MATHEMATICS PREPARATION OF HIGH SCHOOL TEACHERS BASED ON COLLEGE PROGRAMS AND TEACHER EXPERIENCE

by

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CHAPTER I

INTRODUCTION

During recent years there has been an increased emphasis upon education in the United States. The emphasis is justified by the fact that today there are more pupils in school than ever before. This influx of pupils from every type of social and intellectual background demands a much different educational program than in the past. In Oregon, where high school attendance is required, the problem of meeting the needs of all youth is even more important.

State Departments of Education and Colleges of Education are constantly striving to improve the educational system by re-defining the objectives of education and improving the entire setting for learning. Yet, no matter how valid the objectives of education, how modern the school plant, or how perfect the curriculum, pupils in the hands of a poor, unprepared teacher cannot receive an adequate education. The Joint Commission of the National Council of Teachers in its Fifteenth Yearbook summarized the problem (26, p.187). They believe that in any consideration of general educational problems, it is necessary to give prominence to the preparation of teachers.

The part of the teachers is so important that other considerations are secondary by comparison. Not until educators turn their thoughts to the persons who are to carry out the instructions of educational theorists is the crux of the matter reached. Only then are mere plans on paper replaced by the personalities who bring either success or failure to these plans.

The following qualities of a mathematics teacher are considered important and are emphasized by educators. First, qualities related to the general culture, social and civic development of the individual. Second, the professional preparation, familiarity with educational problems and skill in the techniques of instruction. Third, a knowledge of and interest in mathematics.

This paper is concerned with the last quality; that of the teacher's knowledge of mathematics. As will be seen later, secondary mathematics is being criticized from many sides. Therefore it seems even more important to have competent teachers of mathematics in the classroom. Many problems face the new teacher on his first assignment. He will have less difficulty if he is confident in his subject field instead of merely one page ahead of his pupils. The Joint Commission's summary (26, p.193) commented on this point also. They asserted that by instituting certain professional requirements,

the initial ineptitude of the teacher has perhaps been guarded against. Also prospective teachers have been encouraged to think about school problems. However, educators seem content with the most modest attainments in the subjects these instructors teach, at least as far as official requirements go. The public desires that boys and girls should be instructed by teachers with social attitudes and community interests, but does not demand that they have contact with teachers who are so well informed as to inspire and assist their pupils toward superior attainment.

Statement of the Problem

The problem is to prepare prospective high school mathematics teachers, who by their mathematical knowledge, are able to inspire, challenge, and assist their students towards higher attainments. This study will attempt to discover, by questioning both Colleges of Education and high school mathematics teachers, the kind of mathematics program that is required to prepare such a teacher. A tremendous amount of mathematics is available, in fact, E.T. Bell (15, p.35) estimates it would take twenty or more geniuses a lifetime of study to master all of the mathematics known. It is impossible to ask a high school

mathematics teacher to attempt to master more than the elementary phases of the subject. Yet the Joint Commission (26, p.186-194) infers that the secondary school mathematics teachers are not masters of the elementary areas. Therefore, a program in college mathematics must be developed to prepare future high school teachers in all areas of secondary school mathematics as well as the more advanced phases of the subject.

Purpose of the Study

The principal purpose of this study is to develop a more adequate college mathematics program for training future high school mathematics teachers. This recommended program is based upon the results of a questionnaire survey of the college and university programs and the recommendations of high school mathematics teachers in Oregon.

Other related purposes of the study may be summarized as follows:

1. To discover the status of secondary school mathematics in Oregon.
2. To discover a representative sample of college mathematics curricula for secondary school teachers of mathematics.
3. To discover the most popular minor fields of

preparation for mathematics teachers.

4. To discover what new mathematics courses are being planned by colleges primarily for prospective high school mathematics teachers.
5. To learn what college people feel should be the next steps in improving the present programs of mathematical preparation.
6. To discover the mathematical background of high school mathematics teachers and what value in teaching they attach to courses completed in college.
7. To discover the high school teachers' recommended mathematical preparation for prospective mathematics teachers and their suggested minor fields of preparation.
8. To discover recent trends in the teaching of high school mathematics.
9. To discover the secondary school mathematics teachers' criticisms of the present teacher training programs.

Location of the Study

Colleges and universities in all forty-eight states and the District of Columbia were questioned regarding

their required mathematical preparation for prospective high school mathematics teachers.

High school mathematics teachers in Oregon were queried concerning the mathematics program in their school, their personal educational background, and their recommendations for a mathematics training plan for prospective teachers of the subject.

Subjects Used in the Study

The mailing list of colleges was compiled from the 1949 Educational Directory published by the United States Office of Education. All colleges and universities reporting a School of Education were used with the exception of Oregon State College, University of Hawaii, and the University of Puerto Rico. Normal schools or teachers colleges were not included in the study. This gave a total of one hundred ten colleges and universities to be questioned. Table I summarizes the types of schools queried.

Table I

Types of Colleges and Universities Used in the Study

Type of school	Number questioned
State Colleges	16
State Universities	51
Combined State College and University	2
State and Private Institutes	2
Private Colleges	4
Private Universities	35

The list of two hundred teachers was compiled from the 1948-49 Oregon School Directory. The teachers were selected from high schools in all areas of the state. Any teacher questioned was listed in the Directory as teaching at least one class in mathematics. Schools of all sizes were represented. The teachers' experience varied from none to thirty-six years. A few part-time teachers were included.

Limitations of the Study

Any study of this type is subject to certain limitations. A major limiting factor of this study as far as the colleges are concerned is the exclusion of small

institutions which did not report a School of Education in the Educational Directory and thus were not mailed questionnaires. These smaller colleges train many teachers and thus their programs would be valuable in this study.

The different titles of mathematics courses cause some confusion in tabulating results. A number of titles are standard but certain course names are misleading. The writer made every effort to make the individual questions definite and to keep the interpretation of the subject titles consistent.

The questionnaire method itself has some limitations. The percent return is an important factor. The interest of the people queried at the time required to fill out the questionnaire affects the number of replies. Also the answers on a questionnaire cannot be as complete as those obtained from a personal interview, but because of the time and distance factors, personal contacts were impossible.

The competence of those questioned is a factor. When compiling the mailing list, the author selected teachers with every type of background and experience. All colleges and universities reporting a School of Education, with the exception of those mentioned earlier

in the chapter, were included.

A possible limitation in discovering teachers' recommendations is that only instructors in Oregon were included in this study. Also several personal questions concerning educational backgrounds and experience perhaps caused some teachers not to reply.

Another factor is the varying experience and educational preparation of the teachers. The author included teachers with a variety of experience, and from all sizes of schools and types of communities.

Perhaps these limitations are numerous, but in interpreting the results of the study they must be considered. The findings in this study suggest the need for further examination of the problem, and the portions of this survey which seem incomplete must be studied more thoroughly if a truly adequate training program for secondary school mathematics teachers is to be attained.

CHAPTER II

MATHEMATICS TEACHING IN THE UNITED STATES

Mathematics has not always occupied the same place in the educational program of the secondary school that it occupies today. The mathematics offerings in high schools have been influenced by changing educational theories and changing practical considerations. There have been periods in which its status has been characterized by stability and prominence and there have been other periods which uncertainty and depression have marked. As the objectives of mathematics change, the content and methods of instruction change, resulting in different expectations from the teacher.

The Evolving Secondary Mathematics Program

Early Arithmetic Butler and Wren (7, p.16-18) write that arithmetic taught in the writing school and the Latin Grammar School was the only mathematics of importance in the secondary schools of the United States during the colonial period. In the latter part of the eighteenth century, arithmetic was given even more recognition through the influence of expanding commercial interests. The subject-matter consisted of a series of rules to be memorized and dogmatically applied.

There were usually no text books and the school master dictated the problem to be solved, stating the rules to be used. The rules and problems were recorded in a "cipher book" and the process itself was called ciphering. A typical rule is one for finding two numbers having given the sum of the numbers and the sum of their squares: (7, p.18)

> "From the square of their sum take the sum of their squares; then from the sum of their squares take the remainder, and the square root of the difference will be the number. To half their sum add half their difference, and the sum will be the greater. From half their sum take half their difference and the remainder will be the less."

The needs of the teacher appeared to be a natural ability at computation, maintaining strict order in the classroom, and a reference book for obtaining rules and problems. So long as the material was that dogmatic and and mechanical, there was little need for special teacher preparation.

The Academy In the Academy (7, p.18-19) the following mathematical subjects appeared in the curriculum during the period from 1787 to 1870: arithmetic, algebra, astronomy, bookkeeping, conic sections, civil engineering, plane geometry, analytic geometry, leveling, logrithms, mapping, mensuration, navigation, statistics, surveying, and trigonometry. The particular attention given to

mathematics during this period was due in part to the practical application required in those times, but principally due to the idea of mental discipline, especially strong from 1860 to 1890. Cubberly (10, p.513) says, "Mathematics subjects logically organized and presented were thought to drill attention, will, memory, imagination, feelings, judgement, reasoning, observation, sense discrimination, and other 'powers of the mind'." Imparting information, drilling for mastery, and controlling the school was the work of the teacher. All pupils, regardless of age, past experience, or physical or mental condition, took the same kind, amount, and order of subject-matter.

Thorough preparation in pure mathematics and the ability to control the classroom appear to be the main qualifications for a mathematics teacher of this period. The courses were already organized and were the same for all pupils. The instructors' needs for academy teaching were met by the college and university programs of the day.

The Pestalozzian Method The Pestalozzian method (13, p.765-768) became popular in this country about 1860 and dominated the educational scene for the next thirty years. There are three main points to this method:

1. The reduction of all subjects to the unanalyzable elements and the teaching of these subjects by carefully graded steps.
2. The use of the object lesson in which an attempt was made to appeal directly to the sense experiences rather than to learn to manipulate words.
3. The oral teaching of all subjects.

In mathematics the Pestalozzian method manifested itself in simple and rapid calculation. Counting beans, boys, sticks, and holes in lace curtains formed the basis of this arithmetic. Sand tables, paper, and slates for ciphering were discarded and the pupils were trained to solve mentally, rather complicated problems with whole numbers and fractions. Warren Colburn's "First Lessons in Arithmetic on the Plan of Pestalozzi", widely used by 1860, contained a multitude of simple, attractively stated problems to be solved mentally. The following extracts (10, p.396) are illustrative:

> How many hands have a boy and a clock?
>
> Judas, one of the twelve Apostles, hung himself; how many were left?
>
> Mrs. Fanny Woodburry was born in 1791, and died in 1814. Miss Hannah Adams lived to be fifty-three years older; how old was Hannah Adams?

