 6 appeared the first two people were in the sample and the third one was not. The sample for each of the other size schools was drawn in a similar manner. This resulted in a total sample of 357 of which 63 were in the schools size 1-99, 104 in schools size 100-399, 50 in 400-899, and 140 in schools size 900 and above.

In checking the samples drawn and address of the teachers it was discovered that a mistake had been made in the listing of teachers in two towns of the 1-99 size. In both cases a substitution was made of the actual teacher for the teachers drawn in the sample. In one case two teachers were drawn for the sample, but there was only one mathematics teacher at the school; therefore, one person was eliminated from the sample. In another case a teacher was listed under two different schools in the same town; therefore, one listing was eliminated.

## Development of the Questionnaire

A questionnaire was developed to be mailed to all mathematics teachers in the sample drawn. The questionnaire was titled, "Second-

ary Mathematics Teacher Questionnaire" (see Appendix B). The questionnaire was designed and then submitted to a committee of Mathematics and Education Professors at Montana State University. The questionnaire was rewritten using the suggestions of the committee. The revised questionnaire was given to eight teachers at the Dillon Public Schools to check the time it took to complete and to see if the teachers understood the questions. The questionnaire was slightly revised a second time. This questionnaire was then mailed to the mathematics teachers in the sample on March 22, 1977, with a follow-up questionnaire to the non-respondents on April 18, 1977.

The questionnaire mailed to the mathematics teachers was designed to gain information in five main areas. These were:

1. Personal data: sex, age, total years of experience, years of experience at their present school, when they made the decision to become a teacher, how they feel about teaching, and what their future plans were.
2. Working conditions: number of classes taught and the number of students in each class, preparation time, and what extra-curricular activities they were responsible for and the time spent on them and were these activities assigned or voluntary.
3. College course work: the classes used for re-

certification, plans for future course work, the NSF or other financially supported courses taken.

4. The opinions of the teachers about the courses they felt were necessary for a mathematics teacher, the need for course guides for the mathematics courses taught in a high school, the need for help for teachers to keep abreast of new material and methods.
5. Professional activities: the professional mathematics organizations to which the teachers belonged, the reading of professional magazines and journals, and the professional meetings the teachers have attended.

A second form was developed to be filled out from the certification records or college records of the teachers in the sample. These forms listed the secondary school classes taught by the teacher, years that degrees were received, majors and minors, and college courses taken and the number of credit hours in mathematics.

Questionnaire Sent

On March 22, 1977, questionnaires and cover letters were then mailed to the 355 remaining mathematics teachers (see Appendix B and Appendix C). Two questionnaires were returned by the Post Office as undeliverable. It was found the school had been listed because they had filed a fall report in 1975 but had not filed one in 1976. Thus

two more teachers were eliminated from the study. By April 18, 1977, one hundred seventy-two questionnaires had been returned. A second questionnaire and cover letter was sent to the non-respondents on April 18, 1977 (see Appendix B and Appendix D).

By May 10, 1977, two hundred fifty-seven of the three hundred fifty-three deliverable questionnaires had been returned. Two of the returned questionnaires were deemed unusable as the respondent was not teaching a mathematics class in grades 9 through 12. Table 3, page 59, indicates the questionnaires sent out and the number and percentage of returns.

Data on the Whole Sample

Data on the whole sample was collected from the Certification Office of the State Office of Public Instruction and from the registrars at the University of Montana (U of M), Montana State University (MSU), Eastern Montana College (EMC), Western Montana College (WMC), and Northern Montana College (NMC).

Data on the mathematics preparation of the mathematics teachers was confidential and thus no names were associated with these data. The registrars were contacted and the campuses of U of M, MSU, and WMC were visited to obtain the data on mathematics preparation of the mathematics teachers. The information from NMC and EMC was obtained by correspondence and telephone. For the teachers in the sample that

were not found in the records of the state schools the data were obtained from the certification records.

The data on the type of certification held and the areas of certification were obtained from a computer print out in the State Office of Public Instruction.

TABLE 3

RETURN OF MATHEMATICS TEACHER QUESTIONNAIRE

| School size | No. of questionnaires sent | No. of returned questionnaires | Percent returned |
|---|---|---|---|
| 1-99 | 62 | 47 | 76% |
| 100-399 | 104 | 76 | 73 |
| 400-899 | 50 | 37 | 74 |
| 900 + | 137 | 97 | 71 |
| Totals | 353 | 257 | 73 |

Analysis of Data

After the data were collected the information was placed in table form and the means and medians were computed where applicable. The data were also analyzed by use of a t-test or one-way analysis of variance where it was deemed applicable. In recording some of the

data it was necessary to place it in a frequency distribution where a given class may have entries of different values such as where the data on age were considered, all people from 21 through 28 years old were in one class.

# Chapter 4

## PRESENTATION, ANALYSIS, AND RESULTS OF DATA

In order to answer the general questions as outlined in chapter one, two methods of collecting data on the sample of 353 mathematics teachers were used. Data on certification and the mathematics preparation of mathematics teachers trained out of state were obtained from the Certification Division of the Office of Public Instruction. The college and university registrars were contacted for the data on the mathematics preparation of the mathematics teachers trained in Montana. Names could not be associated with the data obtained on the mathematics preparation of the teachers since this information is confidential. The other method of collecting of data was by using a questionnaire sent to the 353 mathematics teachers selected in the sample. The data on the whole sample is on 352 teachers as one mathematics teacher was found to be uncertified and thus information was unavailable on this teacher. Two hundred and fifty-seven of the questionnaires were returned; of these 255 were usable.

## RESULTS ON ENTIRE SAMPLE

### Certification

The requirements for certification as given in the pamphlet Questions & Answers on Certification of Montana Teachers and School Administrators published by the Office of Public Instruction are:

Class 1 (Professional)--B.A. plus one year which strengthens training and three years teaching or the equivalent. Class 2 (Standard)--B.A. and student teaching. Class 5 (Provisional)--B.A. and student teaching or appropriate intern experiences. Class 8 (life)--This certificate is no longer issued. Elementary--This may be either a class 1 or class 2 certificate.

TABLE 4

CLASS OF CERTIFICATION

| | Number and percentage of mathematics teachers with given type of certification | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| School size | Class 1 | | Class 2 | | Class 5 | | Class 8 | | Elementary | |
| | No. | % | No. | % | No. | % | No. | % | No. | % |
| 1-99 | 9 | 15 % | 49 | 81.7% | 2 | 3.3% | 0 | 0 | 2 | 3.3% |
| 100-399 | 23 | 22.1 | 78 | 75 | 1 | 1 | 2 | 1.9 | 1 | 1 |
| 400-899 | 17 | 34 | 32 | 64 | 1 | 2 | 0 | 0 | 1 | 2 |
| 900 + | 68 | 49.6 | 64 | 46.7 | 2 | 1.5 | 3 | 2.2 | 3 | 2.2 |
| Totals | 117 | 33.3 | 223 | 63.5 | 6 | 1.7 | 5 | 1.4 | 7 | 2 |

Table 4 indicates the result of the examination of the computer print out on certification. There was one person drawn in the school size 1-99 that was not certified to teach. The teachers that

are counted as being elementary are also included in one of the other classes. The Class 8 certificate is a life certificate which is no longer issued.

Table 4 indicates the larger the school the higher the percentage of teachers that have the Class 1 (professional) certificate. The percentage of mathematics teachers having elementary certification is small. One would expect this percentage to change over the next few years to meet the State Standards for Accreditation. Standard 223 is quoted from Standards for Accreditation of Montana Schools, as amended by the Board of Public Education March 8, 1976.

> Teachers in state-approved junior high schools shall hold valid Montana teaching certificates endorsed for appropriate levels and subjects. Certification at the elementary level based on a bachelor's degree entitles the holder to teach in grades kindergarten through nine. Teachers with such certification shall have minimum of 30 quarters (20 semester) credits in all subjects which they teach at the ninth grade level. The proportion of teachers certified at the elementary or secondary levels shall not be less than one-fourth at either level. (Note: The last provision concerning proportion of teachers is to be fully implemented by the 1980-81 school year.)

The implementation of this standard should not adversely affect the quality of mathematics teaching for the ninth through twelfth grade as a person teaching in the ninth grade still needs at least 30 quarter hours of credit in mathematics.

Endorsement

The area of endorsement is determined by the number of credits

a teacher has in a field or by the standards set by the Montana college or university from which the teacher graduated. A minimum of 30 quarter hour credits is required for endorsement in a field by the State Office of Public Instruction (1975:8). Table 5, page 65-66, indicates the areas of certification. The heading physical science includes physics, physical science, and chemistry. The heading biological science includes endorsements in biology, biological science, earth science, and science. The social science endorsement includes political science, social science, sociology, economics, economics-sociology, geography, history, and history-political science. The physical education heading includes physical education and health. The business heading includes all commercial subject areas. The classification other contains those certified in psychology, English, industrial arts, guidance and counseling, foreign language, library, music, art, distributive education, elementary, et. al. The people that have a life certificate are not endorsed in a particular area.

From Table 5 it is evident that as the school size increases the percent of teachers teaching mathematics without a mathematics endorsement decreases. The table also indicates that the most popular endorsements to go along with mathematics are some type of physical science, biological science, and physical education in that order.

TABLE 5

DISTRIBUTION OF MATHEMATICS TEACHERS
IN AREAS OF ENDORSEMENT

| Area of endorsement | School size 1-99 | | 100-399 | | 400-899 | | 900 + | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % | No. | % |
| Mathematics | 44 | 73.3 | 86 | 82.7 | 46 | 92.0 | 127 | 92.7 | 303 | 86.3 |
| Other areas along with math | | | | | | | | | | |
| Physical science | 20 | 33.3 | 47 | 45.2 | 16 | 32.0 | 42 | 30.7 | 125 | 35.6 |
| Biological science | 9 | 15.0 | 14 | 13.5 | 7 | 14.0 | 26 | 19.0 | 56 | 16.0 |
| Business | 1 | 1.7 | 0 | 0.0 | 3 | 6.0 | 1 | 0.7 | 5 | 1.4 |
| Physical education | 9 | 15.0 | 13 | 12.5 | 12 | 24.0 | 24 | 17.5 | 58 | 16.5 |
| Social science | 8 | 13.3 | 6 | 5.8 | 4 | 8.0 | 18 | 13.1 | 36 | 10.3 |
| Other | 7 | 11.7 | 11 | 10.6 | 10 | 20.0 | 23 | 16.8 | 51 | 14.5 |
| Not endorsed in mathematics | 16 | 26.7 | 16 | 15.4 | 4 | 8.0 | 7 | 5.1 | 43 | 12.3 |
| Alternate area of endorsement | | | | | | | | | | |
| Physical science | 0 | 0.0 | 5 | 4.8 | 0 | 0.0 | 1 | 0.7 | 6 | 1.7 |
| Biological science | 7 | 11.7 | 12 | 11.5 | 0 | 0.0 | 1 | 0.7 | 20 | 5.7 |
| Business | 8 | 13.3 | 2 | 1.9 | 1 | 2.0 | 0 | 0.0 | 11 | 3.1 |
| Physical education | 3 | 5.0 | 4 | 3.8 | 0 | 0.0 | 1 | 0.7 | 8 | 2.3 |

TABLE 5 (continued)

| Area of endorsement | School size 1-99 | | 100-399 | | 400-899 | | 900 + | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % | No. | % |
| Social Science | 4 | 6.7 | 5 | 4.8 | 1 | 2.0 | 2 | 1.5 | 12 | 3.4 |
| Other | 6 | 10.0 | 0 | 0.0 | 3 | 6.0 | 5 | 3.6 | 14 | 4.0 |
| Life certificate | 0 | 0.0 | 2 | 1.9 | 0 | 0.0 | 3 | 2.2 | 5 | 1.4 |

Mathematics Preparation of Teachers

The credit hours of mathematics preparation of the mathematics teachers was obtained from the college transcripts or from the transcripts on file at the State Department of Public Instruction. In either case there could be no names connected with the information. Two teachers in the sample had to be eliminated from this part of the study as their transcripts were illegible. In considering the credit hours of mathematics no course was counted that was considered to be a lower level course than the college algebra and trigonometry sequence, such as intermediate algebra, theory of arithmetic, or fundamentals of mathematics. The methods courses were also not included in the mathematics courses. There were a number of courses of a type such as, "Trends in Junior High School Mathematics," that were counted as mathematics credit. Many of these were given as mathematics institute courses.

The mean credit hours of mathematics for teachers of each school size were calculated from a frequency table where the width of the class was five (i.e. the class may be from 5.5 to 10.5 credits; the next class is from 10.5 to 15.5 credits). The means of the schools from small to large were found to be respectively 41.75, 48.68, 52.5, and 55.90. The mean will be somewhat skewed because one teacher had 142 credits in mathematics. The mean for all teachers

TABLE 6

DISTRIBUTION OF MATHEMATICS TEACHERS ACCORDING TO THE QUARTER CREDIT HOURS OF MATHEMATICS PREPARATION

| Credit hours | School size 1-99 | 100-399 | 400-899 | 900 + | Totals |
|---|---|---|---|---|---|
| 0-14 | 16 | 13 | 2 | 6 | 37 |
| 15-29 | 3 | 10 | 3 | 13 | 29 |
| 30-44 | 12 | 16 | 13 | 25 | 66 |
| 45-59 | 14 | 39 | 17 | 46 | 116 |
| 60-74 | 8 | 9 | 8 | 20 | 45 |
| 75-89 | 5 | 10 | 4 | 9 | 28 |
| 90-104 | 2 | 4 | 2 | 11 | 19 |
| 105-119 | 0 | 1 | 1 | 5 | 7 |
| 120- | 0 | 1 | 0 | 1 | 2 |
| Mean credit hours | 41.75 | 48.68 | 52.5 | 55.90 | 50.9 |
| Median credit hours | 44.5 | 49.96 | 50.21 | 51.5 | 50.2 |
| Percent with 15 credits or less | 26.7 % | 12.6 % | 2.0 % | 4.4 % | 10.6 % |
| Percent with less than 30 credits | 31.7 % | 22.3 % | 5.0 % | 14.0 % | 18.9 % |
| Percent with more than 60 credits | 25.5 % | 24.3 % | 30.0 % | 33.8 % | 28.9 % |

was 50.9 quarter credit hours. Thus as the school size increased so did the mean number of credit hours of mathematics preparation of the mathematics teachers.