Teaching by this method required a more skillful and better prepared teacher. The teacher must stand alone, know the proper methods of presentation, have a sound knowledge of subject-matter, and be able to organize the materials into units. New emphasis was placed on teacher education, there was a noticeable growth of professional educational classes, and the techniques of presenting mathematics were introduced into the teacher training schools and colleges.

The Period of Dissatisfaction The last quarter of the nineteenth century saw the public high school replace the academy as the important secondary school. Rapid changes were being made in the social, political and industrial customs of the United States, and evidences of the attempts of the high school to keep pace with these developments may be seen in the large number of courses added to the curriculum. Algebra, geometry, and even the calculus became quite universal in the curricula. The result by 1900 was a general dissatisfaction with the mathematics program. The pupils were not grasping the subject, since a large part of the high school failures were in mathematics, colleges complained of the poor mathematics backgrounds of their freshmen, and businessmen were doubtful of the opportunity for the application of

secondary mathematics as taught. The average man had completed more mathematics than he could assimilate or apply.

A survey at the turn of the century by Stamper (33, p.288) indicated that the majority of the teachers were sufficiently prepared on the subject-matter side, although many were not familiar with the calculus. Even at this late time, there was little training for secondary mathematics teachers other than in the academic aspects of the subject.

Stafford (32, p.10-11) suggests that another teaching idea in mathematics, popular at the time, was the reasoning power theory. Mathematics was considered the abstract for natural sciences and was valuable as a training of reasoning power, not simply because it was abstract, but because it was a representation of actual things. This theory held as long as the subject-matter was based on the concrete, but texts gradually lapsed into more and more abstract forms until mathematics became a torture for both the student and the teacher. The requirements for teaching this type of mathematics was a bachelor's degree with a major in mathematics and a minor in some related field such as physics or chemistry. The belief was still strong that the teacher was born, not made, resulting in little preparation in teaching techniques.

Functional Mathematics The most recent development in secondary mathematics is to make the subject more functional and to organize general mathematics courses. The problems of how to reorganize and coordinate the garbled mathematics program of 1900 were studied by many committees. Some of these groups were:

The Committee of Ten	1893
The Committee on College Entrance Requirements	1899
The International Commission	1911, 1918
The National Committee of Fifteen	1908
The National Committee on Mathematics Requirements	1916

The reports of these various committees pointed to the problem of making mathematics more functional, especially in the junior high school. Even today, the problem is far from being solved. The standard propositions which authors have been stating for the past two decades are summarized by William Betz (2, p.96).

1. The mathematical curriculum "for all but the few" should stress only those minimum essentials which are actually needed in life.
2. All the mathematics taught in the school should be derived from actual life situations.

3. Academic mathematics of the usual type does not "meet the needs" of the vast majority of our young people, "the other eighty-five percent". It is largely "non-functional" and should be reserved "for the few".
4. "All but a few" of our pupils can get along without any mathematics in the secondary schools.

The sincerity of the advocates of all the above propositions makes the problem of finding the truly functional mathematics program even more difficult. There remains a need for further study and experimentation.

The Joint Commission of the National Council of Teachers of Mathematics (26, p.21-34) desires to keep mathematics in secondary education on a high level as opposed to the minimum education theory. It interprets the contributions which mathematics can make to the following objectives of secondary education:

1. Ability to think clearly.
    a. Gathering and organizing data.
    b. Representing data.
    c. Drawing conclusions.
    d. Establishing and judging claims of proof.
2. Ability to use information, concepts, and general principles.

3. Ability to use fundamental skills.

4. Desirable attitudes:

   a. Respect for knowledge.

   b. Respect for good workmanship.

   c. Open-mindedness.

5. Interest and appreciations:

   (Under this heading special attention is directed to the school's obligation to arouse and cultivate new interests as well as to foster and develop those desirable ones which the students have already acquired.)

6. Other objectives:

   (Health, citizenship, and worth home membership)

A somewhat different approach is presented in Life Adjustment Education for American Youth (37, p.94) in listing the fundamental skills which every citizen should possess and basic knowledges which every citizen is likely to need. These include:

> "skill in the fundamental operations of addition, subtraction, multiplication, and division; ability to read numerical data in graphic form and with an understanding of the basic features of graphic presentation which make a chart readable; an understanding of the truth that an equation is of such a nature that whatever is done with one side must

> be done with the other side if the equation is to remain valid; ability to use scale drawings in making maps and plans of houses; to handle personal finances and money wisely; and the solving of problems which are concrete and come within the experience of daily living."

To teach this functional mathematics requires a more skillful and better prepared teacher. No longer is he a drill master and disciplinarian who teaches from only one text book. Today there are more pupils in high school than ever before and it is the teacher's task to interest these pupils in mathematics, to apply mathematics to everyday life, and to give the students going to college an insight into the power of mathematics as a tool for further study. This type of teacher requires more complete and careful training.

The Training of Secondary School Mathematics Teachers

College Mathematics Smith (31, p.18-32, 65-74) writes that during the colonial period, the colleges were the only schools offering mathematics beyond the simple arithmetic. Even as late as the middle of the eighteenth century, the preparation for entering these courses in college was pitifully weak. Extra tutoring was usually necessary. The result was that much arithmetic and what

today is classified as high school mathematics were taught in college.

The course in Algebra at Harvard included solving "adfected quadratic equations","the resolution of cubick equations", "the method of converging series", and "Dr. Hulley's theorems for solving equations of all sorts". Besides the work in algebra there was a "method of resolving geometrical problems algebraically" and geometry studied from Playfair's Euclid and Allsted's text.

Around the middle of the eighteenth century, Thomas Clap developed a new plan at Yale which included arithmetic and algebra in the first year, geometry in the second year, and "mathematics and natural philosophy" (physics) in the third year. He wrote in 1866, that many of the juniors understood surveying, navigation, the calculation of eclipses, and some were fairly proficient with the conic sections and fluxions (differentials).

The programs of these two schools illustrate the representative curriculum of most of the colleges throughout the eighteenth century. The tendency was toward application with little emphasis on teacher preparation.

The first half of the nineteenth century was a time for preparation for action and by 1875 there was the beginning of the period of rapid advancement which has

extended until the present day. During this same period there was a rapid development of the small colleges, usually religious in nature. The mathematics was taught by a preacher or politician out of work. The professors were poorly prepared and the work assigned to them left little time for any serious study. The salary schedule was low, a good professor getting "600 dollars if we can raise it" (31, p.66). There was not enough mathematics known in America to warrant a professorship of mathematics and even in the larger schools, such as Harvard and Yale, the professors of mathematics were professors of astronomy, physics or theology as well.

According to Smith (31, p.17) the following subjects were taught at Dartmouth and Yale at the end of the first two quarters of the nineteenth century:

1825 Freshmen: Arithmetic and algebra

Sophomores: Euclid, plane trigonometry, mensuration, surveying and navigation

Juniors: Conic sections, spheres, natural philosophy, spherical trigonometry, and astronomy

1850 Freshmen: Plane geometry, algebra (complete)

Sophomores: Trigonometry, surveying, mensuration, analytics, and calculus

Juniors: Natural philosophy and astronomy.

The work of the freshman year of college continued to be merely that of an average high school curriculum of today. This fact gives some reason for the poor preparation of the teachers of the period and for the unsatisfactory work done in the field of mathematics in the secondary schools of the time.

After 1875 mathematics became a subject rather than a minor subordinate taught in conjunction with astronomy and physics. As a result the more elementary phases were moved into the expanding high school and many more competent teachers were required.

Specific Training for Secondary School Mathematics Teachers Almost nothing was done in the United States prior to 1900 to train specifically the teacher of secondary mathematics. The preparation of teachers for special work in mathematics was neglected by the universities. It was left to a few of the more advanced normal schools to first attempt this special preparation. The state normal schools of Wisconsin in 1867 offered an advanced course of one year, in which among many other things, the student learned geometry, trigonometry, and surveying; and it appears that the prospective teacher taught these subjects in a model school. The purpose of this year's

work was not to teach in high school but in the higher grades of the elementary school. In 1892 the State Normal School at Albany, New York was offering instruction in methods of teaching algebra and plane and solid geometry. In the same year the New York College for Training Teachers, now Teachers College of Columbia University, gave a course in methods of teaching geometry. By 1895 the Michigan State Normal College at Ypsilanti offered, as electives, methods in algebra and geometry. These are the only schools and courses reported before 1900 writes Stamper (33, p.283-284).

During the period between 1900 and 1910 a rapid growth in the offerings of mathematics methods courses was noticeable. This corresponds closely to the period of dissatisfaction and committee study of the secondary mathematics programs mentioned earlier in this chapter. The leaders of the movement were Columbia University and Chicago University. The situation in 1910 concerning the preparation of mathematics teachers can be summarized as follows:

Institutions having Colleges of Education	18
Institutions giving courses in teaching of secondary mathematics	38
Institutions requiring practice teaching in mathematics	19
Institutions offering courses in the history of mathematics	29
Institutions giving courses in logical foundations of mathematics	8

Stamper (33, p.286-287) writes that the educational needs and qualifications of a secondary mathematics teacher at the turn of the century were:

First a thorough preparation in advanced mathematics was required. Not only should the teacher have studied through the calculus but he should be an able mathematician. A working knowledge of the theory of functions or group theory was considered to unify his conception of the subject. A university course in geometric logic and absolute geometry were regarded as necessary to provide a study of the foundations of mathematics. By virtue of his knowledge of advanced mathematics, the teacher was considered well equipped to interpret the high school phases of the subject.

A second requirement was that he be familiar with the history of mathematics, including the history of

teaching the subject. A knowledge of the development of the subject matter in the succeeding ages and the sequence of development of the various branches were considered to give the teacher a fund of usable information and a clearer insight into the whole field of mathematics. Mathematics at that time continued to be presented in the traditional sequence of subject matter.

Third, the teacher should be a master of the pedagogy of his particular field and he should be actively aware of all the problems in general education. The teacher should have a willingness to cooperate with the other departments and realize that there are common ends which concern the school as a whole.

These needs and qualifications were very modern, but from the above summary of the offerings of schools of the period, they were not being achieved by the teacher training institutions.

In a government report of 1920 (39) on the training of mathematics teachers, the following facts were noted: The main requirement was a high school diploma. Many were teaching at this time with nothing beyond the high school requirement but the number was rapidly decreasing. The North Central Association required twelve hours of college mathematics. To teach permanently, a Bachelor

of Arts degree was almost universally required. In this same association the educational background of secondary mathematics teachers may be summarized as follows:

Bachelor Degree	65.2%
Advanced Degrees	11.9%
Some Professional Training	89.3%
Trained in only part of subject taught	37.0%

The picture for that period was much the same over the entire country. Professor Reeve (39, p.452) at the time said, "We ought to be able to presently require the calculus of all prospective teachers of mathematics in the secondary schools."

It is interesting to compare the German requirements for a mathematics teacher of the same period. The prospective teacher spent four years in subject matter preparation in a college or university, followed by a state examination on religion, philosophy, language, and two majors and a minor. If he passed, he spent two years as an apprentice to a teacher in a secondary school, followed by a professional examination. Only if he passed this final hurdle did he receive his certificate. England at the time required an honors degree and twelve weeks of practice teaching (39).

By 1930, eighty-five percent of the colleges

required practice teaching (12). In an article written in 1949, Howard Fehr (15, p.34) summarizes the general pattern of the training of secondary mathematics teachers today as:

> "much pure mathematics, including foundations, a course or two in applied mathematics, a course in psychology, a course in methods of mathematical teaching, and collegiate study in the minor related fields of knowledge."

This is the point to which the mathematics teacher training program has advanced in January 1950 when this study was made.

Some Problems of Secondary Mathematics Applicable to Teacher Training

No analysis of mathematics teaching as applied to teacher training is complete without a brief discussion of the problems facing secondary mathematics in 1950.

The Problem of Decreasing Enrollment A very disturbing problem is the continued decrease in the percentage of high school pupils enrolled in mathematics. Table II shows clearly that the percentage of total student registrations in mathematics has, since 1910, been characterized by a consistent decrease.

Table II (7, p.14)

Percentage of Students in Mathematics in Public High Schools Since 1890

Subject	1890	1895	1900	1905	1910	1915	1922	1928	1934
Algebra	40.40	54.27	56.29	57.51	56.85	48.84	40.15	35.22	30.41
Geometry	21.33	25.34	30.87	28.16	30.87	26.55	22.68	19.80	17.06
Trigonometry		2.53	1.91	1.71	1.87	1.48	1.53	1.27	1.33
Astronomy		4.79	2.78	1.22	.53	.28	.07	.06	.06
Arithmetic							10.53	2.42	2.30
Commercial Arithmetic							1.47	9.65	4.91
Totals	61.73	86.93	91.85	88.60	90.12	77.15	76.63	65.92	56.07

The only recent figures available are in a study by the Commission on Post War Plans in 1948 (29). One hundred thirty-six schools with a total enrollment of 133, 121 pupils were querried. The percent enrolled in mathematics by grades were:

Grade Nine	92%
Grade Ten	65%
Grade Eleven	38%
Grade Twelve	26%

The average mathematics registration for senior high schools was forty-four percent. This is not a complete picture but does indicate that enrollment is not on the up grade. True, there are more pupils registered in mathematics, but the percentage of the total school population is less. With life becoming more quantative and much more dependent on mathematics it would seem logical that the enrollment should increase. The above table denotes a noticeable decrease.

How this decrease affects teacher training may be seen from reviewing some of the major criticisms of high school mathematics as presented by E.R. Breslich (5, p.204-205). These criticisms are summarized below. All point directly to the teacher.

First, pupils do not know how to use their

mathematics when they meet problem situations where they need mathematics. This criticism comes from teachers of other subjects, teachers of advanced mathematics, businessmen, industrial leaders, and the military. Opinions as to the reason agree that the pupils never mastered the fundamental concepts; that pupils memorized a few facts instead of learning the over all problem and applications; and that the teachers encouraged mechanical performance instead of understandings.

Second, pupils dislike mathematics. This reason seems to be a universal complaint, almost a conditioned response. The teacher's ability to arouse interest seems an outstanding factor here. Perhaps the teacher himself does not have the enthusiasm for the subject necessary to create real motivation. Some pupils who are interested in and understand mathematics like the subject even if they are unsuccessful with it. If pupils do not understand mathematics and are not interested in it, they soon develop an intense dislike for the subject.

Third, teachers make the study unnecessarily difficult, so much so that some people believe that a special ability is needed to study the basic essentials of high school mathematics. This is given by some administrators as the reason for many failures. Perhaps the present way of presenting high school geometry, trigonometry, and

advanced algebra does make it difficult for the average pupil. Secondary mathematics can be presented in a simple understandable way without going into the involved theory.

The Problem of Lax Certification Requirements

The problem of lax certification standards most certainly affects teacher training. W.I. Layton (21, p.21-23) made a study of the requirements for certification of mathematics teachers of grades one through twelve in the forty-eight states and the District of Columbia. The rules and regulations on certification issued by each state department of education were carefully analyzed. A summary of the report follows:

States requiring no content courses in mathematics for initial secondary certification.....almost 30%

Range of required semester hours of mathematics..... 0 to 24

Mean hours required..... 10

States specifying particular courses... 5

Algebra.....2

Geometry.....2

Trigonometry.....5

Mathematics of Finance..1

College Algebra.....3

Freshman Mathematics...1

College Geometry.....2

Analytic Geometry.....2

Calculus.....2

States requiring related fields of study.....1

States requiring methods courses.....2

The total number of hours prescribed in mathematics for teachers of the subject is somewhat lower than that in English content for English teachers. All states require professional training, but the only course prescribed by 50% or more is practice teaching. The hours of professional education work required is nearly twice the mathematics requirements. A majority of the states require a minimum of four years of college for a secondary certificate. Very few states require a minimum average grade, recommendation from a college, or a certificate from a physician.

Much is to be desired in the certification requirements in the various states. With the minimum requirements so low, it is not difficult to vision a field overcrowded with mediocre mathematics teachers. The colleges therefore have an obligation to develop philosophies of training and prescribe courses for future mathematics teachers.

CHAPTER III

THE STUDY

The information gathered for this study was obtained by questioning colleges of Education and high school mathematics teachers. One hundred ten questionnaires were sent to colleges and universities throughout the United States and two hundred were sent to teachers in Oregon. A stamped self addressed envelope was enclosed with each inquiry to facilitate easier return. After eight weeks from the mailing date, the final tabulations were made. The task of reading and organizing these answers as well as the additional encouraging statements by many has been interesting and stimulating.

Part I

The Teachers' Report

The total number of usable returns from high school mathematics teachers was eighty-nine, or forty-four and one half percent. Five returned the questionnaire unanswered because they were no longer teaching and two were returned by the schools since the teacher had moved, leaving no forwarding address.

To show this as a normal sampling of the secondary

mathematics teachers in Oregon, the answers have been classified as to the size of school, years of teaching experience, and the number of mathematics courses taught. The number of schools and teachers from these schools included in this study based on the size of the school are indicated in Table III.

Table III

Teachers' Replies Classified as to Size of School

Size of school	Number of schools	Number of teachers
0 - 50	9	9
51 - 100	12	12
101 - 250	18	19
251 - 500	14	16
501 - 1000	14	18
over 1001	9	14
Did not indicate		1
Total	76	89

The replies are well distributed among all sizes of schools. The representation of the smaller schools is valuable because of the particular problems facing the mathematics teacher in such schools. The high percentage of answers from teachers in the larger schools is

helpful since it is usually these teachers who teach straight mathematics courses. The seventy-six high schools included represent one third of the 227 secondary schools listed in the 1949-50 Oregon School Directory.

Table IV classifies the teachers' replies according to years of experience in teaching mathematics.

Table IV

Teachers' Replies Classified as to Teacher Experience

Years of Math. Teaching Experience	Number of Teachers	Percent of Teachers
0 - 5	31	34.8
6 - 10	15	16.9
11 - 15	14	15.7
16 - 20	13	14.6
21 and over	13	14.6
Did not say	3	3.4
Total	89	100.0

The above table shows that teachers with five years and less teaching experience in mathematics form a large part of the responses. There are possibly two reasons for this. First, until recently the high schools have been short of teachers and many new teachers are in the

various school systems. Secondly, these new teachers are interested since they have recently graduated from college and the inadequacies of their preparation are evident to them. What the new teachers lack in experience is made up for by their closeness to the present college teacher preparation programs and their ability to give a complete picture of their own training in mathematics.

The replies are classified as to the number of mathematics courses taught by the teachers, in Table V.

Table V

Teachers' Replies Classified as to the Number of Mathematics Courses Taught

Number of Mathematics Courses	Teachers Teaching	Percent of Teachers Teaching
0	2	2.2
1	8	9.0
2	28	31.5
3	15	16.9
4	18	20.2
5	9	10.1
6	2	2.2
No Answer	5	5.6
Attending School	2	2.2
Total	89	100.0

This table shows that over eighty-five percent of the replying teachers teach two or more mathematics courses and only seven teach no mathematics or did not indicate the courses. The two instructors doing graduate work gave very complete and usable answers to all questions suggesting an interest of other students in the problem.

The percent of high school pupils enrolled in mathematics in Oregon as determined by this survey, is 47.80 ± 1.79. The range was from six to eighty-three percent. Assuming this to be a random sampling, it can be stated with confidence, (ninety-five chances in one hundred) that the true percentage of high school pupils enrolled in mathematics is between 1.96 standard errors on either side of the mean or within the interval 44.29 to 51.31 percent. If no chances are taken, the interval is from 42.43 to 53.17 percent. All standard errors presented in this paper may be interpreted in a like manner. The author draws attention to the fact that if the percent actually enrolled in high school mathematics is the maximum as shown by this sample, it is an extremely low figure. However, compared to the national picture presented in Chapter II, the percentage follows the general trend throughout the United States.

To further interpret this particular condition, the percents enrolled in secondary mathematics are

calculated for the varying sizes of schools and are shown in Table VI.