The median credit hours of mathematics was also calculated for the teachers in each of the four school size categories. The median was also calculated from the frequency table where the class width was five. The median number of quarter credit hours of mathematics for the teachers in the small school to the large school are respectively 44.5, 49.96, 50.21, and 51.5 with the median for all teachers being 50.2. A one-way analysis of variance was used to test if there was a significant difference between the means of the mathematics preparation of the teachers in the four different size schools. An F value of 4.59 was found. From the F table in Ferguson (1966:408-11) at the .01 level of significance and 3 degrees of freedom for the numerator and 348 for the denominator, the F value is approximately 3.88. Thus there is a significant difference in the mathematics preparation of the teachers in Montana in 1976-77 classified by the four sizes of schools. The mathematics teachers in the larger schools have more preparation in mathematics than teachers in the smaller schools.

CUPM Recommendation

The mathematics courses taken by mathematics teachers were

compared with CUPM level II-J and level III recommendations as outlined in Appendix A. The teachers listed in the report of mathematics teachers as teaching only general mathematics (or business mathematics) or Algebra 1 were compared with the level II-J and the rest of the teachers were compared with the level III recommendations.

The four state-supported schools (University of Montana U of M , Montana State University MSU , Eastern Montana College EMC , and Western Montana College WMC ) trained most of the mathematics teachers that graduated in Montana that were considered in this study. Two catalogs from each of these four schools were examined. The catalogs considered were the 1972 catalog and the current catalog. From the examination of the catalogs of 1972, it was found that none of the schools had requirements that would meet the level III recommendations for a major or level II-J for a minor.

The U of M and WMC had the major requirements that came closest to meeting the level III recommendations; each only lacked requiring real analysis and a computer course. Both MSU and EMC lacked real analysis, linear algebra, and a computer course. MSU required a course in logic and sets instead of a modern algebra or statistics, but a student had to select a sequence from statistics or modern algebra or advanced calculus. The most notable change in the new catalog requirements is that EMC now requires linear algebra

and both U of M and EMC require a computer course.

The mathematics minor requirements of these schools were also compared with the level 11-J requirements in the two catalogs from each school. None of the four schools required a computer course in either catalog. The U of M is the only school to require a linear algebra course. Neither MSU or EMC required a modern algebra course, although MSU required the course in sets, logic, and foundations of mathematics. There was not much difference in the requirements as far as meeting the level 11-J requirements.

When the transcripts of the teachers in the sample were examined it was sometimes very difficult to classify some of the courses as to content from the names given on a transcript. This would be especially true of a modern algebra course and sometimes of a linear algebra course, both of which might be called something else.

With the requirements of the four schools mentioned, it was not surprising to find that only 8 teachers met the exact CUPM requirements. In some instances a teacher had more than 60 credit hours of mathematics and still did not meet the exact CUPM level 11-J recommendations. The courses most often lacking were real analysis, linear algebra, and computer.

There were 38 teachers teaching a mathematics course that had not taken any course in calculus. There were 15 teachers that taught

TABLE 7

DISTRIBUTION OF ALGEBRA 1 AND GENERAL MATHEMATICS TEACHERS THAT TEACH NO OTHER MATHEMATICS COMPARED TO THE LEVEL 11-J CUPM RECOMMENDATIONS

| | School size | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1-99 | | 100-399 | | 400-899 | | 900 + | | Totals | |
| | No. | % | No. | % | No. | % | No. | % | No. | % |
| Number of teachers | 17 | 150 | 38 | 100 | 18 | 100 | 54 | 100 | 127 | 100 |
| Met level 11-J requirements | 0 | 0 | 2 | 5.3 | 0 | 0 | 3 | 5.5 | 5 | 3.9 |
| Number of courses lacked | | | | | | | | | | |
| 1 | 0 | 0 | 2 | 5.3 | 2 | 11.1 | 9 | 16.7 | 13 | 10.2 |
| 2 | 1 | 5.9 | 10 | 26.3 | 5 | 27.8 | 10 | 18.5 | 26 | 20.5 |
| 3 | 0 | 0 | 3 | 7.9 | 4 | 22.2 | 15 | 27.8 | 22 | 17.3 |
| 4 | 2 | 11.8 | 4 | 10.5 | 4 | 22.2 | 7 | 13.0 | 17 | 13.4 |
| 5 + | 14 | 82.4 | 17 | 44.7 | 3 | 16.7 | 10 | 18.5 | 44 | 34.6 |
| All | 8 | 47.1 | 9 | 23.7 | 2 | 11.1 | 6 | 11.1 | 25 | 19.7 |

TABLE 7 (continued)

| | School size | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1-99 | | 100-399 | | 400-899 | | 900 + | | Totals | |
| | No. | % | No. | % | No. | % | No. | % | No. | % |
| Courses lacked | | | | | | | | | | |
| Calculus | | | | | | | | | | |
| Teaches only general math | 9 | 52.9 | 9 | 23.7 | 2 | 11.1 | 5 | 9.3 | 25 | 19.7 |
| Teaches algebra | 0 | 0 | 1 | 2.6 | 0 | 0 | 2 | 3.7 | 3 | 2.4 |
| One course in Calculus | 1 | 5.9 | 4 | 10.5 | 1 | 5.5 | 3 | 5.5 | 9 | 7.1 |
| Linear algebra | 9 | 52.9 | 21 | 55.3 | 14 | 77.8 | 33 | 61.1 | 77 | 60.6 |
| Modern algebra | 8 | 47.1 | 13 | 34.2 | 7 | 38.8 | 12 | 22.2 | 40 | 31.5 |
| Geometry | 7 | 41.2 | 16 | 42.1 | 6 | 33.3 | 16 | 29.6 | 45 | 35.4 |
| Probability & statistics | 6 | 35.3 | 10 | 26.3 | 3 | 16.7 | 21 | 38.9 | 40 | 31.5 |
| Computer | 9 | 52.9 | 22 | 57.9 | 14 | 77.8 | 38 | 70.4 | 83 | 65.5 |

TABLE 8

DISTRIBUTION OF MATHEMATICS TEACHERS THAT TEACH AT LEAST ONE COURSE OTHER THAN GENERAL MATHEMATICS OR ALGEBRA 1, COMPARED TO THE LEVEL III CUPM RECOMMENDATIONS

| | School size | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1-99 | | 100-399 | | 400-899 | | 900 + | | Totals | |
| | No. | % | No. | % | No. | % | No. | % | No. | % |
| Number of teachers met Level III | 43 | 100 | 65 | 100 | 32 | 100 | 82 | 100 | 222 | 100 |
| Number of courses lacked | 0 | 0 | 1 | 1.5 | 0 | 0 | 2 | 2.4 | 3 | 1.4 |
| 1 | 4 | 9.3 | 2 | 3.1 | 0 | 0 | 3 | 3.7 | 9 | 4.1 |
| 2 | 9 | 20.9 | 21 | 32.3 | 8 | 25 | 19 | 23.2 | 57 | 25.7 |
| 3 | 16 | 37.2 | 21 | 32.3 | 14 | 43.8 | 26 | 31.7 | 77 | 34.7 |
| 4 | 4 | 9.3 | 6 | 9.2 | 6 | 18.8 | 10 | 12.2 | 26 | 11.7 |
| 5+ | 10 | 23.3 | 14 | 21.5 | 4 | 12.5 | 22 | 26.8 | 50 | 22.5 |
| all | 2 | 4.7 | 1 | 1.5 | 0 | 0 | 0 | 0 | 3 | 1.4 |

TABLE 8 (continued)

| | School size | | | | | | | | Totals | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1-99 | | 100-399 | | 400-899 | | 900 + | | | |
| | No. | % | No. | % | No. | % | No. | % | No. | % |
| Courses lack Calculus | | | | | | | | | | |
| 1 course | 3 | 7.0 | 6 | 9.2 | 3 | 9.4 | 12 | 14.6 | 24 | 10.8 |
| 2 courses | 1 | 2.3 | 3 | 4.6 | 0 | 0 | 5 | 6.1 | 9 | 4.1 |
| 3 courses | 4 | 9.3 | 2 | 3.1 | 1 | 3.1 | 3 | 3.7 | 10 | 4.5 |
| Real analysis | 34 | 79.1 | 56 | 86.2 | 26 | 81.3 | 64 | 78.0 | 180 | 81.1 |
| Linear algebra | 26 | 60.5 | 47 | 72.3 | 21 | 65.6 | 57 | 69.5 | 151 | 68.0 |
| Modern algebra | 12 | 27.9 | 18 | 27.7 | 7 | 21.9 | 16 | 19.5 | 53 | 23.9 |
| Geometry | 7 | 16.3 | 17 | 26.2 | 4 | 12.5 | 24 | 29.3 | 52 | 23.4 |
| Probability & statistics | 11 | 25.6 | 16 | 24.6 | 11 | 34.4 | 27 | 32.9 | 65 | 29.3 |
| Computer | 36 | 83.7 | 46 | 70.8 | 31 | 96.9 | 67 | 81.7 | 180 | 81.1 |

only mathematics listed as either business mathematics or consumer mathematics in the report of mathematics teachers. The other teachers are teaching a class of general mathematics or higher and have never taken any calculus. From Table 8 page 74, one can see that there are 10 teachers teaching a mathematics course of a level above algebra 1 that have never taken a calculus course.

General Mathematics Teachers

One often hears that the teachers of general mathematics are not as well prepared in mathematics and that the general mathematics courses are given to the less experienced teachers. In order to test these two hypotheses the mathematics teachers were broken into two groups. The groups were the teachers that taught one or more general mathematics classes and those that did not teach any general mathematics classes though they did teach other mathematics courses. The whole sample was used when credit hours of mathematics was considered but in considering the years of experience only those answering the questionnaire could be used. The teachers in the schools size 1-99 were not considered in this because 71 percent of the teachers taught a general mathematics class since a number of these schools have only one mathematics teacher.

In the sample from the three larger classes of school there were 184 teachers that taught a general mathematics class and 105 that

TABLE 9

DISTRIBUTION OF THE GENERAL MATHEMATICS TEACHERS AND NON-GENERAL MATHEMATICS TEACHERS ACCORDING TO THEIR MATHEMATICS PREPARATION

| Quarter credit hours | School size | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 100-399 | | 400-899 | | 900 + | | Totals | |
| | General math | Non general math | General math | Non general math | General math | Non general math | General math | Non general math |
| 0-5 | 7 | 0 | 2 | 0 | 4 | 1 | 13 | 1 |
| 6-10 | 2 | 1 | 0 | 0 | 0 | 1 | 2 | 2 |
| 11-15 | 3 | 0 | 0 | 0 | 0 | 0 | 3 | 0 |
| 16-20 | 1 | 1 | 0 | 0 | 1 | 0 | 2 | 1 |
| 21-25 | 3 | 1 | 2 | 0 | 2 | 1 | 7 | 2 |
| 26-30 | 3 | 1 | 1 | 0 | 6 | 3 | 10 | 4 |
| 31-35 | 2 | 3 | 5 | 1 | 3 | 1 | 10 | 5 |
| 36-40 | 3 | 2 | 0 | 1 | 7 | 3 | 10 | 6 |
| 41-45 | 2 | 4 | 3 | 4 | 9 | 6 | 14 | 14 |
| 46-50 | 8 | 6 | 3 | 2 | 9 | 6 | 20 | 14 |
| 51-55 | 13 | 4 | 6 | 1 | 6 | 4 | 25 | 9 |
| 56-60 | 6 | 2 | 2 | 2 | 10 | 6 | 18 | 10 |
| 61-65 | 3 | 1 | 2 | 2 | 4 | 4 | 9 | 7 |

TABLE 9 (continued)

| Quarter credit hours | School size | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 100-399 | | 400-899 | | 900 + | | Totals | |
| | General math | Non general math | General math | Non general math | General math | Non general math | General math | Non general math |
| 66-70 | 1 | 1 | 0 | 0 | 4 | 1 | 5 | 2 |
| 71-75 | 2 | 1 | 3 | 1 | 1 | 7 | 6 | 9 |
| 76-80 | 6 | 1 | 2 | 1 | 1 | 2 | 9 | 4 |
| 81-85 | 2 | 0 | 1 | 0 | 3 | 1 | 6 | 1 |
| 86-90 | 1 | 0 | 0 | 0 | 2 | 0 | 3 | 0 |
| 91-95 | 1 | 0 | 0 | 0 | 2 | 2 | 3 | 2 |
| 96-100 | 1 | 1 | 0 | 2 | 4 | 2 | 5 | 5 |
| 101-105 | 1 | 0 | 0 | 0 | 1 | 1 | 2 | 1 |
| 106-110 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 2 |
| 111-115 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| 116-120 | 1 | 0 | 0 | 0 | 0 | 2 | 1 | 2 |
| 121- | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |

TABLE 10

DISTRIBUTION OF GENERAL MATHEMATICS TEACHERS AS COMPARED TO NON-GENERAL MATHEMATICS TEACHERS ACCORDING TO TOTAL YEARS OF EXPERIENCE

| Years of experience | School size | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 100-399 | | 400-899 | | 900 + | | Total | |
| | General math | Non general math | General math | Non general math | General math | Non general math | General math | Non general math |
| 1-3 | 10 | 3 | 3 | 1 | 6 | 1 | 19 | 5 |
| 4-6 | 10 | 7 | 3 | 2 | 8 | 3 | 21 | 12 |
| 7-9 | 9 | 3 | 4 | 3 | 10 | 4 | 23 | 10 |
| 10-12 | 13 | 6 | 2 | 1 | 9 | 5 | 24 | 12 |
| 13-15 | 1 | 2 | 2 | 5 | 9 | 6 | 12 | 13 |
| 16-18 | 2 | 4 | 4 | 2 | 7 | 5 | 13 | 11 |
| 19-21 | 1 | 0 | 2 | 1 | 3 | 4 | 6 | 5 |
| 22-24 | 0 | 0 | 1 | 0 | 0 | 2 | 1 | 2 |
| 25-27 | 1 | 2 | 1 | 0 | 2 | 4 | 4 | 6 |
| 28-30 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 2 |
| 31-33 | 0 | 0 | 0 | 0 | 1 | 3 | 1 | 3 |
| 34- | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |

did not. The mean quarter hours of credit for the general mathematics teachers was 50.20 credits and for the other teachers it was 57.28 credits.