Table VI

Percent of High School Pupils Enrolled in Mathematics Classified as to the Size of the School

Size of School	Percent in Mathematics
0 - 50	59.16 5.03
51 - 100	49.56 4.00
101 - 250	49.41 4.80
251 - 500	47.22 5.80
501 -1000	44.79 3.75
1001 and over	39.51 3.16

The above table confirms the fact that the smaller schools do not have the variety of courses to offer and therefore the pupils have no other choice but to take mathematics. In the larger schools which may offer every type of mathematics, the percent enrolled falls below the mean of all schools. The standard errors are included in the table if the reader wishes to interpret the percents as representing the actual condition of high school mathematics in Oregon.

The mathematics courses offered in the secondary

schools of Oregon are presented in Table VII.

Table VII

Mathematics Courses Offered in Oregon High Schools

Course	Offered	percent offering	Offered if * desired	Required	Or Another Math Course Required
General Math	68	88.3±3.8		39	18
Algebra I	74	96.1±2.2		1	17
Algebra II	56	72.7±5.1	1		7
Plane Geometry	68	83.3±3.8			7
Solid Geometry	21	27.3±5.1	1		6
Trigonometry	43	55.8±5.7	1		7
Senior Math	17	22.1±4.7			
Senior Prac. Math	5	6.5			
Arithmetic	6	7.8			1
Consumer Math	1	1.3			
Business Math	1	1.3			1
Shop Math	1	1.3			
Senior Review	2	2.6			1

* If enough pupils desire such a course.

Table VII shows that of the schools represented in this survey, seventy-four offered beginning algebra. Plane geometry and general mathematics are the second most frequently offered courses. Second year algebra, trigonometry, solid geometry, and senior mathematics follow in that order. Why first year algebra and plane geometry rank over and even respectively with general mathematics is possibly explained by the fact that many of the high schools, especially the smaller ones, are offering only college preparatory courses. Also many of the schools questioned were senior high schools and perhaps did not offer general mathematics. The standard errors are presented for those who wish to interpret the percents as representative of all Oregon high schools. The fact that the algebra, geometry, trigonometry combination is still the outstanding group taught in the high schools is brought out by the table.

The table also shows that thirty-nine of the schools questioned required general mathematics, and one required first year algebra. It is interesting to note the high percentage of schools requiring general mathematics for graduation, yet several high school teachers and college professors questioned if this course is what the pupils really want and need.

Only two schools in this survey require more mathematics than the minimum set by the State Department of Education. Both of these schools require two years of mathematics.

It would be interesting to pursue further the study of the condition of secondary mathematics in Oregon but that is not the purpose of this study. The above material is sufficient to show some of the problems facing the new high school mathematics teacher.

The educational background of teachers of high school mathematics in Oregon is an important aspect of this study. All of the teachers who answered the questionnaire hold Bachelor's Degrees, twenty-two hold Master's Degrees, and seven have completed their fifth year work.

Fifty-three or about sixty percent of the teachers were educated in Oregon, sixteen of these graduating from Oregon State College. Thirty,or one-third,received their education out of the state. This possibly confirms a trend already pronounced, that is, the huge influx of teachers into Oregon because of the teacher shortage and Oregon's higher salary scale. This also may explain in part why the shortage of high school teachers soon turned into an over-supply with the resulting attempt to funnel many secondary teachers into the elementary field. Four

teachers did part of their work in Oregon and two did not answer this part of the questionnaire.

To present the findings relevant to the major and minor preparation of the mathematics instructors in this survey, the replies are organized in Table VIII.

Table VIII

Major and Minor Subject Preparation
of Oregon Mathematics Teachers

Subject field	Major Preparation	Percent	Minor Preparation	Percent
Mathematics	42	47.2	32	36.0
Physical Science	10	11.2	43	48.3
Biological Science	9	10.1	19	21.4
English	8	9.0	13	14.6
Engineering	7	7.9		
Language	5	5.6	6	6.7
Physical Education	5	5.6	7	7.9
Business Education	4	4.5	6	6.7
Social Science	4	4.5	25	28.1
Education	3	3.4		
Agriculture	2	2.2		
Industrial Arts	1	1.1	2	2.2
Music	1	1.1	5	5.6
Home Economics	1	1.1	1	1.1
Philosophy	1	1.1		
Psychology	1	1.1		
Drawing			1	1.1
General Science			1	1.1
Elementary			1	1.1
Library Science			1	1.1
None	5	5.6	8	9.0

Number Responding-- 89

The outstanding fact gleaned from Table VIII is that 16.85±3.96 percent of the teachers questioned had neither a major or minor preparation in mathematics in college. If it is assumed that this is a normal sample, the actual percent may be said, with confidence at the five percent level, to fall within the interval 9.09 to 24.61 percent. In interpreting this fact, the author suggests that mathematics can be taught directly from the the text with little advanced knowledge of the subject. However in order to challenge the brighter students and properly prepare the pupils going to college, the teacher must have a larger perspective of mathematics which comes from much personal contact with the higher branches of the subject. Also to interest the other large group of students who are required to take mathematics, the teacher must know about the applications of mathematics. This comes from many courses in the applied mathematics.

Less than one-half of the teachers questioned had major preparation in mathematics. Fifty-three of the teachers have either a major or minor in physical science. Twenty-nine have preparation in social science, twenty-eight in biological science, and twenty-one in English. The other fields mentioned are scattered and show no definite pattern.

Five teachers did not complete a major teaching field in college. The number of minors ranged from none to five.

The high school courses which mathematics teachers are called upon to teach are useful in discussing teacher preparation. These are presented in Table IX.

Table IX

Courses Taught by Teachers Questioned

Course	Number Teaching	Percent Teaching
1 General Mathematics	35	39.4
2 Algebra I	57	64.1
3 Algebra II	41	46.1
4 Plane Geometry	47	52.8
5 Solid Geometry	14	15.7
6 Trigonometry	27	30.4
7 Senior Mathematics	5	5.6
8 Senior Practical Math	4	4.5
9 Arithmetic	3	3.4
10 Senior Review	1	1.1
1 General Science	8	9.0
2 Physics	14	15.7
3 Chemistry	10	11.2
4 Biology	5	5.6
5 Physical Education	5	5.6
6 Social Science	6	6.7
7 Commercial	5	5.6
8 English	4	4.5
9 Industrial Arts	2	2.2
10 Drawing	2	2.2
11 Crafts	1	1.1
12 Language	1	1.1
13 Home Economics	1	1.1
14 Agriculture	2	2.2
15 Administration	2	2.2
16 Going to School	2	2.2
17 No Answer	2	2.2

The science - mathematics combination is common with forty-one percent of the teachers teaching some area of science. There are various unusual combinations such as mathematics and home economics, agriculture, or language. This is probably explained by the small school and is an argument used by many to urge a general college curriculum for teacher preparation in preference to the specialized subject field. Only ten teachers taught either senior mathematics or senior practical mathematics.

The number of additional courses taught by mathematics teachers is presented in Table X.

Table X

Number of Additional Courses Taught by Mathematics Teachers

Courses	Number Teaching	Percent Teaching
Straight Mathematics	41	46.1
Mathematics plus one course	18	21.3
Mathematics plus two courses	17	19.1
Mathematics plus three courses	4	4.5
No Mathematics	2	2.2
No Answer	5	5.6
Attending School	2	2.2
Total	89	100.0

The table shows that less than half of the teachers participating in the study were teaching straight mathematics. One fifth were teaching one or two subject areas in addition to mathematics. The importance of good minor preparation is suggested by these results.

An important part of any teacher's preparation is his knowledge of subject matter. The number of term hours of mathematics taken by the teachers used in this survey is presented in Table XI.

Table XI

Term Hours of Mathematics Completed by High School Mathematics Teachers

Number of Term Hours	Number of Teachers	Percent of Teachers
0	1	1.1
1 - 10	2	2.2
11 - 20	13	14.6
21 - 30	16	18.0
31 - 40	20	22.4
41 - 50	12	13.5
51 - 60	6	6.7
Over 60	7	7.8
No Answer	12	13.5
Total	89	100.0

Average Term Hours -- 35.03±2.25

The range of term hours of college mathematics completed by high school teachers is from none to ninety, with a mean of 35.03 ± 2.25. To further interpret this mean as the average number of term hours taken by all teachers of mathematics in Oregon, the standard error is calculated. Only five teachers recorded less than the fifteen term hours required by the Oregon State Department of Education.

The specific courses completed by teachers and their opinions as to the value of these courses in later teaching are presented in Table XII.

Table XII

Mathematics Courses Completed by Teachers and the Value of These Courses in Teaching

Course	Number* Completed	Percent	Number Feltx Course Valuable	Percent
Trigonometry	74	86.1	37	61.7
Analytic Geometry	72	83.7	27	45.0
Calculus	66	76.8	18	30.0
College Algebra	65	75.6	37	61.7
Differential Equations	28	32.6	0	
Introduction to Calculus	22	25.6	10	16.6
Theory of Equations	18	20.9	3	5.0
College Geometry	18	20.9	3	5.0
Statistics	17	19.8	3	5.0
Advanced Algebra	16	18.6	7	11.7
History of Mathematics	14	16.3	5	8.3
Unified Mathematics	12	14.0	6	10.0
Projective Geometry	10	11.6	1	1.7
Solid Geometry	8	9.3	1	1.7
Spherical Trigonometry	8	9.3	4	6.7
Mechanics	6	7.0	1	1.7
Business Mathematics	6	7.0	0	
Descriptive Geometry	5	5.8	0	
Advanced Analytic Geometry	4	4.7	1	1.7
Advanced Calculus	5	5.8	0	
Non-Euclidean Geometry	2	2.3	0	
Advanced Differential Equations	1	1.2	0	
Foundations of Mathematics	2	2.3	0	
Arithmetic	1	1.2	0	
Slide Rule	1	1.2	1	1.7
Astronomy	3	3.5	0	
R.O.T.C. Mathematics	1	1.2	0	
Drawing	1	1.2	0	
Engineering Courses	9	10.5	1	1.7
Other Advanced Mathematics	11	12.8	0	
Methods	28	32.6	11	18.3
None	1	1.2		
None Valuable			1	
No Answer	2		28	

* Number Responding -- 86

x Number Responding -- 60

The first five courses, trigonometry, analytic geometry, calculus, college algebra and differential equations are what would be expected. College algebra in this case means an advanced elementary algebra, not to be confused with higher algebra. College geometry and theory of equations rank seventh, followed closely by elementary statistics, advanced algebra, and history of mathematics. All of the other courses were taken by less than fifteen percent of the teachers with the exception of methods in teaching mathematics. The writer suggests that many more undoubtedly have taken methods courses but did not consider them subject matter preparation.