Using a t-test to test the hypothesis that the mean quarter hours of credit in mathematics of the non-general mathematics teachers was greater than that of the general mathematics teachers yields a t value of 2.35. This was found to be significant at the .01 level.

The mean number of years experience of the general mathematics teachers was 10.5, and the mean number of years experience for the non-general mathematics teachers was 13.9. A t-test was used to test the hypothesis that the mean years of experience of the non-general mathematics teachers is greater than the mean of the years of experience of the general mathematics teachers. The t value computed from Table 10 page 79 is 3.24 with 206 degrees of freedom. The 3.24 is significant at the .01 level of significance.

Location of Undergraduate Training

Montana State University trained more of the mathematics teachers in the sample studied than any of the other schools. Approximately 21 percent of the teachers were trained by MSU. Both the University of Montana and Eastern Montana College trained about 16 percent. These were followed by Western Montana College with about 10 percent. None of the other colleges in the state had more

TABLE 11

DISTRIBUTION OF THE MATHEMATICS TEACHERS ACCORDING TO THE COLLEGE, UNIVERSITY, OR STATE WHERE THE UNDERGRADUATE TRAINING WAS RECEIVED

| School or state | School size 1-99 | | 100-399 | | 400-899 | | 900 + | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % | No. | % |
| MSU | 13 | 21.7 | 19 | 18.3 | 12 | 24.0 | 30 | 21.9 | 74 | 21.1 |
| U of M | 5 | 8.3 | 21 | 20.2 | 9 | 18.0 | 20 | 14.6 | 55 | 15.7 |
| EMC | 9 | 15.0 | 18 | 17.3 | 8 | 16.0 | 21 | 15.3 | 56 | 16.0 |
| WMC | 9 | 15.0 | 12 | 11.5 | 5 | 10.0 | 9 | 6.6 | 35 | 10.0 |
| NMC | 4 | 6.7 | 3 | 2.9 | 1 | 2.0 | 3 | 2.2 | 11 | 3.1 |
| Carroll College | 0 | 0.0 | 2 | 1.9 | 1 | 2.0 | 3 | 2.2 | 6 | 1.7 |
| College of Great Falls | 2 | 3.3 | 4 | 3.8 | 2 | 4.0 | 3 | 2.2 | 11 | 3.1 |
| Rocky Mountain | 3 | 5.0 | 2 | 1.9 | 0 | 0.0 | 3 | 2.2 | 8 | 2.3 |
| Idaho | 0 | 0.0 | 2 | 1.9 | 0 | 0.0 | 1 | 0.7 | 3 | 0.9 |

TABLE 11 (continued)

| School or state | School size 1-99 | | 100-399 | | 400-899 | | 900 + | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | No. | % | No. | % | No. | % | No. | % | No. | % |
| Wyoming | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 | 0 | 0.0 |
| North Dakota | 5 | 8.3 | 5 | 4.8 | 8 | 16.0 | 9 | 6.6 | 27 | 7.7 |
| South Dakota | 1 | 1.7 | 1 | 1.0 | 0 | 0.0 | 4 | 2.9 | 6 | 1.7 |
| Washington | 1 | 1.7 | 3 | 2.9 | 1 | 2.0 | 2 | 1.5 | 7 | 2.0 |
| Oregon | 0 | 0.0 | 1 | 1.0 | 0 | 0.0 | 1 | 0.7 | 2 | 0.6 |
| Other | 8 | 13.3 | 11 | 10.6 | 3 | 6.0 | 28 | 20.4 | 50 | 14.2 |

than about 3 percent. About 27 percent of the teachers in the sample were trained out of state with North Dakota accounting for about 8 percent.

The percent of teachers trained out of state was high in comparison with the study by Bertan (1971,80) in Indiana and Pegula (1965,140) in West Virginia where they found about 15 to 16 percent were trained out of state. The percent trained in Montana has increased substantially since the Christman (1950:225) study in 1949-50 where he reported that only 51 percent of the mathematics teachers of Montana received their degree in state.

Mathematics Preparation of Teachers Before 1966 and from 1966 to 1976

The mathematics preparation of 104 mathematics teachers that graduated before 1966 was compared with the mathematics preparation of 142 teachers graduating from 1966 to 1976 (see Table 12, page 84). The mean credit hours completed for teachers graduating before 1966 was 53.04 quarter credit hours and for those 1966 through 1976 was 47.08. Using a t-test to test the hypothesis that the mean of the before 1966 graduates is larger than the mean of the 1966 to 1976 yielded a t value of 1.81 which is not significant at the .01 level of significance with 261 degrees of freedom.

TABLE 12

DISTRIBUTION OF THE MATHEMATICS TEACHERS ACCORDING TO THE QUARTER CREDIT HOURS OF MATHEMATICS TAKEN BY THE TEACHERS THAT GRADUATED BEFORE 1966 AND THOSE THAT GRADUATED 1966 TO 1976

| Quarter hours of credit | School size | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1-99 | | 100-399 | | 400-899 | | 900 + | | Totals | |
| | Before 1966 | 1966 to 1976 | Before 1966 | 1966 to 1976 | Before 1966 | 1966 to 1976 | Before 1966 | 1966 to 1976 | Before 1966 | 1966 to 1976 |
| 0- 5 | 1 | 6 | 0 | 7 | 2 | 0 | 2 | 0 | 5 | 13 |
| 6-10 | 0 | 3 | 1 | 2 | 0 | 0 | 0 | 1 | 1 | 6 |
| 11-15 | 1 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 3 |
| 16-20 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| 21-25 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 4 |
| 26-30 | 1 | 3 | 2 | 1 | 1 | 0 | 5 | 0 | 9 | 4 |
| 31-35 | 0 | 1 | 2 | 2 | 2 | 3 | 2 | 2 | 6 | 8 |
| 36-40 | 0 | 0 | 3 | 2 | 1 | 0 | 4 | 2 | 8 | 4 |
| 41-45 | 1 | 4 | 2 | 4 | 4 | 1 | 9 | 3 | 16 | 12 |

TABLE 12 (continued)

| Quarter hours of credit | School size | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1-99 | | 100-399 | | 400-899 | | 900 + | | Totals | |
| | Before 1966 | 1966 to 1976 | Before 1966 | 1966 to 1976 | Before 1966 | 1966 to 1976 | Before 1966 | 1966 to 1976 | Before 1966 | 1966 to 1976 |
| 46-50 | 1 | 2 | 7 | 7 | 3 | 0 | 7 | 4 | 18 | 13 |
| 51-55 | 0 | 5 | 2 | 11 | 1 | 4 | 3 | 5 | 6 | 26 |
| 56-60 | 0 | 2 | 3 | 2 | 2 | 2 | 7 | 6 | 12 | 12 |
| 61-65 | 1 | 3 | 0 | 3 | 1 | 2 | 4 | 4 | 6 | 12 |
| 66-70 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 2 | 2 |
| 71-75 | 0 | 1 | 1 | 2 | 2 | 1 | 3 | 3 | 6 | 7 |
| 76-80 | 0 | 1 | 2 | 3 | 1 | 0 | 0 | 2 | 3 | 6 |
| 81-85 | 1 | 0 | 0 | 2 | 0 | 0 | 7 | 2 | 2 | 4 |
| 86-90 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 2 | 1 |
| 91-95 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 0 |
| 96-100 | 0 | 1 | 1 | 0 | 1 | 0 | 3 | 1 | 5 | 2 |

TABLE 12 (continued)

| Quarter hours of credit | School size | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1-99 | | 100-399 | | 400-899 | | 900 + | | Totals | |
| | Before 1966 | 1966 to 1976 | Before 1966 | 1966 to 1976 | Before 1966 | 1966 to 1976 | Before 1966 | 1966 to 1976 | Before 1966 | 1966 to 1976 |
| 101-105 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | 3 | 1 |
| 106-110 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| 111-115 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| 116-120 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| 121- | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |

## RESULTS OF THE QUESTIONNAIRE

The remainder of this chapter will present results that are based on the 255 usable questionnaires returned. The only questionnaires that were not used in this part were those returned by teachers that were teaching no high school mathematics classes. At times there were variations in the number of teachers that answered a particular question. There were a few unanswered questions and several teachers left a page of the questionnaire blank.

### Teachers Classified as to Sex

It was found that about 17 percent of the mathematics teachers that answered the questionnaire were women and 83 percent were men. The percent varied from a high of about 24 percent women for the schools with 1-99 students to a low of about 11 percent women in the school size 400-899.

The percent of female teachers in Montana is low when compared to the studies in Indiana and Nevada where Bertan (1971, 65) and Bradshaw (1968, 74) found the percent of female teachers to be 22 percent.

### Age of Mathematics Teachers

The mean and median ages of the mathematics teachers were calculated from the formulas dealing with data grouped in a frequency

TABLE 13

DISTRIBUTION OF THE MATHEMATICS TEACHERS CLASSIFIED AS TO SEX

| Sex | School size | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1-99 | | 100-399 | | 400-899 | | 900 + | | Total | |
| | No. | % | No. | % | No. | % | No. | % | No. | % |
| Female | 11 | 23.9 | 13 | 17.1 | 4 | 10.8 | 15 | 15.6 | 43 | 16.9 |
| Male | 35 | 76.1 | 63 | 82.9 | 33 | 82.9 | 81 | 84.4 | 212 | 83.1 |

TABLE 14

DISTRIBUTION OF THE AGE OF MATHEMATICS TEACHERS CLASSIFIED BY SEX AND SIZE OF SCHOOL

| Age | School size | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1-99 | | 100-399 | | 400-899 | | 900 + | | Totals | | Total of both |
| | F | M | F | M | F | M | F | M | F | M | |
| 21-28 | 9 | 15 | 7 | 15 | 2 | 6 | 5 | 7 | 23 | 43 | 66 |
| 29-36 | 1 | 12 | 2 | 33 | 1 | 12 | 4 | 36 | 8 | 93 | 101 |
| 37-44 | 0 | 4 | 2 | 11 | 0 | 10 | 4 | 19 | 6 | 44 | 50 |
| 45-52 | 1 | 2 | 1 | 1 | 0 | 3 | 0 | 12 | 2 | 18 | 20 |
| 53-60 | 0 | 2 | 0 | 2 | 1 | 2 | 2 | 6 | 3 | 12 | 15 |
| 61-68 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 2 |
| Mean age | 27.0 | 31.3 | 32.0 | 32.0 | 33.3 | 34.9 | 33.8 | 36.5 | 31.5 | 34.1 | 33.6 |
| Median age | 25.4 | 30.2 | 27.9 | 32.4 | 28.5 | 35.5 | 33.5 | 35.9 | 28.0 | 33.9 | 33.3 |

distribution table. From the data the mean age for the women mathematics teachers was found to be 31.5 years and for the men was 34.1 years. The mean of all mathematics teachers was 33.3 years. The median age of the women was found to be 28.0 years, and for the men it was 33.9 years.

The median age here agrees with a survey made in 1961 (NSF, 1963:4) which found half of the mathematics teachers to be less than 35 years of age. This same survey also found about 25 percent older than 45 years, but only about 18.5 percent of Montana's mathematics teachers are 45 years or older. Bertan (1971:62) found the mean age to be 36.9 years and a median of 34.8 years for the teachers in Indiana.

The average age of the Montana mathematics teachers had made a significant decrease from 1949-50 when Christman (1950:224) did his study. Christman found the average age of women to be 46 years as compared to 31.5 years in this study. For men the average age found by Christman was 38 years and for this study it was 34.1 years, and for all teachers Christman listed the average age as 40 years whereas in this study it is 33.6 years.