The important part of the above table is the value attached to the various courses by the teachers. Over sixty percent of those answering felt that trigonometry and college algebra were of great value to them in their teaching. This suggests a strong argument for the inclusion of college algebra in the training program of teachers, regardless of the high school algebra completed. Forty-five percent felt analytic geometry very valuable and forty-six percent indicated calculus as important. Methods, higher algebra, unified mathematics, and spherical trigonometry follow in order. The remainder of the courses were of value to five percent of the teachers or less.

One outstanding fact is noticeable in the table. Although nearly one-third of the teachers have taken differential equations, not a single one indicated that it was of any value to them in later teaching. Two inconsistencies concerning calculus and college geometry will be noted later. A final interesting point is that one teacher stated none of his college mathematics was important in high school teaching, yet he had completed most of the less advanced offerings in college.

The number of term hours of mathematics recommended by the teachers ranges from six to sixty-five, the mean being 31.81. This is approximately three hours less than the mean number of term hours of mathematical preparation by the teachers questioned. This perhaps indicates that they are not relying completely upon their own preparation in suggesting a program. The specific courses suggested are presented in Table XIII.

Table XIII

Mathematics Courses Recommended by Oregon Teachers

Course	Number* Recommended	% Recommending	Average Term Hours
Trigonometry	60	81.1	4.6
Calculus	60	81.1	6.7
College Algebra	47	63.6	9.6
Analytic Geometry	39	52.7	4.3
College Geometry	24	32.4	4.1
History of Mathematics	16	21.6	3.3
Theory of Equations	15	20.3	4.1
Unified Mathematics	9	12.3	9.5
Business Mathematics	9	12.3	4.4
SolidGeometry	9	12.3	3.8
Statistics	8	10.8	5.6
Spherical Trigonometry	7	9.5	3.4
Descriptive Geometry	6	8.1	3.6
Arithmetic	6	8.1	5.7
Differential Equations	4	5.4	4.7
High School Mathematics Review	4	5.4	
Advanced Algebra	3	4.1	6.0
Foundations of Mathematics	3	4.1	4.5
Advanced Analytic Geometry	2	2.7	3.0
Mechanics	2	2.7	9.0
Projective Geometry	2	2.7	3.0
Theory of Numbers	1	1.4	
Non-Euclidean Geometry	1	1.4	
Shop Mathematics	1	1.4	9.0
Forestry Mathematics	1	1.4	9.0
Drawing	3	4.1	6.0
Engineering Problems	2	2.7	
Visual Aids in Mathematics	2	2.7	4.0
Applications of Mathematics	9	12.3	10.6
Methods	27	36.5	4.7
Astronomy	2	2.7	
Aviation	2	2.7	
Physics	3	4.1	10.5
Chemistry	1	1.4	9.0
Higher Mathematics	2	2.7	
Thorough Background	3	4.6	
Three plus years	5	6.8	
Emphasize Methods	2	2.7	
No Answer	15		

* Number Responding -- 74

Trigonometry and calculus head the list and college algebra is the second most frequently recommended, followed in order by analytic geometry, methods, college geometry, history of mathematics, and theory of equations. Unified mathematics (considered as an introduction to college mathematics), business mathematics, solid geometry, elementary statistics, and spherical trigonometry follow in that order. Nine people suggested "applications of mathematics" as a title of a course. Other courses were suggested by less than five percent of the teachers replying and show no pattern. The author points out these significant facts about the teachers' recommendations:

1. In general the teachers feel that the preparation of future teachers of mathematics should be concerned with the more elementary phases; work beyond calculus is seldom suggested. The average term hours of calculus is 9.6.
2. Two inconsistencies are noticed in comparing the recommendations with the results in Table XII. Only five percent of the teachers felt that college geometry was valuable in teaching, yet nearly one-third suggested it, and although less than half of the teachers believed calculus valuable, 81.1 percent recommended the course.

3. Business mathematics is a somewhat popular recommendation and, although offered by many schools, it is not required of many prospective teachers.
4. As many as eighteen term hours of"applications of mathematics" are suggested, the average being 10.6. Applications in engineering, social science, art, music, business, economics, mapping, astronomy, calculating devices, and drawing were specifically mentioned.
5. Many lay emphasis on methods of teaching and perhaps others would have included such a course but did not consider it subject matter preparation. The term hours of such a course ranged as high as ten, the mean being 4.7.

The findings pertaining to the suggested minor teaching fields are presented in Table XIV.

Table XIV

Minor Teaching Field Recommendations by Oregon Teachers

Subject Field	Number* Recommending	Percent Recommending
General Science	44	58.7
Physical Science	28	37.4
Social Science	11	14.7
Business	11	14.7
English	9	12.0
Physical Education	4	5.3
Industrial Arts	4	5.3
Engineering	3	4.0
Home Economics	1	1.3
Agriculture	1	1.3
Astronomy	1	1.3
All Possible	2	2.7
Determined by Interest	1	1.3
No Answer	14	

*Number Responding 75

As is expected, general science and physical science are, by far, the most popular minor fields. Social science, English, and business education rank high.

Other suggestions made by the teachers were too scattered to show any definite pattern.

In answer to the question, "Do you think that the colleges are properly preparing prospective teachers?" thirty-six percent of the teachers answered in the affirmative, and forty percent in the negative. One teacher thought the preparation was fair, and twenty did not answer the question. As an interesting side light, ten of the sixteen Oregon State College graduates believed that the preparation was adequate, five believed that it was not, and one considered the program fair. The important fact is that over half of the teachers responding felt that the college training program in mathematics was not what it should be. This is a serious indictment against present teacher training programs in mathematics. It is important that teacher training institutions keep in mind the type of program needed by the teachers in the field.

Many teachers were quite definite in their criticisms of the present training program. The diverse objections and suggestions are organized in Table XV.

Table XV

Criticisms of Present College Mathematics for Teacher Preparation

Criticism	Number* Stating	Percent Stated
Too many Pure and Advanced Courses	17	30.9
Better Methods Courses Needed	13	23.6
More Emphasis on Methods	14	25.4
More Application Courses	8	14.5
Learn Basic Concepts	7	12.7
More Practical Courses	6	10.9
Too Little Time	4	7.3
Needed More Mathematics	4	7.3
More Historical Background	3	5.5
Too Many Professional Courses	2	3.6
More Practice Teaching	2	3.6
More Practical Education Courses	2	3.6
Professors, No High School Experience	1	1.8
Better Selection and Guidance	1	1.8
More College Geometry	1	1.8
No Answer	34	

*Number Responding -- 55

The outstanding single criticism, which was also inferred by the recommended curriculum for prospective teachers, is that future teachers are given too many pure and advanced mathematics courses. In addition to the above statement, eight felt that more application courses are needed, seven wanted emphasis put on basic concepts of mathematics, not techniques of solving complicated problems, and six wished to see more practical mathematics courses instituted.

Twenty-seven of the teachers were concerned with methods of teaching mathematics. Fourteen felt the need for more emphasis on methods, and thirteen wanted better technique courses. The way in which the teacher presents mathematics is a most important factor for pupil understanding and interest. Several suggested a separate methods course for each high school mathematics subject. The other criticisms are too scattered to show any pattern.

A final question about the trends in high school mathematics as seen by the teacher was included in an attempt to discover in what new directions the prospective teachers must be trained. There are many ideas presented. In an effort to make the material as objective as possible, Table XVI is presented.

Table XVI

Trends in High School Mathematics

Trend	Number* Stating	Percent Stating
Practical Math. for Average Pupil	29	42.1
Lower Standards - Little Thinking Required	24	34.8
Less Required	13	18.9
More General Mathematics	13	18.9
More Allowance for Individual Diff.	11	15.9
More Functional	9	13.0
Poor Elementary Background	8	11.6
Emphasis on Memory Work	4	5.8
Less Drill (more needed)	3	4.3
Visual Aids	3	4.3
Correlation with other Subjects	2	2.9
Still Geared for College Preparation	4	5.8
More Mathematics Taught	2	2.9
More Thorough Presentation	2	2.9
Neglect of Story Problems	2	2.9
Democratic Procedures	2	2.9
Drop in Registration	2	2.9
More Pupil Guidance	1	1.4
Unit Method of Teaching	1	1.4
More Interest by Administrators	1	1.4
General Math. Not What Pupils Want	3	4.3
Little or No Change	6	8.7
No Answer	20	

* Number Responding -- 69

A trend quite noticeable and confirmed by this survey is the inclusion of more practical, functional, and

general mathematics for the average pupil. Over one third of the teachers were greatly concerned with the lowering of requirements and standards of secondary mathematics. As shown above thirty-four percent of those answering felt the standard too low, and about nineteen percent thought much more mathematics is needed. Such statements as "spoon feeding the pupils", "not teaching mathematics, just keeping the kids off the streets", "sugar coating mathematics", "we are too soft ", and "we omit basic fundamentals", were evident. This can be dismissed as a complaint of the "old school", yet these statements come from both experienced and new teachers.

The allowance for individual differences is mentioned by many. Eight teachers were concerned with the poor preparation in mathematics in the elementary school. Six see little or no change in high school mathematics.

Part II

The College and University Report

The total number of usable replies received from colleges and universities was sixty-two or fifty-six percent. Two schools returned unanswered questionnaires because they did not train mathematics teachers, and two other institutions replied that they were forwarding the inquiries to other places. There is at least one answer from schools in thirty-six states and the District of Columbia. The number of returns from colleges organized by states into geographical areas is presented in Table XVII.