Amount of Experience

The number of years of experience varied depending on the size school. The smaller the school the less years of experience on the

TABLE 15

DISTRIBUTION OF THE MATHEMATICS TEACHERS ACCORDING TO THE TOTAL NUMBER OF YEARS EXPERIENCE AND YEARS AT PRESENT LOCATION

| Years experience | School size | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1-99 | | 100-399 | | 400-899 | | 900 + | | Totals | |
| | Total | Present location | Total | Present location | Total | Present location | Total | Present location | Total | Present location |
| 1- 3 | 16 | 27 | 13 | 27 | 4 | 9 | 7 | 16 | 40 | 79 |
| 4- 6 | 13 | 7 | 17 | 14 | 5 | 5 | 11 | 16 | 46 | 42 |
| 7- 9 | 8 | 4 | 12 | 14 | 7 | 8 | 14 | 19 | 41 | 45 |
| 10-12 | 1 | 2 | 20 | 13 | 3 | 3 | 16 | 15 | 40 | 33 |
| 13-15 | 2 | 1 | 3 | 2 | 7 | 5 | 13 | 11 | 25 | 19 |
| 16-18 | 1 | 3 | 5 | 3 | 6 | 5 | 13 | 7 | 25 | 18 |
| 19-21 | 3 | 0 | 1 | 0 | 3 | 2 | 7 | 6 | 14 | 8 |
| 22-24 | 1 | 1 | 0 | 2 | 1 | 0 | 2 | 0 | 4 | 3 |
| 25-27 | 1 | 1 | 3 | 1 | 1 | 0 | 5 | 2 | 10 | 4 |
| 28-30 | 0 | 0 | 2 | 0 | 0 | 0 | 1 | 1 | 3 | 1 |
| 31-33 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 1 | 4 | 1 |
| 34- | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 2 | 0 |
| Mean | 7.08 | 5.59 | 9.34 | 6.97 | 11.65 | 9.05 | 13.72 | 9.95 | 10.9 | 8.13 |

average. This ranged from a mean of 7.08 years of experience for the school size 1-99 to 13.72 years of experience for schools of 900-above. The total mean years of experience for all mathematics teachers was 10.9 years. Using a one-way analysis of variance test the F value calculated was 10.76 which was significant at the .01 level.

The years of experience at the present location was also considered and the results were much the same as for the total years of experience. The mean number of years of teaching mathematics at the present location varied from 5.59 years at the small schools to 9.95 years at the large schools. Using a one-way analysis of variance the F value calculated was 6.79 which was significant at the .01.

The median for the total years of experience was 9.5 years. In Christman's (1950:225) study he found the median years of teaching experience to be 12 years. He also found that 3 percent of the teachers had 35 or more years of experience whereas in this study less than one percent had 34 years or more experience.

Number of Classes and Preparations

The number of mathematics classes and the total number of classes taught by the teachers were obtained from the questionnaire (see Tables 16-19, pages 93 through 96). The mean number of mathematics classes per mathematics teacher varied from 4.16 classes for schools size 100-399 to 4.67 classes for schools size 400-899

TABLE 16

DISTRIBUTION OF THE MATHEMATICS TEACHERS ACCORDING TO NUMBER OF CLASSES OF MATHEMATICS, TOTAL CLASSES, AND NUMBER OF PREPARATIONS PER DAY THAT TEACHERS ARE ASSIGNED IN SCHOOLS SIZE 1-99

| Number of classes or preparations | Math | Total classes | Preparations | Non-math classes |
|---|---|---|---|---|
| 1 | 3 | 0 | 0 | 10 |
| 2 | 4 | 0 | 0 | 6 |
| 3 | 6 | 1 | 2 | 4 |
| 4 | 7 | 3 | 4 | 2 |
| 5 | 15 | 15 | 19 | 1 |
| 6 | 9 | 20 | 16 | 1 |
| 7 | 1 | 6 | 4 | 0 |

TABLE 17

DISTRIBUTION OF THE MATHEMATICS TEACHERS ACCORDING TO NUMBER OF CLASSES OF MATHEMATICS, TOTAL CLASSES, AND NUMBER OF PREPARATIONS PER DAY THAT TEACHERS ARE ASSIGNED IN SCHOOLS SIZE 100-399

| Number of classes or preparations | Math | Total classes | Preparations | Non-math classes |
|---|---|---|---|---|
| 1 | 7 | 1 | 2 | 13 |
| 2 | 6 | 1 | 3 | 7 |
| 3 | 15 | 2 | 15 | 8 |
| 4 | 8 | 3 | 27 | 5 |
| 5 | 17 | 35 | 21 | 2 |
| 6 | 20 | 30 | 6 | 0 |
| 7 | 1 | 2 | 0 | 0 |

TABLE 18

DISTRIBUTION OF THE MATHEMATICS TEACHERS ACCORDING TO NUMBER OF CLASSES OF MATHEMATICS, TOTAL CLASSES, AND NUMBER OF PREPARATIONS PER DAY THAT TEACHERS ARE ASSIGNED IN SCHOOLS SIZE 400-899

| Number of classes or preparations | Math | Total classes | Preparations | Non-math classes |
|---|---|---|---|---|
| 1 | 1 | 0 | 1 | 3 |
| 2 | 2 | 1 | 10 | 1 |
| 3 | 2 | 0 | 21 | 3 |
| 4 | 3 | 1 | 3 | 0 |
| 5 | 23 | 28 | 0 | 0 |
| 6 | 5 | 6 | 1 | 0 |

TABLE 19

DISTRIBUTION OF THE MATHEMATICS TEACHERS ACCORDING TO NUMBER OF CLASSES OF MATHEMATICS, TOTAL CLASSES, AND NUMBER OF PREPARATIONS PER DAY THAT TEACHERS ARE ASSIGNED IN SCHOOLS SIZE 900 +

| Number of classes or preparations | Math | Total classes | Preparations | Non-math classes |
|---|---|---|---|---|
| 1 | 2 | 0 | 4 | 4 |
| 2 | 8 | 1 | 38 | 5 |
| 3 | 4 | 2 | 47 | 3 |
| 4 | 11 | 14 | 6 | 2 |
| 5 | 60 | 68 | 0 | 0 |
| 6 | 10 | 10 | 0 | 0 |

TABLE 20

THE MEAN AND MEDIAN OF THE NUMBER OF MATHEMATICS CLASSES, TOTAL NUMBER OF CLASSES, AND NUMBER OF PREPARATIONS FOR WHICH MATHEMATICS TEACHERS ARE RESPONSIBLE

| Schools size | Math classes | | Total classes | | Preparations | |
|---|---|---|---|---|---|---|
| | Mean | Median | Mean | Median | Mean | Median |
| 1-99 | 4.29 | 5 | 5.6 | 6 | 5.36 | 5 |
| 100-399 | 4.16 | 5 | 5.27 | 5 | 4.08 | 4 |
| 400-899 | 4.67 | 5 | 5.06 | 5 | 2.83 | 3 |
| 900-above | 4.57 | 5 | 4.88 | 5 | 2.58 | 3 |

(see Table 20, page 97). The mean of the total number of classes taught by mathematics teachers varied from 5.6 classes for schools size 1-99 to 4.88 classes for schools size 900-above. The trend then is that a teacher in a small school tends to have more total classes than the teacher in the large school, but using a one-way analysis of variance there is not a significant difference at the .01 level of significance.

The Standards for Accreditation of Montana Schools regulation 231.3 (1976:16) states: "No teacher shall have more than 28 clock hours of assigned student responsibility per week." This regulation as stated would allow a teacher to have six 55 minute classes per day or seven 45 minute classes per day. Twenty-nine percent of the mathematics teachers in this survey had six or more classes per day. From the data it was also found that 84 percent of the mathematics teachers have 5 or more classes. The 1961 survey by NSF (1963:29) reported that 58 percent of the mathematics teachers had 5 or more classes.

The place where the load of a mathematics teacher in a small school is heavier than the mathematics teacher in a large school is in the number of different preparations (see Tables 16-19, pages 93-96). The mean number of preparations varied from a high of 5.36 in school size 1-99 to a low of 2.58 in the schools size 900-above (see Table 20,

page 97). This was a significant difference at the .01 level of significance using a one-way analysis of variance. The teachers in the small school also tended to have some special classes with only one or two students in a class. These were not considered as a class in the tabulations. In the schools size 1-99 there were six teachers with one special class with one or two students. There were three teachers with three special classes.

Non-Mathematics Classes Taught

From the Tables 16 through 19, pages 93 through 96, it is evident that the mathematics teachers tend to teach mainly mathematics. In the two smaller size high schools about half of the mathematics teachers teach at least one non-mathematics class. In the two larger size high schools less than 20 percent of the teachers teach a non-mathematics class. Chemistry and physics were the classes most often taught along with mathematics. This was followed by other types of science such as biology, earth science, and other courses of this type. Next would be business and physical education. There were a number of other courses and duties listed such as drivers education and counseling, but most of these categories contained only one or two teachers at most in each different size of high school.

The percent of teachers teaching non-mathematics courses

have decreased from 1949-50 when the Christman (1950:222-23) study found that over 75 percent of the mathematics teachers taught in at least two or more fields.

Student Contacts

The Standards for Accreditation of Montana Schools regulation 231.3 (Board of Public Education, 1976:16) states: "The number of students assigned per day shall not exceed 160." Page 13 of the Standards states, "Class load also affects the quality of classroom instruction." Therefore, the number of students per day was calculated from the number of classes taught and the class sizes reported in the questionnaire (see Table 21, page 101).

The mean of the total number of student contacts per day of the mathematics teachers varied from a low of 55.7 contacts for mathematics teachers in school size 1-99 to a high of 119.7 contacts in the schools size 900-above. Using a one-way analysis of variance this was a significant difference at the .01 level. Thus as the school size increased so did the number of student contacts that a mathematics teacher could expect.

Preparation Time

The Standards for Accreditation of Montana Schools states "To make the best use of a teacher's talent, release time is required to

TABLE 21

DISTRIBUTION OF THE MATHEMATICS TEACHERS ACCORDING TO TOTAL STUDENT CONTACTS BY SIZE OF SCHOOL

| Total student contacts | School size | | | |
|---|---|---|---|---|
| | 1-99 | 100-399 | 400-899 | 900 + |
| 0- 39 | 10 | 2 | 0 | 0 |
| 40- 59 | 16 | 3 | 1 | 2 |
| 60- 79 | 15 | 13 | 4 | 3 |
| 80- 99 | 3 | 28 | 5 | 14 |
| 100-119 | 1 | 13 | 12 | 25 |
| 120-139 | 0 | 9 | 12 | 41 |
| 140-159 | 0 | 2 | 0 | 7 |
| 160-179 | 0 | 2 | 0 | 2 |
| 180-199 | 0 | 0 | 0 | 1 |

develop lesson plans,..." (Board of Public Education, 1976:13). Thus the questionnaire asked for the amount of preparation time allotted to each teacher (see Table 22, page 103).

Two-thirds of the mathematics teachers indicated that they had from 46 to 60 minutes of preparation time daily. There were four teachers that indicated that they had no preparation time. One of these stated that he had no preparation time during football and track seasons.

Extra Curricular Activities

The classroom load is not an adequate indication of the total load of a teacher. Therefore, the mathematics teachers were asked to indicate the extra curricular activities for which they were responsible. The extra curricular activities for which the mathematics teachers were most often responsible was one of the sports programs such as football, girls' basketball, and cross country (see Table 23, page 104). About 64 percent of the teachers indicated that they had some type of extra curricular activities, and of the teachers that had extra curricular activities, 40 percent spent over 200 hours per year on the activity (see Table 24, page 105). Most of those spending over 200 hours on activities were coaching one or more sports programs.

The teachers were asked to indicate if the extra curricular activities were voluntary or assigned. For the activities such as the

TABLE 22

DISTRIBUTION OF MATHEMATICS TEACHERS ACCORDING TO PREPARATION TIME PER DAY BY SIZE OF SCHOOL

| Minutes per day | School size | | | | | |
|---|---|---|---|---|---|---|
| | 1-99 | 100-399 | 400-899 | 900 + | Totals | % |
| 0 | 1 | 2 | 0 | 1 | 4 | 1.6 |
| 10- 15 | 0 | 0 | 0 | 0 | 0 | 0.0 |
| 16- 30 | 1 | 3 | 0 | 0 | 4 | 1.6 |
| 31- 45 | 9 | 7 | 1 | 4 | 21 | 8.5 |
| 46- 60 | 26 | 48 | 19 | 71 | 164 | 66.7 |
| 61- 75 | 3 | 2 | 3 | 0 | 8 | 3.3 |
| 76- 90 | 2 | 2 | 2 | 10 | 16 | 6.5 |
| 91-105 | 1 | 1 | 5 | 2 | 9 | 3.7 |
| 106-120 | 0 | 5 | 7 | 8 | 20 | 8.1 |

TABLE 23

DISTRIBUTION OF MATHEMATICS TEACHERS ACCORDING TO EXTRA CURRICULAR ACTIVITIES BY SIZE OF SCHOOL

| Activity | School size | | | |
|---|---|---|---|---|
| | 1-99 | 100-399 | 400-899 | 900 + |
| Fall sport | 13 | 14 | 9 | 19 |
| Winter sport | 11 | 12 | 8 | 18 |
| Spring sport | 10 | 11 | 5 | 21 |
| Class sponsor | 20 | 24 | 4 | 4 |
| Ticket taker or timer | 4 | 3 | 5 | 9 |
| Club | 10 | 29 | 7 | 8 |
| Cheerleaders and pep club | 4 | 5 | 1 | 0 |
| Other | 5 | 4 | 3 | 12 |

TABLE 24

DISTRIBUTION OF MATHEMATICS TEACHERS ACCORDING TO TIME SPENT IN EXTRA CURRICULAR ACTIVITIES BY SIZE OF SCHOOL

| Hours | School size | | | | |
|---|---|---|---|---|---|
| | 1-99 | 100-399 | 400-899 | 900 + | Totals |
| 1- 40 | 3 | 12 | 6 | 9 | 30 |
| 41- 80 | 5 | 9 | 7 | 5 | 26 |
| 81-120 | 3 | 5 | 1 | 8 | 17 |
| 121-160 | 5 | 8 | 1 | 5 | 19 |
| 161-200 | 2 | 1 | 1 | 2 | 6 |
| over 200 | 13 | 21 | 11 | 22 | 65 |

sports and club sponsorship, it was about evenly divided between the voluntary and assigned. The class sponsorship was almost always assigned. There was no definite trend indicated in the other activities.