Table XVII

Return from Colleges

SOUTH			MIDWEST			NORTH			FAR WEST		
State	SENT	REPLIES	State	SENT	REPLIES	State	SENT	REPLIES	State	SENT	REPLIES
Alabama	3	2	Colorado	1	0	Connecticut	1	1	Arizona	1	1
Arkansas	1	1	Iowa	2	0	Delaware	1	0	California	8	3
Dist. of Columbia	1	1	Kansas	2	1	Illinois	2	2	Idaho	1	1
Florida	3	0	Minnesota	1	1	Indiana	3	1	Montana	1	0
Georgia	2	1	Missouri	1	1	Maine	1	0	Nevada	1	1
Kentucky	1	1	Nebraska	1	1	Maryland	1	1	Oregon	1	1
Louisiana	5	3	New Mexico	1	1	Massechusetts	3	1	Utah	1	0
Mississippi	3	2	N. Dakota	2	1	Michigan	3	0	Washington	3	1
N. Carolina	1	1	S. Dakota	1	1	New Hampshire	1	1			
Oklahoma	2	1	Wyoming	1	1	New Jersey	1	1			
S. Carolina	2	0				New York	9	5			
Tenessee	1	1				Ohio	10	8			
Texas	4	3				Pennsylvania	5	3			
Virginia	3	3				Rhode Island	1	0			
						Vermont	1	0			
						West Virginia	2	2			
						Wisconsin	1	0			
Total	32	20		13	8		46	26		19	8
Percent	62.5%			61.5%			56.5%			42.1%	
Percent of total	32.3			12.9			41.9			12.9	

The excellent return from the south possibly indicates a desire to improve their educational and teacher training programs. The almost equally high percent from the midwest, but from fewer schools, perhaps shows a desire for improvement also. The west is the only area which fell below the fifty percent mark in answering the questionnaires. The closeness in geographical distance perhaps had some effect.

The last row of the above table gives the percentage of colleges and universities used in this study from each geographical area. The apparent over-representation of the east and south is explained by the fact that the east, with its great population, and the south, with its dual education program, contain many more schools than either the west or midwest.

The colleges and universities questioned trained 741 mathematics teachers in 1948-49 and indicated that 905 are being trained in 1949-50. Here are 1646 new mathematics teachers going into the field from the schools used in this survey alone. It is not known what percent of these teachers will secure jobs. A review of the investigation of teacher supply and demand in 1948, indicated that there was an apparent surplus of both mathematics and science teachers in all areas except the central and south central association (27, p.58). There

is little to indicate that the situation has improved. Only the best prepared will secure positions. The following tables will describe the mathematical preparations of the graduates from the schools in this survey.

The college mathematics required by the thirty-six State Departments of Education ranged from none, in Massechusetts where it is determined by the community, to forty-eight term hours in Illinois and New York City. The mean minimum requirement is 24.3 term hours of college mathematics. This indicates that Oregon, which requires fifteen term hours, ranks far down the list as to the hours required for certification. The fact is, that of the states answering, only two fell below Oregon's requirement. These are Massechusetts and Nevada which require none.

The term hours of mathematics required by the colleges are presented in Table XVIII.

Table XVIII

Term Hours of Mathematics Required of Mathematics Teachers by Colleges

Term Hours	Number of Colleges Requiring	Percent of Colleges Requiring
0	0	
1-10	0	
11-20	2	3.2
21-30	15	24.2
31-40	23	37.1
41-50	16	25.8
51-60	3	4.8
No Answer	1	
Graduate Schools	2	

Mean -- 36.96 ± 1.18

The number of term hours ranged from eighteen to fifty-eight and one-half. The mean was calculated as 36.96 ± 1.18 which to the nearest tenth is thirty-seven term hours. Assuming this is a random sample, the true mean of all colleges and universities can confidently be said to fall within the interval of 34.69 to 39.31 term hours. According to this survey, the average college requirement

is about twelve more hours than is required by the respective State Departments of Education. Thirty-nine colleges and universities require more mathematics than the minimum set by their State Department of Education.

Twenty schools recommend more mathematics than they actually require. The term hours recommended range from twenty-nine to sixty-five, with the mean being 48.7.

The specific courses required and the courses recommended are presented in Table XIX.

Table XIX

College Required and Recommended Mathematics for High School Mathematics Teachers

Course	Required*	Percent Required	Average Term Hours Required	Recommended^x	Percent Recommended	Average Term Hours Recommended
1 Trigonometry	54	88.6	4.6	4	6.6	5.3
2 Analytic Geometry	53	86.9	5.1	3	3.3	5.3
3 Diff. Calculus	48	78.7	5.4	5	8.2	5.3
4 Int. Calculus	44	72.2	5.6	6	9.8	6.4
5 Higher Algebra	20	32.8	4.8	15	24.6	5.3
6 College Geometry	19	31.2	4.7	18	29.5	4.2
7 Intro. to Calculus	19	31.2	5.2	5	8.2	4.5
8 College Algebra	17	27.9	5.5	2	3.3	4.9
9 Theory of Equat.	11	18.0	4.8	13	21.3	4.2
10 Diff Equations	11	18.0	4.3	8	13.1	4.6
11 History of Math.	9	14.7	4.3	15	24.6	4.1
12 Teaching of Math.	7	6.6	3.8			
13 Spherical Trig	3	4.9	4.0	6	9.8	4.2
19 Elem. Statistics	2	3.3	4.5	19	31.2	4.8
15 Math. of Finance	2	3.3	4.5	12	19.7	4.6
16 Theory of Numbers	2	3.3	6.0	6	9.8	4.1
17 Foundations of Elem. Math.	2	3.3	6.8	3	4.9	
18 Fund. of H.S. Math.	2	3.3	9.0	1	1.6	5.0
19 Adv. Diff Equat	2	3.3	7.5			
20 Projective Geom.	1	1.6	4.5	6	9.8	4.8
21 Math. for Teachers	1	1.6	4.5	2	3.3	4.5
22 Adv. Calculus	1	1.6		1	1.6	3.0
23 Non Euclidean Geom.	1	1.6	4.5	2	3.3	3.0
24 Alg. for Teachers	1	1.6		1	1.6	3.0
25 Geom. for Teachers	1	1.6		1	1.6	3.0
26 Teaching Arith.	1	1.6	4.5	1	1.6	
27 Educ. Statistics	1	1.6	4.5			
28 Vector Analysis				2	3.3	4.5
29 Solid Geometry				1	1.6	
30 Accounting				1	1.6	10
None	3	4.9				
No Answer	2	3.3		23	37.7	

*Number Responding -- 61

xNumber Responding -- 61

The first four courses, trigonometry, analytic geometry, differential calculus, and integral calculus, indicated in the table are the ones which can be expected to head the list of requirements. Two courses, higher algebra, required or recommended by thirty-five schools, and college geometry, by twenty-seven, rank surprisingly high. Following in close order are theory of equations and history of mathematics by twenty-four, elementary statistics by twenty-one, college algebra and differential equations by nineteen and mathematics of finance by fourteen.

The author calls attention to the fact that the above courses, especially college algebra, geometry, theory of equations, history of mathematics, statistics and mathematics of finance are included in many college and university programs. These institutions evidently believe that these courses give necessary background for teaching secondary mathematics today.

To ask an instructor to teach geometry with a high school background or general mathematics with no college preparation in business or applied mathematics is unreasonable. Yet it is done as can be shown from the above table where twenty-five colleges neither require or recommend any college geometry, forty-eight no business mathematics,

and thirty-eight no history of mathematics. Only eight schools mentioned any foundation or basic concept courses of elementary mathematics and five suggested special mathematics for teacher courses such as Algebra for Teachers. Three schools required no specific mathematics, simply elective courses and hours in the field.

The colleges and universities were asked what special mathematical application courses were offered or planned in the future for the prospective teacher. The replies are summarized in Table XX.

Table XX

Special Courses Offered and Planned for Mathematics Teachers

Course	Offered	Percent Offering	Planned	Percent Planning
Mathematics of Finance	23	37.1	1	1.6
Consumer Mathematics	5	8.1	3	4.8
Mathematics Applications	3	4.8	2	3.2
Teaching of Mathematics	2	3.2	6	9.7
Fundamentals of High School Mathematics	1	1.6	3	4.8
Fundamentals of Elementary Mathematics			7	11.3
Statistics	1	1.6		
Mathematics for Teachers	1	1.6		
Visual Aids in Mathematics			2	3.2
Psychological Devel. of Mathematics			1	1.6
Adv. Euclid. Geometry			1	1.6
Tools for Geometry			1	1.6
Algebra for Teachers			1	1.6
None	25	40.3	36	58.1
No Answer	3		4	

Forty percent of the schools in this survey have no special application courses for mathematics teachers at present and fifty-eight percent have not planned such courses for the future. This is a rather significant result. While professional educators are talking of teaching mathematics for living, the colleges and universities are giving the prospective teachers preparation in the traditional pure mathematics. It is unreasonable to ask a high school teacher to present mathematics for living when he himself has had no training in what mathematics is needed for every day life. Some schools are recognizing the fact as seen in the table, and are offering and planning some courses specifically for futere mathematics teachers.

Twenty-three schools offer, and one is planning to offer in the future, mathematics of finance. Consumer mathematics is offered or planned by eight schools. Five listed mathematical applications as a title of a course. Such a course included applications in physical, biological, and earth sciences, industry, business, and vocations, and art, architecture, and music.

Eight schools mentioned teaching of mathematics. This suggests methods and techniques. Ten are planning courses in fundamentals of elementary mathematics. This

type of course presents basic concepts from an advanced standpoint based in many of the schools on Courant and Robbins "What is Mathematics" (9). Two schools plan to offer visual aids in mathematics. A scattering of colleges indicated other subjects as can be seen from the table.

The recommendations of colleges for minor teaching field preparations and their statements concerning the minor followed by their students are presented in Table XXI.

Table XXI

Minor Field Recommendations of Colleges and Universities

	Minor Field	Recommended	Percent Recommended	Followed	Percent Following
1	General Science	33	53.2	32	51.7
2	Physical Science	32	51.7	23	37.1
3	Biological Science	7	11.3	6	9.7
4	Physical Education	6	9.7	4	6.5
5	Social Science	5	8.1	4	6.5
6	Industrial Arts	4	6.5		
7	English	2	3.2	2	3.2
8	Commercial	2	3.2	2	3.2
9	Language	1	1.6	1	1.6
10	Accounting	1	1.6	1	1.6
11	Music			1	1.6
12	No Answer	1	1.6	6	9.7

The replies, as might be expected, indicated the popularity of the general and physical sciences as minor fields of preparation. Several reasons are seen for this mathematics - science combination. Traditionally the mathematics and sciences have been classed together. The relationship between the two is close as science is built on the logical approach used in mathematics. Often School administrators want this combination for teachers in their schools because of this close relationship. However today there is a decreasing enrollment in the physical sciences. A committee appointed by the Commissioner of Education (36, p.102) discovered that only seven percent of the total high school population was enrolled in physics or chemistry in 1943, whereas a large number was enrolled in the biological sciences. Although this study shows the popularity of the physical science - mathematics combination in teacher preparation, the low percentage of high school pupils registered in physical science indicates the possibility that other minor fields of preparation may be desirable for the prospective teacher.