Courses for Teaching Certificate Renewal

The teachers were asked to indicate the areas in which they had taken courses to renew a certificate in order to ascertain if the required six quarter hours of credit was being used to extend or improve their knowledge in their teaching field. Just over 75 percent of the respondents indicated that they had taken courses to renew their teaching certificates (see Table 25, page 107). Some of the respondents that answered no may have done so because they did not specifically take courses to renew a certificate but took them to get an advanced degree or fifth year program which ultimately led to a new certificate.

Fifty-eight percent of the mathematics teachers indicated that they had taken at least some type of mathematics course to renew their teaching certificate (see Tables 26-29, pages 108-111). About 46 percent indicated they had taken an education course to renew their certificate.

TABLE 25

DISTRIBUTION OF MATHEMATICS TEACHERS THAT HAVE TAKEN COURSES TO RENEW A TEACHING CERTIFICATE BY SCHOOL SIZE

| Taken a course | School size | | | |
|---|---|---|---|---|
| | 1-99 | 100-399 | 400-899 | 900 + |
| Yes | 31 | 58 | 30 | 76 |
| No | 14 | 14 | 7 | 16 |

TABLE 26

DISTRIBUTION OF MATHEMATICS TEACHERS INDICATING COURSES TAKEN TO RENEW A TEACHING CERTIFICATE IN SCHOOL SIZE 1-99

| Quarter credit hours | Education | Math | Science | English | Social studies | Voc. | Art or music | Other |
|---|---|---|---|---|---|---|---|---|
| 1- 3 | 3 | 5 | 0 | 1 | 0 | 0 | 0 | 1 |
| 4- 6 | 3 | 3 | 4 | 0 | 1 | 0 | 1 | 5 |
| 7- 9 | 4 | 4 | 0 | 0 | 1 | 0 | 0 | 2 |
| 10-12 | 6 | 4 | 0 | 0 | 0 | 0 | 0 | 1 |
| 13-15 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| 16-18 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| 19-21 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 22-24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| above 24 | 1 | 2 | 0 | 0 | 1 | 0 | 0 | 0 |

TABLE 27

DISTRIBUTION OF MATHEMATICS TEACHERS INDICATING COURSES TAKEN TO RENEW A TEACHING CERTIFICATE IN SCHOOL SIZE 100-399

| Quarter credit hours | Education | Math | Science | English | Social studies | Voc. | Art or music | Other |
|---|---|---|---|---|---|---|---|---|
| 1- 3 | 8 | 4 | 2 | 0 | 0 | 1 | 0 | 4 |
| 4- 6 | 7 | 13 | 5 | 0 | 2 | 1 | 0 | 4 |
| 7- 9 | 4 | 7 | 3 | 0 | 0 | 0 | 0 | 1 |
| 10-12 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 3 |
| 13-15 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 1 |
| 16-18 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 1 |
| 19-21 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22-24 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| above 24 | 5 | 9 | 2 | 0 | 0 | 0 | 0 | 0 |

TABLE 28

DISTRIBUTION OF MATHEMATICS TEACHERS INDICATING COURSES TAKEN TO RENEW A TEACHING CERTIFICATE IN SCHOOL SIZE 400-899

| Quarter credit hours | Education | Math | Science | English | Social studies | Voc. | Art or music | Other |
|---|---|---|---|---|---|---|---|---|
| 1- 3 | 2 | 3 | 0 | 1 | 0 | 0 | 0 | 6 |
| 4- 6 | 4 | 5 | 4 | 0 | 1 | 0 | 0 | 5 |
| 7- 9 | 5 | 1 | 2 | 0 | 0 | 0 | 0 | 1 |
| 10-12 | 2 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 13-15 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| 16-18 | 0 | 2 | 0 | 0 | 0 | 1 | 0 | 0 |
| 19-21 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 22-24 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| above 24 | 2 | 10 | 0 | 0 | 0 | 0 | 0 | 0 |

TABLE 29

DISTRIBUTION OF MATHEMATICS TEACHERS INDICATING COURSES TAKEN TO RENEW A TEACHING CERTIFICATE IN SCHOOL SIZE 900 +

| Quarter credit hours | Education | Math | Science | English | Social studies | Voc. | Art or music | Other |
|---|---|---|---|---|---|---|---|---|
| 1- 3 | 3 | 4 | 4 | 1 | 2 | 0 | 2 | 7 |
| 4- 6 | 9 | 8 | 2 | 0 | 1 | 1 | 0 | 2 |
| 7- 9 | 4 | 6 | 2 | 0 | 0 | 0 | 0 | 1 |
| 10-12 | 8 | 9 | 1 | 0 | 0 | 0 | 0 | 4 |
| 13-15 | 3 | 8 | 1 | 1 | 1 | 0 | 1 | 3 |
| 16-18 | 3 | 4 | 1 | 0 | 0 | 0 | 0 | 0 |
| 19-21 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| 22-24 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| above 24 | 16 | 21 | 3 | 0 | 0 | 1 | 0 | 0 |

Future Course Work

In the section on certification it was found that 34.7 percent of the teachers held either a class 1 or a life teaching certificate. This indicates that the other 65.3 percent of the mathematics teachers will need to have some more course work to renew a teaching certificate within the next five years. The 67.2 percent that indicated they planned to take some type of mathematics course could very well be taking the courses mainly for certification (see Table 30, page 113). From the percents indicating mathematics and the ones indicating taking non-mathematics courses, one can see that the teachers plan to take at least part of their work in their teaching field.

NSF Courses

In order to ascertain what effect the NSF had on mathematics teachers were asked to indicate the type of financially-supported courses they had attended (see Table 31, pages 114-15). It was found that about 12 percent of the mathematics teachers had attended at least one academic year institute, about 30 percent a summer institute, and about 34 percent had taken an in-service course (see Table 32, page 116). A total of approximately 54 percent of the respondents had attended some type of NSF-supported institute.

The percent of Montana mathematics teachers that have attended a summer institute or academic year institute was somewhat smaller than

TABLE 30

DISTRIBUTION OF THE MATHEMATICS TEACHERS ACCORDING TO THEIR PLANS TO TAKE COURSES IN NEXT FOUR YEARS

| Plan and answer | School size | | | | Totals | |
|---|---|---|---|---|---|---|
| | 1-99 | 100-399 | 400-899 | 900 + | No. | % |
| Take a math course | | | | | | |
| Yes | 25 | 47 | 25 | 57 | 154 | 67.2 |
| No | 10 | 22 | 10 | 30 | 62 | 27.1 |
| Undecided | 2 | 2 | 2 | 7 | 13 | 5.7 |
| A course other than math | | | | | | |
| Yes | 23 | 54 | 23 | 62 | 162 | 67.2 |
| No | 12 | 15 | 12 | 26 | 65 | 27.0 |
| Undecided | 2 | 3 | 2 | 7 | 14 | 5.8 |

TABLE 31

DISTRIBUTION OF MATHEMATICS TEACHERS ATTENDING FINANCIALLY SUPPORTED INSTITUTES BY SCHOOL SIZE

| Type of institute and school size | Number of times attended | | | | | | |
|---|---|---|---|---|---|---|---|
| Academic year institutes | 1 | 2 | 3 | 4 | 5 | 6 | 7 or more |
| 1- 99 | 2 | 0 | 0 | 0 | 0 | 0 | 0 |
| 100-399 | 8 | 1 | 0 | 0 | 0 | 0 | 0 |
| 400-899 | 6 | 0 | 0 | 0 | 0 | 0 | 0 |
| 900 + | 13 | 1 | 0 | 0 | 0 | 0 | 0 |
| Summer institute | | | | | | | |
| 1- 99 | 4 | 2 | 1 | 2 | 0 | 0 | 0 |
| 100-399 | 5 | 4 | 2 | 5 | 3 | 0 | 0 |
| 400-899 | 4 | 2 | 3 | 5 | 2 | 1 | 0 |
| 900 + | 12 | 8 | 6 | 14 | 1 | 1 | 0 |
| In-service institute | | | | | | | |
| 1- 99 | 3 | 1 | 0 | 1 | 0 | 0 | 0 |
| 100-399 | 13 | 5 | 2 | 0 | 0 | 0 | 0 |
| 400-899 | 3 | 4 | 3 | 0 | 0 | 0 | 0 |
| 900 + | 17 | 16 | 8 | 7 | 1 | 1 | 1 |

TABLE 31 (continued)

| Type of institute and school size | Number of times attended | | | | | | |
|---|---|---|---|---|---|---|---|
| Other | 1 | 2 | 3 | 4 | 5 | 6 | 7 or more |
| 1- 99 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 100-399 | 2 | 2 | 1 | 0 | 0 | 0 | 0 |
| 400-899 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 900 + | 2 | 1 | 1 | 0 | 0 | 0 | 0 |

Bertan (1971:98-100) found in Indiana where it was found that about 39 percent had attended a summer institute and about 14 percent had attended an academic year institute. The percents of teachers that had attended an in-service course were the same at about 33 percent.

Mathematics Courses for Teachers

The mathematics teachers were asked to circle a number 1, 2, 3, or 4 on the questionnaire to indicate how they felt about courses that could be taken at the undergraduate level for a mathematics major or minor. A 1 meant of no value, a 2 meant it was helpful, a 3 meant it should be in the major, and a 4 meant it was an essential course and all mathematics teachers needed this course (see Table 33, page 118).

In tabulating the questionnaires the teachers were divided into three groups. One group was the teachers that taught general mathematics or algebra 1. Teachers that taught only a business mathematics course were not considered in this group as many of these had a poor mathematics background and several indicated on the questionnaire they did not feel qualified to answer the question. The second group were the teachers that taught up to a geometry course (i.e. general mathematics, algebra 1, geometry). The third group was classified as all levels. This group consisted of those teachers teaching at least one course of a higher level than geometry such as

TABLE 32

PERCENTAGE OF MATHEMATICS TEACHERS THAT ATTENDED AN NSF FINANCIALLY SUPPORTED INSTITUTE BY SCHOOL SIZE

| Type of institute | School size | | | | Percent of totals |
|---|---|---|---|---|---|
| | 1-99 | 100-399 | 400-899 | 900 + | |
| Academic year | 4.3% | 9.2% | 16.2% | 14.6% | 12.1% |
| Summer institute | 19.6 | 25.0 | 45.9 | 43.8 | 33.8 |
| In-service | 10.9 | 26.3 | 27.0 | 53.1 | 33.6 |
| At least one institute of any type | 26.1 | 48.7 | 54.1 | 71.9 | 53.9 |

TABLE 33

HOW MATHEMATICS TEACHERS RANKED MATHEMATICS COURSES AS TO VALUE FOR MATHEMATICS TEACHERS

| Course | Mean rank, on scale from low 1 to high 4 given by teachers of given level | | |
|---|---|---|---|
| | General mathematics and algebra 1 | Algebra and Geometry | All Levels |
| College algebra | 3.7 | 3.5 | 3.6 |
| Trigonometry | 3.0 | 3.6 | 3.6 |
| Analytic geometry | 3.0 | 3.5 | 3.2 |
| Calculus | 2.9 | 3.1 | 3.2 |
| Calculus and analytic geometry | 3.1 | 3.4 | 3.3 |
| Elementary statistics | 3.0 | 3.0 | 3.0 |
| Statistical methods | 2.5 | 2.4 | 2.6 |
| Differential equations | 2.3 | 2.3 | 2.3 |
| Introduction to algebraic theory | 2.5 | 2.8 | 2.7 |
| Boolean algebra | 2.2 | 2.5 | 2.1 |
| History of mathematics | 2.7 | 2.7 | 2.9 |
| Linear algebra | 2.8 | 3.0 | 3.1 |
| Advanced Euclidean geometry (including non-euclidean) | 2.3 | 2.5 | 2.1 |

TABLE 33 (continued)

| Course | Mean rank, on scale from low 1 to high 4 given by teachers of given level | | |
|---|---|---|---|
| | General mathematics and algebra 1 | Algebra and geometry | All Levels |
| Modern Geometry | 3.0 | 3.0 | 3.1 |
| Advanced calculus | 1.9 | 2.0 | 2.1 |
| Probability | 2.7 | 3.0 | 2.9 |
| Introduction to topology | 1.9 | 2.0 | 2.0 |
| Theory of numbers | 2.7 | 2.9 | 2.7 |
| Complex variables | 1.9 | 2.2 | 2.1 |
| Theory of equations | 2.4 | 2.5 | 2.6 |
| General physics | 2.8 | 2.7 | 2.9 |

algebra 11 or trigonometry.