An attempt was made in the questionnaire to obtain expressions from college personnel concerning their opinion for improving the college mathematics curriculum for high school teachers of the subject. The answers are organized in Table XXII.

Table XXII

College Opinion on Improvements

Step or Point of Issue	Number Stating	Percent* Stating
1 More Application Courses	12	35.3
2 Less Adv., Different Mathematics	11	32.4
3 Study of High School Curricula by Colleges	8	23.5
4 Survey High School Teachers	4	11.8
5 More Observation and Practice	4	11.8
6 More Careful Selection of Teachers	2	5.9
7 More Emphasis on General Education	2	5.9
8 More Emphasis on Basic Concepts	2	5.9
9 Adequate Program Now	1	3.0
10 Change High School Curriculum	1	3.0
11 More History of Mathematics	1	3.0
12 Experiences (grade papers etc.)	1	3.0
13 Five Year Program	1	3.0
14 Re-evaluate College Courses	1	3.0
15 Re-define Needs of People	1	3.0
16 Visual Aids	1	3.0
No Answer	28	45.1

Number Responding -- 34

The author was disappointed to find that nearly half of the participants in colleges answering the questionnaire had no opinion concerning this particular question. Whether they actually had no opinion or simply did not take time to answer is not known.

Of the ones answering, thirty-five percent wanted to see more application courses in mathematics put into the curriculum. Another third of the group answering mentioned a different, less advanced mathematics program for prospective high school teachers. Such statements as "not more mathematics but a more functional approach to mathematics", "the organization of materials effective in high school mathematics teaching rather than involved delving into super higher mathematics", and "stress basic concepts", typify reactions placed under this heading.

Twelve others felt a study of high school curricula and survey of high school teachers was needed. This is the reason which prompted the writer to include high school mathematics teachers in this study.

One educator felt that the program today was adequate for the courses which the teachers were called upon to teach in the high school but that the secondary school mathematics curriculum needs reorganization. Other suggestions were too scattered to show any trend.

Part III

Comparison of College Programs and Teacher Recommendations

This section will present a comparison of the college mathematics programs in secondary mathematics teacher training and the teachers' recommendations of what they feel constitutes an adequate preparatory program. First the mathematics programs suggested by each will be compared. Second the minor fields of preparation are contrasted. Lastly the teachers' criticisms will be compared with college people's opinion as to the first steps in improving the present mathematics curriculum for prospective teachers.

The mean number of term hours of mathematics required by colleges was 36.96 while the average suggested by high school teachers was 31.81. The difference was 5.15 term hours. In an attempt to explain the difference, the author suggests these two reasons: First, is the fact that in general the teachers suggested less advanced courses than are required by the colleges and universities. This fact will be brought out in Table XXIII. A second reason is that many teachers in answering stated "applications" with no specified number of hours attached.

The college and university required work in

mathematics is compared to the recommended program from high school teachers in Table XXIII.

Table XXIII

College Mathematics Requirements Compared to Teacher Experience and Teacher Recommendations

Course	Percent College Req.	Percent Teacher Value	Percent Teacher Rec.	Av. College Term Hours	Av. Teach. Rec. Term Hours
Trigonometry	88.6	61.7	81.1	4.6	4.6
Analytic Geom.	86.9	45.0	52.7	5.1	4.3
Diff. & Int. Calculus	72.2	30.0	63.6	11.0	9.6
Higher Algebra	32.8	11.7	4.1	4.8	6.0
College Geometry	31.2	5.0	32.4	4.7	4.1
Intro. to Calculus	31.2	16.6	17.6	5.2	4.0
College Algebra	27.9	61.7	63.6	5.5	6.7
Theory of Equat.	18.0	5.0	20.3	4.8	4.1
Diff. Equations	18.0		5.4	4.3	4.7
History of Math.	14.7	8.3	21.6	4.3	3.3
Teaching of Math.	6.6	18.3	36.5	3.8	4.7
Spherical Trig.	4.9	6.7	9.5	4.0	3.4
Statistics	3.3	5.0	10.8	4.5	5.6
Math. of Finance	3.3		12.3	4.5	4.4
Theory of Numbers	3.3		1.4	6.0	
Foundations	3.3		4.1	6.8	4.5
Fund. of H.S. Math.	3.3		5.4	9.0	
Adv. Diff. Equat.	3.3		0.0	7.5	
Projective Geom.	1.6	1.7	2.7	4.5	3.0
Math. for Teachers	3.3		0	4.5	
Advanced Calculus	1.6		0		
Non Euclidean Geom.	1.6		1.4	4.5	
Solid Geometry		1.7	12.3		3.8
Unified Math.		10.0	12.3		9.5
Adv. Analytic Geom.		1.7	2.7	3.0	
Descriptive Geom.			8.1		3.6
Arithmetic			8.1		5.7

To discover the agreement between the college required mathematics and the value teachers attach to these courses, the rank correlation coefficient was calculated, and was found to be .83. This shows a substantial relationship which was the only thing desired to discover by this statistical process. This may be interpreted to mean that the courses required by most colleges are felt to be of value by experienced teachers. The outstanding exceptions are differential equations required by eleven colleges but not considered valuable by a single teacher, and theory of equations which was required by eleven colleges but of value to only three instructors. One inconsistency is noted when only three teachers feel that college geometry is of value yet twenty-four of the same teachers recommend it as preparation. The only explanation is that perhaps not many of the instructors answering the question completed the course in college.

The rank correlation coefficient between college programs and teacher recommended programs is .61. This may be interpreted to further indicate that the colleges and universities are preparing future teachers well as far as required mathematics courses are concerned, or that teachers are relying upon their own preparation as a basis for suggesting courses. Since teachers attached value to

many of their courses it is perhaps correct for them to recommend courses they completed in college. The exceptions are higher algebra required by twenty universities and recommended by only three teachers, and differential equations required by eleven schools while being recommended by only four teachers. College algebra ranked second on the teachers' list while rating seventh on college requirements. Teaching of mathematics was suggested by a third of the teachers but required by only four universities. Perhaps many of the schools did not consider the latter a subject matter course. The other courses ranking somewhat higher on the teacher's list were history of mathematics, spherical trigonometry, statistics, and mathematics of finance, although the last was recommended by many colleges. Nine teachers suggested solid geometry and some form of unified mathematics, and six mentioned descriptive geometry and arithmetic while none of these were required by colleges. There are no great differences in the mean term hours attached to courses. The teachers, however, recommend somewhat less calculus and history of mathematics and a little more college algebra and methods.

The author suggests that this close correlation between teacher suggested courses and the higher institutions' requirements denotes less disagreement than was

assumed from the fact that forty percent of the instructors felt the colleges were not properly prepairing teachers of mathematics. Perhaps the teachers see faults and become over critical when a closer observation indicates that the overall situation is good. However, just criticism is an excellent stimulation for improvements.

College and high school teachers' suggested minor teaching fields are contrasted in Table XXIV.

Table XXIV

College and Teacher Recommended Minors Compared

Subject Field	Percent College Recommended	Percent Teacher Recommended
General Science	53.2	58.7
Physical Science	51.7	37.4
Biological Science	11.3	0
Physical Education	9.7	5.3
Social Science	8.6	14.7
Industrial Arts	6.5	5.3
English	3.2	12.0
Commercial	3.2	14.7
Language	1.6	
Accounting	1.6	
Music	1.6	

The rank correlation coefficient between the fields indicated by both colleges and teachers is .56. This again denotes positive relationship but somewhat less than the agreement on the mathematics curriculum. For all three of these coefficients of correlation, the degree of correspondence is not as important as the fact that there is a definite agreement between the two groups. In this minor field correlation, the figure is not significant for itself since only seven items are compared. The two which record the highest percent suggesting, general science and physical science, are ranked first and second respectively by both colleges and teachers. Strangely no teachers recommended biological science whereas eleven percent of the colleges did. The outstanding differences come with the various courses which are in the low percentage areas and therefore little other significance can be attached to the findings. The outstanding fact is that teachers and colleges still overwhelmingly recommend general science and physical science minors for mathematics teachers with social science and physical education also showing popularity.

It is difficult to compare the teachers' criticisms of the present curricula with the college professors' opinions for improvements because of the diverse ideas

expressed. To compare these opinions as objectively as possible, Table XXV is presented.

Table XXV

College Opinions for Improving Training Programs Compared to Teachers' Criticisms of Present Preparation

Point of Issue	Number of Colleges	Number of Teachers
Study of Secondary Curricula and Survey of High School Teachers	12	
More Application Courses	12	12
Less Advanced and Different Mathematics for Teachers	11	17
More Observation and Practice	4	1
More Careful Selection	2	1
Emphasize Basic Concepts	2	7
More Historical Background	1	3
Emphasize Methods (Better Methods)		27

About one third of those replying in each group thought a less advanced and a different college mathematics program for secondary school teachers should be instituted. Thirty-five percent of the colleges and twenty-five percent of the teachers answering desired more practical application courses. About one quarter of the instructors wanted

better methods courses, while a like amount called for more emphasis on techniques courses in college. Twelve percent of the colleges answering and two teachers did mention the need for more practice teaching. The other outstanding opinion of college educators, expressed by thirty-five percent, was the need for a survey of high school curricula. No teachers suggested this perhaps because of the wording of the question. Two college professors suggested more careful selection of prospective teachers as did one teacher. Three teachers and one college representative mentioned more historical background and seven teachers suggested more emphasis on basic concepts as did one college. The only definite areas of agreement therefore are the need for a different mathematics curriculum for prospective teachers and the inclusion of more practical application courses. One thing mentioned by almost half the teachers answering this particular question, but not mentioned by colleges, was increased emphasis on methods. This suggests that teachers feel a lack of preparation in mathematics teaching techniques.

CHAPTER IV

SUMMARY, CONCLUSIONS AND RECOMMENDED PROGRAM

Summary

This study is based upon a questionnaire survey of sixty-two Colleges of Education in thirty-six states and the District of Columbia, and of eighty-nine secondary school mathematics teachers from seventy-six high schools in Oregon. Its purpose is to develop a more adequate training program in mathematics for prospective teachers. The following points were revealed from the teachers' replies.