One rather surprising result was how close the three groups agreed on their ranking of the courses. From the ranking of the courses by the teachers, a 30 to 40 quarter hour minor should include calculus and analytic geometry, elementary statistics, modern geometry, linear algebra, history of mathematics, number theory, and probability. The reason that college algebra and trigonometry are not included in this list is that it was felt these courses should be taken in high school and a student should come to college prepared to take a calculus course. A number of teachers indicated this feeling on the questionnaire and that was the recommendation of most of the teacher training curriculum groups such as CUPM.

If the minor was to be extended to a major the courses that would need to be added, as per the ranking of the teachers, would be introduction to algebraic theory, theory of equations, and statistical methods. Any other courses would be electives as there was not a very defined pattern on other courses. All groups indicated that a physics course was very desirable. The courses that seem to be of least value to the teachers as ascertained from their ranking were introduction to topology, complex variables, advanced calculus, Boolean algebra, and differential equations.

The indication that teachers would like to have a history of

mathematics and number theory course is consistent with VonKuster's (1971:77) finding where the teachers also indicated they would like these courses instead of so much calculus.

Enjoyment of Teaching Different Mathematics Areas

The teachers were asked to rank their enjoyment of teaching in three different areas: general mathematics, algebra and geometry, and advanced mathematics. They were to answer only in the area in which they teach. A rank of 1 meant that they did not enjoy the subject area and 5 meant that they enjoyed it very much. In each different size school the mean rank increased as the level of mathematics course increased (see Table 34, page 122). As the size of school increased, the mean rank of general mathematics decreased.

Enjoyment of Teaching

The mathematics teachers were asked to respond to how they felt about teaching. The choices given were: 1) I do not enjoy teaching. 2) I like to teach but do not enjoy teaching mathematics. 3) I like to teach mathematics as well as other subjects. 4) I like to teach only mathematics. There were 5.3 percent of the respondents that indicated one of the first two choices indicating that they did not enjoy teaching mathematics (see Table 35, page 124). It is interesting to note that as the school size increased, the higher the

TABLE 34

DISTRIBUTION OF MATHEMATICS TEACHERS ACCORDING TO THEIR ENJOYMENT OF TEACHING SUBJECT AREAS ON SCALE 1 TO 5

| School size and subject | Rank | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | mean rank |
| 1-99 | | | | | | |
| Gen.math. | 2 | 8 | 17 | 10 | 1 | 3.0 |
| Algebra & geom. | 0 | 0 | 5 | 8 | 24 | 4.5 |
| Adv. math | 0 | 1 | 0 | 7 | 28 | 4.7 |
| 100-399 | | | | | | |
| Gen. mathq | 14 | 12 | 16 | 14 | 9 | 2.9 |
| Algebra & geom. | 0 | 4 | 7 | 16 | 38 | 4.4 |
| Adv. math | 0 | 1 | 1 | 2 | 43 | 5.0 |
| 400-899 | | | | | | |
| Gen. math. | 2 | 13 | 12 | 3 | 4 | 2.8 |
| Algebra & geom. | 0 | 0 | 1 | 14 | 23 | 4.6 |
| Adv. math. | 0 | 0 | 0 | 5 | 21 | 4.8 |
| 900-above | | | | | | |
| Gen. math | 23 | 27 | 22 | 9 | 2 | 2.3 |
| Algebra & geom. | 0 | 1 | 7 | 28 | 54 | 4.5 |
| Adv. math. | 0 | 0 | 7 | 13 | 41 | 4.6 |

percentage of teachers that indicated that they like to teach only mathematics.

There were several comments by teachers to the effect that they enjoyed teaching but did not like the administration, school board, or bureaucratic methods. Another comment was that they enjoyed teaching but hated the paper work that goes with it. One teacher said he enjoyed teaching but could not afford the habit. Over all the majority of mathematics teachers enjoy their teaching. The most dissatisfaction came from those teaching the general mathematics classes.

In a study by Bradshaw (1968:134) in Nevada from a sample of 251 mathematics teachers, which is almost the same as this sample, he found 10 teachers dislike teaching mathematics, 63 preferred another subject, 22 said mathematics and other teaching about equal, and 145 preferred mathematics. The difference between these studies is that in Montana only 5 people preferred another subject, 144 indicated they liked mathematics and other subjects about equal, and only 89 indicated they preferred mathematics.

## The Decision to Teach

The teachers were asked to indicate when they made the decision to become a teacher. The answers most frequently checked were "in high school" which was checked by about 28 percent and

TABLE 35

DISTRIBUTION OF MATHEMATICS TEACHERS ACCORDING TO THEIR ENJOYMENT OF TEACHING MATHEMATICS

| Responses | School size | | | | |
|---|---|---|---|---|---|
| | 1-99 | 100-399 | 400-899 | 900 + | Total |
| Do not enjoy teaching | 0 | 3 | 0 | 5 | 8 |
| Like to teach but do not enjoy math | 1 | 3 | 1 | 0 | 5 |
| Like to teach math and other subjects | 31 | 51 | 21 | 41 | 144 |
| Like to teach math only | 9 | 16 | 18 | 46 | 89 |

"while studying engineering or science in college" which was checked by about 29 percent of the respondents. There were 11 percent of the respondents that indicated they had started another profession before deciding to become a teacher. Several of the teachers that checked the "other" blank said the decision came while they were in the service.

Bradshaw (1968:126) found in his study in Nevada that only 30 percent of the teachers made their decision to teach during college while in this study about 45 percent decided in college. Bradshaw also found only 16 percent made the decision while in high school while in this study it was found that 28 percent made the decision in high school.

Future Plans

One item in the questionnaire asked the teachers to indicate their plans, for the next 5 years, with respect to teaching. There were 23.5 percent of the mathematics teachers that indicated they did not plan to teach mathematics for the next 5 years and 4.3 percent were undecided if they would teach mathematics (see Table 37, page 127). One will note from the table that in the school size 100-399 the large number of teachers that are planning to leave the field of education. Several teachers indicated they were looking at several different possibilities such as school administration or leaving the

TABLE 36

DISTRIBUTION OF MATHEMATICS TEACHERS ACCORDING TO WHEN THE DECISION WAS MADE TO TEACH

| When the decision was made | School size | | | | Totals | |
|---|---|---|---|---|---|---|
| | 1-99 | 100-399 | 400-899 | 900 + | No. | % |
| In grade school | 6 | 6 | 1 | 2 | 15 | 6.1 |
| In high school | 14 | 24 | 14 | 17 | 69 | 28.3 |
| After starting another profession | 3 | 7 | 6 | 11 | 27 | 11.1 |
| While studying engineering or science in college | 11 | 17 | 7 | 35 | 70 | 28.7 |
| While taking general studies in college | 5 | 12 | 6 | 18 | 41 | 16.8 |
| Other | 1 | 7 | 3 | 11 | 22 | 9.0 |

TABLE 37

DISTRIBUTION OF MATHEMATICS TEACHERS ACCORDING TO THEIR PROFESSIONAL PLANS FOR THE NEXT FIVE YEARS

| Plans | School size | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1-99 | | 100-399 | | 400-899 | | 900 + | | Total | |
| Plan to teach mathematics | No. | % | No. | % | No. | % | No. | % | No. | % |
| yes | 26 | 56.5% | 42 | 55.3% | 27 | 73.0% | 77 | 80.2% | 172 | 67.5% |
| no | 11 | 23.9 | 26 | 34.2 | 10 | 27.0 | 13 | 13.5 | 60 | 23.5 |
| undecided | 3 | 6.5 | 4 | 5.3 | 0 | 0 | 4 | 4.2 | 11 | 4.3 |
| did not answer | 6 | 13.0 | 4 | 5.3 | 0 | 0 | 2 | 2.1 | 12 | 4.7 |
| Plan if answer above was no | | | | | | | | | | |
| school administration | 2 | | 5 | | 0 | | 0 | | 7 | 2.7 |
| retire | 1 | | 4 | | 1 | | 5 | | 11 | 4.3 |
| leave field of education | 5 | | 15 | | 4 | | 7 | | 31 | 12.2 |
| teach in different field | 3 | | 2 | | 3 | | 1 | | 9 | 3.5 |
| did not answer | 0 | | 0 | | 2 | | 0 | | 2 | 0.8 |

field of education. One person indicated he wanted to teach but was afraid he would not get a contract because of the budget situation at his school.

Course Guide

More than ten years ago the State Office of Public Instruction provided a course guide for the different mathematics courses offered in the secondary schools. This has not been re-done in recent years. In order to ascertain the feelings of the mathematics teachers on this subject, they were asked to indicate if they felt a course guide should be furnished and if they felt it should, who should furnish it. In response to the question 82 percent of the teachers indicated they felt a course guide should be furnished (see Table 38, page 129). The response as to who should furnish the guide was not decisive. There was a trend toward the State Mathematics Supervisor. Many indicated it should be a joint effort. A number of the teachers indicated that the teachers in the field should have input along with the college instructors as the secondary teachers wanted to know what was expected of the students entering college. Several teachers indicated this should not be an "Ivory Tower" document. The idea that the guide should be just a guide and not a required outline was also mentioned several times.

Staying Current

To ascertain the feeling of teachers on their ability to keep

TABLE 38

DISTRIBUTION OF MATHEMATICS TEACHERS ACCORDING TO THEIR FEELINGS ON COURSE GUIDES

| Feelings | School size | | | | |
|---|---|---|---|---|---|
| | 1-99 | 100-399 | 400-899 | 900 + | Totals |
| Should a course guide be furnished? | | | | | |
| Yes | 36 | 55 | 33 | 79 | 203 |
| No | 5 | 18 | 4 | 17 | 44 |
| If yes, who should provide the guide? | | | | | |
| Individual schools | 3 | 10 | 5 | 22 | 40 |
| State Math Supervisor | 12 | 18 | 9 | 21 | 60 |
| Colleges | 14 | 14 | 4 | 8 | 40 |
| Math Supervisors and colleges | 5 | 0 | 2 | 3 | 10 |
| Combination of all the above | 2 | 7 | 4 | 16 | 29 |
| Other | 0 | 6 | 9 | 9 | 24 |

abreast with new developments in mathematics, they were asked if they felt a need for help in keeping current with new developments. The results indicated that a vast majority felt a need for help (see Table 39, page 131). The majority of the teachers felt that the State Supervisor of Mathematics along with the colleges and universities and the NSF should furnish this service. Some teachers indicated this help should be in the form of workshops or courses in curriculum and materials. There was an indication that some felt there was a need for financial support for these programs from the NSF. Other suggestions as to where the help should come from were the Montana Council of Teachers of Mathematics, secondary school department heads, and the school districts.

Professional Activities

In order to determine the professional activity of the mathematics teachers, three types of data were asked for in the questionnaire: To what professional mathematics organizations do you belong? To what professional mathematics journals do you subscribe? What professional mathematics meetings have you attended in the past four years?

There were 121 or 47.5 percent of the teachers that checked that they were members of the Montana Council of Teachers of Mathematics (MCTM) (see Table 40, page 133). A check of the "Analysis of

TABLE 39

DISTRIBUTION OF MATHEMATICS TEACHERS ACCORDING TO THEIR FEELINGS ABOUT THE NEED FOR HELP IN KEEPING UP WITH NEW MATERIAL AND WHO SHOULD FURNISH THE HELP?

| | School size | | | | |
|---|---|---|---|---|---|
| | 1-99 | 100-399 | 400-899 | 900 + | Totals |
| Need help keeping current? | | | | | |
| Yes | 39 | 65 | 37 | 79 | 220 |
| No | 6 | 8 | 0 | 16 | 30 |
| If yes, who should furnish help? | | | | | |
| Principal | 0 | 0 | 0 | 1 | 1 |
| State Math Supervisor | 16 | 18 | 11 | 19 | 64 |
| Colleges | 8 | 12 | 5 | 9 | 34 |
| NSF | 2 | 5 | 2 | 5 | 14 |
| Combination of the above | 12 | 27 | 19 | 41 | 99 |

Membership" of the MCTM as prepared by membership chairman Ray Meyers of the MCTM indicated 159 secondary memberships and 42 from elementary schools. This would mean that about 30 percent of the secondary mathematics teachers of the state are members of MCTM. These figures may not be as far off as they appear because in this study teachers that were listed as junior high school teachers were considered to be secondary teachers if they taught in the ninth grade. One place a discrepancy was noticed in the data from the questionnaire was in the way the teachers answered the questions about membership in the National Council of Teachers of Mathematics (NCTM) and the journals to which they subscribed. There were several teachers who indicated they were members of NCTM but did not indicate that they subscribed to a journal or they indicated that they subscribed to one of the NCTM journals and did not indicate that they were a member of NCTM. Either they left one part out or did not realize that one of the journals was a privilege of membership.

About 58 percent of the mathematics teachers indicated that they either read regularly or sometimes The Mathematics Teacher (see Table 41, page 133). Almost 43 percent indicated they had attended a MCTM state meeting in the last four years, and about half that many or about 22 percent had attended some type of NCTM meeting in the past four years (see Table 42, page 134).

TABLE 40

DISTRIBUTION OF MATHEMATICS TEACHERS ACCORDING TO MEMBERSHIP IN PROFESSIONAL MATHEMATICS ORGANIZATIONS

| Organization | School size | | | | Totals | |
|---|---|---|---|---|---|---|
| | 1-99 | 100-399 | 400-899 | 900 + | No. | % |
| MCTM | 15 | 33 | 21 | 52 | 121 | 47.5 |
| NCTM | 13 | 17 | 10 | 34 | 74 | 29.0 |
| SSMA | 0 | 0 | 0 | 0 | 0 | 0.0 |
| MAA | 1 | 1 | 0 | 0 | 2 | 0.8 |

TABLE 41

DISTRIBUTION OF MATHEMATICS TEACHERS ACCORDING TO THE PROFESSIONAL JOURNALS THEY SUBSCRIBE TO OR READ

| Journal | Subscribe to | Read regularly | Read sometimes |
|---|---|---|---|
| The Arithmetic Teacher | 32 | 31 | 51 |
| The Mathematics Teacher | 66 | 60 | 89 |
| The Mathematics Magazine | 6 | 6 | 19 |
| MAA Journal | 2 | 1 | 11 |

TABLE 42

DISTRIBUTION OF MATHEMATICS TEACHERS ACCORDING TO PROFESSIONAL MEETINGS ATTENDED IN LAST FOUR YEARS

| Meetings | School size | | | | Totals | |
|---|---|---|---|---|---|---|
| | 1-99 | 100-399 | 400-899 | 900 + | No. | % |
| Local Math Club | 8 | 4 | 2 | 31 | 45 | 17.6 |
| MCTM State | 14 | 24 | 18 | 53 | 109 | 42.7 |
| NCTM National or Name of site | 4 | 11 | 12 | 28 | 55 | 21.6 |

# Chapter 5

## SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This study was undertaken to delineate selected characteristics of the secondary mathematics teachers of Montana and to ascertain certain needs felt by these teachers relative to their teaching. In order to do this the secondary schools of the state were divided into four different size categories by the number of students. The four classifications were schools 1 to 99, 100 to 399, 400 to 899, and 900 and above. The names of the mathematics teachers in the schools were obtained from the list of teachers of mathematics supplied by the Science and Mathematics Supervisor of the State Office of Public Instruction. From this list two-thirds of the mathematics teachers in each of the four classifications of secondary schools were randomly selected. There were 353 teachers in the sample.

Data were collected in two different ways. Data on certification of all teachers and the mathematics preparation of certain of the teachers were obtained from the Certification Division of the State Office of Public Instruction. The data on mathematics preparation of the other teachers were obtained from the colleges and universities of Montana. The second method of collecting data was from a questionnaire. There were 255 usable questionnaires returned.

One teacher was found to be uncertified and thus was eliminated from the study because information could not be obtained on this per-

son. For the information that was obtained from sources other than the questionnaire, the full 352 sample was used.

The following results were obtained from the full sample:

1. In checking the certification of the teachers, it was found that 33.3 percent of the teachers had a class 1 certificate which meant that they had completed either a master's degree of a fifth year of work which strengthened their training. The percentage with the class 1 certification varied from 15 percent in the schools size 1-99, to 49.6 percent in the schools with 900 or more students. There were only six teachers with provisional certificates and five teachers with life certificates and five with elementary certification only. This has changed from Christman's (1950:226) study where he found ten percent of the mathematics teachers had emergency certificates and 43 percent had life certificates.

2. It was found that 12.3 percent of the mathematics teachers were not endorsed in mathematics. This varied with the size of school from 26.7 percent in small schools to 5.1 percent in the large schools. The other three main areas of endorsement were in physical science with 37.3 percent, biological science with 22.8 percent, and physical education with 19.9 percent.

3. When considering the mathematics credits of the mathematics teachers, the methods courses were left out as were any courses

considered to be of lower level than college algebra and trigonometry. There were 10.6 percent of the mathematics teachers with less than 15 quarter credit hours of mathematics and 18.9 percent with less than 30 quarter credit hours. The median quarter hours was about 50 quarter hours. It was found that there was a significant difference in mathematics preparation of the teachers with those in the larger size schools having the greater preparation.

4. The mathematics preparation of the Montana mathematics teachers was compared to the CUPM level II-J and level III recommendations. Those teachers that taught only general mathematics or algebra 1 were compared to the level II-J and any mathematics teacher teaching a class of higher level than general mathematics or algebra 1 was compared to the level III recommendations. Only 8 teachers fully met the CUPM recommendations for their teaching position. It was also noted that none of the colleges or universities had requirements for the mathematics major or minor that exactly fit the requirements. The main courses lacking were real analysis, linear algebra, and a computer course. It was also found that ten teachers were teaching at a level higher than algebra 1 and had never taken a calculus course.

5. It was found that seventy-two percent of the mathematics teachers received their undergraduate training in Montana. This was in contrast to a study during 1949-50 school year when only 51 percent

were trained in Montana (Christman, 1950:225).

6. At the .01 level of significance, the mathematics preparation of the non-general mathematics teachers was significantly more than that of the general mathematics teachers. The years of experience of the general mathematics teachers was significantly less than the years of experience of the non-general mathematics teachers.

7. The mathematics preparation of the teachers that graduated before 1966 was compared to those that graduated 1966 or after, but no significant difference was found in either groups' preparation.

The following results were obtained from the 255 usable questionnaires:

1. Women accounted for about 17 percent of the total mathematics teachers in Montana. This is somewhat low when compared to other studies.

2. The mean years of teaching experience for all the mathematics teachers was 10.9 years. The teachers in the larger school had more experience than the teachers in the small schools. The mean years at the teacher's present location was 8.1 years.

3. The mean age of men mathematics teachers was 34.1 years and for women it was 31.5 years and for all teachers it was 33.6 years. This has changed since 1949-50 when the average was listed as 40 years for all teachers.

4. The mean of the number of classes per day taught by a mathematics teacher varied from 4.88 classes per day in schools size 900 or more to 5.6 classes per day for teachers in the schools size 1 to 99. The number of preparations per day also varied from a low of 2.58 in the large schools to 5.36 preparations per day in the small schools.

5. The mean number of student contacts per day varied from 55.7 students in the small schools to 117.7 students per day in the large schools.

6. In the two smaller size schools about half of the teachers taught at least one non-mathematics class. In the larger schools less than 20 percent taught a non-mathematics class. The physical sciences were the non-mathematics courses most often taught by a mathematics teacher.

7. Two-thirds of the mathematics teachers indicated that they had from 46 to 60 minutes of preparation time per day. The teachers in the larger schools tended to have the most preparation time.

8. The most often indicated extra curricular activity handled by the mathematics teachers was some type of coaching. About 64 percent of the teachers were responsible for some type of extra curricular activity. About 25 percent of the teachers spent over 200 hours per year working with extra curricular activities.

9. There were 76 percent of the mathematics teachers that indicated they had taken courses to renew a teaching certificate, while 58 percent of the teachers indicated they had taken a mathematics course to renew a certificate.

10. About 67 percent of the teachers indicated they intend to take a mathematics course in the next four years, and about the same percent indicated that they will take a non-mathematics course in the next five years.

11. It was found that 12 percent of the mathematics teachers had attended at least one academic year institute, about 30 percent a summer institute, 34 percent an in-service course where financial assistance came from the NSF. Approximately 54 percent of the teachers had taken at least one of the NSF programs.

12. From the evaluation of courses by teachers, a minor in mathematics should include calculus and analytic geometry, elementary statistics, modern geometry, linear algebra, history of mathematics, number theory, and probability. To extend the minor to a major the teacher evaluations would add specifically introduction to algebraic theory, theory of equations, statistical methods as well as electives.

13. The teachers ranked general mathematics as the least enjoyable mathematics class to teach. The teachers in smaller schools ranked general mathematics higher than teachers in larger schools.

14. There were 13 of the teachers indicated they did not enjoy teaching mathematics. In the smaller schools teachers enjoyed teaching other subjects as well as mathematics, but as the school size increased the teachers were more apt to indicate they enjoyed teaching only mathematics.

15. The decision to teach was made by 29 percent of the teachers while enrolled in a science or engineering course in college and by 28 percent of the teachers while they were in high school. Eleven percent of the teachers made the decision to teach after having started in another profession.

16. There were 23 percent of the mathematics teachers that did not plan to teach mathematics for the next five years. About 12 percent of the teachers were leaving the field of education because of reasons other than retirement. About three and one-half percent planned to teach in a different field.

17. Approximately 80 percent of the teachers indicated they felt a course guide should be furnished for the courses taught in secondary schools. When asked who should prepare this guide the teachers indicated the State Mathematics Supervisor, individual schools, and the colleges and universities.

18. More than 86 percent of the teachers indicated that they had trouble keeping up with new materials and programs. The greatest

number felt that a combination of the State Mathematics Supervisor, the colleges and universities, and the NSF should help them to keep current.

19. About 47 percent of the teachers indicated that they were members of MCTM and 29 percent said they were members of NCTM. There were 58 percent of the teachers that indicated they read The Mathematics Teacher sometimes. Approximately 43 percent indicated they had attended a MCTM state meeting in the last four years and about 22 percent had attended some type of NCTM meeting in that period.

## Conclusions

From the data collected and analyzed the following conclusions were reached:

1. The general mathematics is taught by teachers with the least experience and the least amount of mathematics training when compared with other secondary mathematics classes.

2. The percent of women mathematics teachers in Montana is low when compared to other states.

3. The mathematics teachers were younger and less experienced than they were 27 years ago.

4. Either there was a marked increase about 12 years ago in the number of mathematics classes offered, or teachers seem to drop out of mathematics teaching after 10-12 years of teaching.

5. The International Commission (Bidwell, 1970:353) states that teachers should have no more than 25 periods a week; thus, 29 percent of the teachers teaching six or more classes exceed this recommended load.

6. Teachers in small schools do not have much time to prepare for the courses they teach because of the number of preparations per day.

7. The number of student contacts per day for the mathematics teachers seems to be, in general, well within the standards of accreditation for all four school sizes.

8. The mathematics teachers tend to teach mainly in the one field. The physical science courses such as physics and chemistry were the courses most often taught in addition to mathematics. This is followed by other sciences and then physical education.

9. The Standards for Accreditation of Montana Schools does not seem to speak to the problems of extra curricular activities. Since 64 percent of the teachers surveyed engage in some form of extra curricular activity, there needs to be some consideration of this in the accreditation of the schools.

10. The requirement of six credit hours to renew a class 2 certificate helped the mathematical preparation of the teachers as 58 percent said that they had taken mathematics courses to renew a

certificate.

11. The NSF has had an effect on the mathematics teachers as 54 percent of the teachers have had some type of course supported by the NSF.

12. The percentage of mathematics teachers that have taken a calculus course has increased significantly since the 1949-50 school year when Christman (1950:226, 227) found that 44 percent of the mathematics teachers had taken calculus. In the present study 85 percent of the teachers had at least one course in calculus.

13. Mathematics teachers felt that three courses which are currently not required are necessary to their professional backgrounds: history of mathematics, number theory, and probability.

14. The general mathematics classes were the least enjoyable mathematics class to teach; however, teachers in small schools rated their enjoyment of teaching general mathematics higher than teachers in large schools.

15. Mathematics teachers in the small schools enjoyed teaching classes other than mathematics more than teachers in large schools.

16. The decision to teach mathematics was most often made while in high school or while taking some type of scientific course of study in college.

17. Judging from the number of teachers that indicated they

would not be teaching mathematics for the next five years, there should be a need for about 100 mathematics teachers over the next five years if the number of mathematics classes remain constant.

18. There is a need for course guides for the courses in mathematics taught in the high schools as was indicated by 82 percent of the teachers in the survey. The guides should be made up by the high school and college teachers working together with the Mathematics Supervisor of the State Office of Public Instruction.

19. The NSF needs to fund courses to help teachers stay current in the mathematics teaching field. The colleges, universities, and Mathematics Supervisor need to increase their efforts to keep mathematics teachers current in their field.

20. Questionnaire data may not be a very reliable way to investigate the membership in professional organizations. The same is true of checking the professional journals to which teachers subscribe.

Recommendations

From the data collected and research done on this project, the researcher feels the following recommendations are justified:

1. A full-time mathematics supervisor should be employed by the State Office of Public Instruction.

2. A set of course guides should be developed for the mathematics courses usually taught in secondary schools. The guides should

not mandate, but suggest a course of study. The guides should be developed by a group of teachers, where colleges and each size of high school are represented. The guide should be a pedagogically sound program.

3. The requirements for a mathematics endorsement from the State Office of Public Instruction should be changed so that a teacher must have credit for at least one course in calculus and at least one other course such as statistics, modern algebra, linear algebra, or computer programming included in the 30 quarter hours credit in mathematics.

4. Article 231.3 of the Standards for Accreditation of Montana Schools be changed from the wording of "No teacher shall have more than 28 clock hours of assigned student responsibility per week" to a maximum of 28 classes that a teacher may teach during a week and a suggested maximum of 25 classes per week. The maximum teacher load should also take into account the extra curricular activities for which a teacher is responsible.

5. The State Office of Public Instruction should lend its support both with finances and with personnel to projects that are designed to keep the mathematics teachers informed of new programs, books, and materials.

6. The NSF should continue to provide financial support for

courses for mathematics teachers.

7. The colleges and universities should continue to apply for NSF funds for in-service courses and institutes for mathematics teachers.

8. The colleges and universities should continue to offer night classes and summer classes that provide the teachers with new methods and materials.

9. The colleges and universities should provide courses in number theory, probability, and history of mathematics which may be used for the minor in mathematics. These courses need to be directed to those topics that would be useful for a secondary teacher.

10. The general mathematics classes should be taught by people that volunteer for the assignment, or the classes should be assigned so that they are not primarily taught by the new or inexperienced teachers.

11. A study should be made to find out why so many teachers indicate that they will leave or want to leave the teaching field.

12. The colleges and universities should require a computer course in the mathematics teaching major and minor.

13. The colleges and universities should not require the exact CUPM level III recommendations for a mathematics teaching major as the teachers would be better served with more breadth than

depth. A course such as number theory or probability would better serve the teachers than the real analysis course in the CUPM recommendations.

14. The colleges and universities need to develop a course to help prepare the teachers to teach general mathematics as most of the teachers will at some time face a general mathematics class.

15. The universities need to provide courses for the secondary teachers that will help them in their teaching of mathematics if these teachers are going to be tempted to take more mathematics in summer school or in their graduate programs.

16. The graduate schools of the state need to introduce a master's degree program patterned after the discontinued master's degree offered by MSU called master of applied science. This degree would allow the graduate school to tailor a program to the needs of the teacher rather than the degree be strictly in one discipline such as education or mathematics.

17. There needs to be a rekindling of a spirit of cooperation between the school board, administration, and teachers in many schools. All three groups need to realize they are all there for the same purpose; namely, to help educate students.

18. School accreditation must be used as a lever to decrease the number of teachers teaching mathematics without certification in the area.

# APPENDICES

# APPENDIX A

## CUPM LEVEL 11-J RECOMMENDATIONS

The level 11-J recommendations are for teachers of junior high school mathematics grades 7 through 9 (CUPM, 1971:14-15). The recommended program is:

A. Two courses in elementary calculus.

B. Two courses in algebra. These courses in linear and modern algebra are identical to those described under C of level 111 recommendations.

C. One course in geometry. Either of the two courses under E of the level 111.

D. A course in probability and statistics. This is the first course under D of level 111.

E. Experience with applications of computing. This is the same as F under level 111.

F. Review of the content of courses 1 and 2 of level 1 (either sequence) through study or audit.

G. Two elective courses.

## CUPM LEVEL 111 RECOMMENDATIONS

The level 111 recommendations are for mathematics teachers of

APPENDIX A (continued)

grades 7 through 12 (CUPM, 1971:15-19). The minimum preparation of high school teachers of mathematics should include:

A. Three courses in calculus.

B. One course in real analysis.

C. Two courses in algebra. One should treat those topics in linear algebra that are essential for the understanding of geometry and that have become crucial in applications, especially to the social sciences. The second algebra course should be abstract algebra.

D. Two courses in probability and statistics. The first of these should begin with intuitive notions of probability and statistics derived from the real world. Mathematical model building and the relationship of mathematics to the real world should be considered. The second course should treat those additional and more advanced topics normally included in a statistics sequence.

E. Two courses in geometry. One course emphasizes a traditional approach by concentrating on synthetic methods and a careful study of the foundations of Euclidean geometry with a brief treatment of non-Euclidean geometry. The other course is strongly linked to linear algebra, includes an investigation of the groups of transformations associated with geometry, and is explicitly related to other parts of mathematics.

APPENDIX A (continued)

F. Experience with applications of computing. This should involve learning the use of at least one higher level programming language such as BASIC or FORTAN.

G. One course in applications. This should place heavy emphasis on mathematical models in the physical or social science.

Nine of these twelve items should be included in the undergraduate program of every prospective high school teacher, namely A, B, C, F, and one course each from D and E. The remaining courses may be deferred to his post-baccalaureate study, although consideration should be given to including them among the electives in his undergraduate program.

# APPENDIX B

## SECONDARY MATHEMATICS TEACHER QUESTIONNAIRE

Please use a circle, check mark or write in your answer to the following questions:

1. Please circle.
   Sex: M F

2. Circle one group to indicate your age.
   Age: 21-28, 29-36, 37-44, 45-52, 53-60, 61-70

3. Counting this year how many years of experience do you have in teaching? _____years

   How many at your present school? _____years

4. Please check the class of teaching certificate that you hold:

   _____Class 1 (professional)
   _____Class 2 (standard)
   _____Class 3 (administrative)
   _____Class 4 (vocational)
   _____Class 5 (provisional)

5. Please answer for the math courses that you are now teaching. The number of classes of each and the number of students in each class:

| | number of classes | class sizes | | | | |
|---|---|---|---|---|---|---|
| General Math | _____ | ____ | ____ | ____ | ____ | ____ |
| Algebra I (first year) | _____ | ____ | ____ | ____ | ____ | ____ |
| Algebra II (second year) | _____ | ____ | ____ | ____ | ____ | ____ |
| Geometry | _____ | ____ | ____ | ____ | ____ | ____ |
| Trigonometry | _____ | ____ | ____ | ____ | ____ | ____ |
| Solid Geometry | _____ | ____ | ____ | ____ | ____ | ____ |
| Business Math | _____ | ____ | ____ | ____ | ____ | ____ |
| Consumer Math | _____ | ____ | ____ | ____ | ____ | ____ |
| Calculus | _____ | ____ | ____ | ____ | ____ | ____ |
| Computer Programming | _____ | ____ | ____ | ____ | ____ | ____ |
| Other (Please specify) | _____ | ____ | ____ | ____ | ____ | ____ |

6. Please list the subjects that you teach other than mathematics and fill in the table:

| | Subject | Number of Classes | Class Enrollments |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |

# APPENDIX B (continued)

7. How much preparation time during school hours do you have per day? _____hours _____minutes

8. Please list the extra curricular activities that you are involved with and give the approximate hours per week you spend on them. Please indicate if they are voluntary or assigned.

| | Activity | Number of Weeks per yr. | Hours per Week | Voluntary | Assigned |
|---|---|---|---|---|---|
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |

9. Have you taken any courses to renew a teaching certificate?
____yes
____no

If yes please indicate the area in which these courses were taken by placing the number of hours taken in the proper column.

| | Quarter hours | Semester hours |
|---|---|---|
| Education | | |
| Mathematics | | |
| Science | | |
| English | | |
| Social Studies | | |
| Vocational | | |
| Art or Music | | |
| Other | | |

10. Do you plan to take any more course work in mathematics in the next 4 years?
____yes
____no

Do you plan to take any course work in other fields than mathematics in the next 4 years?
____yes
____no

11. Indicate which of the following financially supported academic programs you have attended.

____NSF Academic Year Institutes. How many? _____

____NSF Summer Institutes. How many? _____

____NSF In-Service Institutes. How many? _____

____Other (specify) _____ How many? _____

## APPENDIX B (continued)

12. In the first column indicate by circling a number on the scale 1 to 4 the value of each course for secondary mathematics teacher education. 1 will mean of no value, 2 helpful, 3 should be in a major, 4 essential, every secondary mathematics teacher needs this course.

In the second column please list the approximate number of quarter hours you think are needed for a teacher in your position. In the third column place a check mark to indicate the courses you have taken.

| Value | Qr. Hours Needed | Courses you have taken | |
|---|---|---|---|
| 1-2-3-4 | _____ | _____ | College Algebra |
| 1-2-3-4 | _____ | _____ | Trigonometry |
| 1-2-3-4 | _____ | _____ | Analytic Geometry (only) |
| 1-2-3-4 | _____ | _____ | Calculus (only) |
| 1-2-3-4 | _____ | _____ | Calculus and Analytic Geometry |
| 1-2-3-4 | _____ | _____ | Elementary Statistics |
| 1-2-3-4 | _____ | _____ | Statistical Methods |
| 1-2-3-4 | _____ | _____ | Differential Equations |
| 1-2-3-4 | _____ | _____ | Introduction to Algebraic Theory (groups, rings, fields, etc.) |
| 1-2-3-4 | _____ | _____ | Boolean Algebra |
| 1-2-3-4 | _____ | _____ | History of Mathematics |
| 1-2-3-4 | _____ | _____ | Linear Algebra |
| 1-2-3-4 | _____ | _____ | Advanced Euclidean Geometry (including non-euclidean) |
| 1-2-3-4 | _____ | _____ | Modern Geometry |
| 1-2-3-4 | _____ | _____ | Advanced Calculus |
| 1-2-3-4 | _____ | _____ | Probability |
| 1-2-3-4 | _____ | _____ | Introduction to Topology |
| 1-2-3-4 | _____ | _____ | Theory of Numbers |
| 1-2-3-4 | _____ | _____ | Complex Variables |
| 1-2-3-4 | _____ | _____ | Theory of Equations |
| 1-2-3-4 | _____ | _____ | General Physics |

# APPENDIX B (continued)

13. On a scale from 1 to 5 please indicate by circling a number, your enjoyment of teaching in the three given areas. Five will mean you enjoy teaching the subjects very much and a 1 will mean you dislike teaching the subject. Answer only for the areas in which you teach.

| | |
|---|---|
| General Math (Business Math, Vocation Math, etc.) | 1 - 2 - 3 - 4 - 5 |
| Algebra and Geometry | 1 - 2 - 3 - 4 - 5 |
| Advanced Math | 1 - 2 - 3 - 4 - 5 |

14. Please check one of the following as to when you decided to become a teacher?

_____in grade school.
_____in high school.
_____after starting in another profession.
_____while studying engineering or sciences in college.
_____while taking general studies in college.
_____other (Please specify.) _____.

15. Do you feel there should be a course guide or course outline for secondary mathematics courses in the state of Montana?

____yes
____no

If yes, who should provide the outline?

____Individual schools
____State Math Supervisor
____Colleges or Universities
____Other (Please specify.) _____.

16. Do you plan to stay in Mathematics teaching for the next five years?

____yes
____no

If no, do you plan to:

____go into school administration
____retire
____leave the field of education
____teach in a different field

17. Which of the following best describes your feeling about teaching:

____I do not enjoy teaching.
____I like to teach but do not enjoy teaching mathematics.
____I like to teach mathematics as well as other subject.
____I like to teach only mathematics.

# APPENDIX B (continued)

18. Do you feel a need for help in keeping abreast with the new materials and programs being developed?

____yes
____no

If yes, who should provide this help?

_____Principal
_____State Math Supervisor
_____Colleges or Universities
_____National Science Foundation
_____Other (Please specify). _____

19. Please check the professional mathematics organizations to which you belong:

_____Montana Council of Teachers of Mathematics
_____National Council of Teachers of Mathematics
_____School Science and Mathematics Association
_____Mathematical Association of America
_____Other (Please specify.) _____

20. Please fill in the following table on the professional journals you read:

| | Subscribe to | Read regularly (2 articles per issue) | Read Sometimes |
|---|---|---|---|
| Arithmetic Teacher | | | |
| Mathematics Teacher | | | |
| Mathematics Magazine | | | |
| MAA Journal | | | |
| Other (Please specify.) | | | |
| _____ | | | |
| _____ | | | |

21. Please indicate the professional mathematical meetings you have attended in the past 4 years.

_____local math club
_____Montana Council of Teachers of Mathematics Annual Meeting
_____National Council of Teachers of Mathematics
name of site or national meeting
_____Other (Please specify.) _____

# APPENDIX C

WESTERN MONTANA COLLEGE
OF THE
MONTANA UNIVERSITY SYSTEM
DILLON

March 9, 1977

Dear Fellow Mathematics Teacher:

I am conducting a study of Mathematics Teachers in the state of Montana to gauge opinions on (a) what should be included in undergraduate mathematics preparation, (b) the in-service help for which mathematics teachers feel a need, (c) who should furnish this service, (d) a profile of the mathematics teachers of the state and (e) the work load of the mathematics teachers.

There has been no other study of this type done in Montana. This investigation will give not only an indication of the current practices but will form a base line from decisions affecting all of us. The NACOME report expressed the need for such a data base. Mr. Larry Thomas, the Science and Mathematics Supervisor from the Office of Public Instruction has indicated the results of this research will be valuable to his office.

Your reply to the questionnaire will remain anonymous and completely confidential. Neither you nor your school will be identifiable in the statistics and conclusions generated.

Your assistance in responding to the questionnaire is essential for a meaningful study. When the questionnaire is completed please staple it together with the return address label visible.

Thank you very much for your time and interest.

Sincerely,

Terrance R. Cypher

Terrance R. Cypher
Associate Professor of Math

TRC/dr

Enclosure

# APPENDIX D

WESTERN MONTANA COLLEGE
OF THE
MONTANA UNIVERSITY SYSTEM
DILLON

April 18, 1977

Dear Fellow Mathematics Teachers:

On March 22, 1977, I sent you a questionnaire for a study I am conducting concerning the mathematics teachers of Montana. You were selected by a stratified random selection process. Therefore, it is necessary to have a high percentage of usable questionnaires returned in order for the results to accurately indicate the feelings of the mathematics teachers in the field. The teachers selected were from those teaching at least one mathematics class in grades 9 through 12 in the public schools as listed in the report of mathematics teachers in Montana furnished by the Science and Mathematics Supervisors Office. For this reason even though you teach only one class in mathematics please answer the questionnaire.

The Study will give information useful to the Universities, Colleges, and the Science and Mathematics Supervisor of the Office of Public Instruction. The Study will also furnish a data base for future studies to see what changes take place in the mathematics teacher of Montana.

Your reply to the questionnaire will remain anonymous and completely confidential. Neither you nor your school will be identifiable in the statistics and conclusions generated.

Your assistance will be appreciated so will you please take about 15 minutes to fill out the questionnaire. In case you have mislaid the first questionnaire there is one enclosed. When completed please fold with the return address visible, staple and drop in the mail.

Thank you very much for your time and interest.

Sincerely,

Terrance R. Cypher

Terrance R. Cypher
Associate Professor of Math

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# BIBLIOGRAPHY

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