Less than half of the high school pupils in the schools used in this study were enrolled in any form of mathematics. The smallest percentage was registered in the larger schools. Courses in algebra, geometry, and trigonometry remain the most popular offerings in the high schools, with general mathematics required by thirty-nine of the schools. The teachers note the increased popularity of general mathematics and many are concerned with the lowered standards and requirements in mathematics at the high school level.

All of the teachers participating in the study held

Bachelor's Degrees and twenty-five percent held Master's Degrees. One third of these teachers received their education outside of Oregon. The average number of term hours of mathematics completed by the teachers was thirty-five. About seventeen percent of the teachers had neither a major or minor preparation in college mathematics.

In general, teachers attached value to the mathematics courses they completed in college with the exception of work done in the more advanced areas of the subject, such as, differential equations and higher algebra.

The teacher-recommended mathematics programs for future teachers were characterized by an emphasis on the basic concepts of the courses which the teacher will be called upon to teach. Work beyond the calculus was seldom suggested except where it was a continuation of algebra or geometry. Trigonometry, calculus, college algebra, analytic geometry, college geometry, history of mathematics, theory of equations, unified mathematics, and solid geometry ranked in that order. Also teachers urged the inclusion of application and methods courses. The average number of term hours of mathematics suggested by teachers was thirty-one.

The recommended minor teaching field were general science and physical science with social science, English and business showing some popularity. The importance of good minor preparation was emphasized by the fact that about half of the participating teachers were teaching in one, two, or three subject fields in addition to mathematics.

About forty percent of the teachers believed that the colleges were not giving prospective teachers adequate preparation in mathematics. The teachers suggested a differently taught, less advanced mathematics curriculum with emphasis on practical applications. Also half of the teachers answering this part of the questionnaire emphasized the need for more and better courses in methods of teaching. This perhaps indicates that many teachers feel a lack of preparation in teaching techniques for presenting mathematics.

The following facts were obtained from the college and university replies.

The average number of term hours of mathematics required for certification by the thirty-six states used in the study was twenty-four. Only two states required less than the fifteen hour minimum requirement in Oregon. The mean number of term hours required by the colleges

was thirty-seven, while they recommended forty-eight.

Trigonometry, analytic geometry, and calculus were almost universally required of prospective teachers by colleges and universities. Higher algebra, college geometry, college algebra, theory of equations, differential equations, and history of mathematics follow in that order. A majority of the colleges indicated no special mathematics courses designed primarily for prospective high school teachers, although several stated that they had such courses planned for the future.

As might be expected general science and physical science were the most popular minors recommended by the colleges and followed by the prospective teachers.

Many college representatives stated that a less advanced, more practical mathematics curriculum for prospective teachers should be instituted in the colleges. Also several believed that a survey of the present high school offerings must be made in order to determine in what direction to train future teachers.

The points of agreement between colleges and teachers are summarized below.

The rank correlation coefficient between college required mathematics and the value teachers attach to the courses they completed in college is .83. The rank

correlation coefficient between college required mathematics and teacher recommended courses is .61. This substantial positive relationship shows encouraging agreement between colleges and teachers in the field concerning preparation of mathematics teachers. Trigonometry, analytic geometry, and calculus were high in on both lists. College algebra, college geometry, theory of equations, and history of mathematics required by many colleges were popular recommendations of teachers. Differential equations and higher algebra required by some colleges ranked low on teachers' lists. Business mathematics and solid geometry were suggested by several teachers but were not required by any of the colleges. Teachers emphasized the value of methods courses.

General science and physical science were the most frequently mentioned minors by both groups with social science, English and business showing some popularity.

Teachers and colleges agreed that a differently taught, less advanced curriculum with emphasis on practical applications should be provided for prospective teachers.

Conclusions

The following conclusions may be drawn from this study:

1. The decrease in the percent of the high school

population enrolled in mathematics in Oregon apparently has not been checked.

2. More practical mathematics is being offered at the high school level in Oregon. However, there is indication that the standards of mathematics taught in the high schools are lower.
3. There is substantial agreement between colleges and high school mathematics teachers concerning the mathematical training program for future teachers.
4. The teacher of mathematics should have a wide background in the subjects he will be called upon to teach with less emphasis on the advanced phases of pure mathematics. He must be familiar with the history of mathematics and its concepts.
5. The courses in mathematical subject matter for the prospective teacher should be professionalized to give a real understanding of the basic concepts rather than mechanical and manipulative skill in operations.
6. It is desirable that a mathematics teacher acquire through proper courses, experience in practical fields where mathematics is used.
7. The mathematics teacher should have adequate training in the teaching methods of all areas

of mathematics which he will be called upon to teach.

8. The mathematics teacher should have a sound background in related minor fields of preparation, especially in the general and physical sciences.

A Recommended Program

The recommended program based on the results of this survey requires thirty-six term hours of mathematics for a major in that field. Assuming that one hundred ninety-two term hours are required for graduation, this leaves ample time for the student to prepare one or two minors, take professional courses and do some work in general education. It is hoped, however, that the prospective teacher of mathematics has enough interest in his subject to take several hours beyond the requirements. For the student whose minor field of preparation is mathematics, probably twenty-four hours are sufficient.

A mathematics program based on the recommendations of teachers cooperating in this study is outlined as follows:

Course	Term Hours	
	Major	Minor
1. College Algebra	4	4
2. Trigonometry	4	4
3. Analytic Geometry (or a general course covering 1, 2, and 3)	4	4
4. Differential and Integral Calculus	9	6
5. College Euclidean Geometry	3	3
6. Applied Mathematics (modeled after Richtmeyer (28).)	6	3
7. History of Mathematics	3	
8. Theory of Equations	3	
Total	36	24

The above courses must be taught specifically for teachers. The work should emphasize the basic concepts and the practical applications of mathematics and not consist of merely learning manipulative techniques of solving problems.

The student should be encouraged to take as electives, fundamental concepts of mathematics, some solid geometry, and further work in statistics. From this point, the students' interest and the advice of a competent

counselor should determine what advanced mathematics is desirable.

A complete course in the teaching of mathematics is advised. Teachers' answers to the questionnaire indicate that as many as six term hours are desirable.

The conclusions and recommended program were deduced as objectively as possible and were based on the results of this study alone. The suggested mathematics program is not the final answer but does reflect the thinking of both the secondary school teachers and teacher training institutions who participated in this survey. It will be criticized but that is the method of advancing. Other recent studies of a similar nature have been made by the National Council of Mathematics Teachers (26) and the Commission on Post War Plans (8). This paper and other studies suggest the advisability of further study of the problem.

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APPENDIX A

CORRESPONDENCE

Corvallis, Oregon
January 25, 1950

Dean of the School of Education

Dear Sir:

Your assistance in providing the information as requested on the enclosed questionnaire will be greatly appreciated. The information will be used as a basis for my thesis toward the Masters degree in Education. It is entitled Mathematics Preparation of High School Teachers Based on College Programs and Teacher Experience. I intend to survey the teacher training programs in mathematics offered by colleges throughout the United States to find out what general plan is followed by most colleges and discover the latest trends in mathematics teacher training. I will then compare these programs with what experienced teachers in Oregon feel constitutes a good training plan and incorporate the best ideas of all into a workable mathematics teacher training program.

We are constantly working toward a better teacher training program. I hope that this study will contribute to the consideration of the problem of how we can better prepare our mathematics teachers.

I sincerely request that the enclosed questionnaire

be filled out and returned as soon as possible. All material will be held in strict confidence.

Yours very truly,

Dean L. Still (signed)

Corvallis, Oregon
January 25, 1950

Dear Fellow Teacher,

Your assistance in providing the information as requested on the enclosed questionnaire will be greatly appreciated. The information will be used as a basis for my thesis toward the Masters degree in Education. It is entitled Mathematics Preparation of High School Teachers Based on College Programs and Teacher Experience. I wish to question experienced high school teachers in Oregon to discover the over-all preparation of our mathematics teachers and obtain their opinions on what an ideal mathematics teacher training program should contain. I will then compare these recommendations with the college training programs throughout the United States today, and incorporate the best ideas of all into a workable training plan.

We are constantly working toward a better teacher training program. I hope that this study will contribute to the consideration of the problem of how we can better prepare our mathematics teachers.

I sincerely request that the enclosed questionnaire be filled out and returned as soon as possible. All material will be held in strict confidence.

Yours very truly,

Dean L. Still (signed)

APPENDIX B

QUESTIONNAIRES

QUESTIONNAIRE FOR MATHEMATICS TEACHERS IN OREGON

Name of High School_____. Address_____
Number of Students_____. Number enrolled in mathematics courses_____.

1. List the courses in mathematics offered by your school and encircle the ones which are required.

   A._____ E._____

   B._____ F._____

   C._____ G._____

   D._____ H._____

2. What degree(s) do you hold? From what institutions?
3. What was your major field of preparation in college?
4. What other subjects did you prepare to teach?
5. How many hours of college mathematics have you had?

   _____(term, semester)

6. What subjects are you now teaching?
7. How many years of mathematics teaching experience have you had?
8. List the courses in mathematics you had in college and underline the ones which were of most value to you.

   A. F.

   B. G.

   C. H.

   D. I.

   E. J.

9. In planning an ideal teacher training program in mathematics, what courses do you think should be included and how many hours of each?

	Hours		Hours
A.		F.	
B.		G.	
C.		H.	
D.		I.	
E.		J.	

10. In what other teaching fields do you suggest the prospective mathematics teacher prepare?

11. Do you believe that the colleges are offering an adequate training program for high school mathematics teachers? (yes,no) Why?

12. What significant trends have you noticed in high school mathematics, both in subject matter and teaching methods?

QUESTIONNAIRE FOR COLLEGES

Name of College_____Address_____.

Number of Mathematics Teachers Trained: 1948-49_____

1949-50_____

1. How many hours of mathematics is required for a student preparing to teach mathematics by your State Department of Education?

_____term or semester hours

2. How many hours of mathematics is required by your School of Education of a student preparing to teach mathematics as a major field of preparation?

_____term or semester hours

3. In column A indicate the number of (term, semester) hours of mathematics required, and column B, the number of hours of the courses recommended. Make any addition to the list that you feel necessary.

Course	A. Required	B. Recommended
1. College Trigonometry		
2. Analytic Geometry		
3. Introduction to Calculus		
4. Elementary Statistics		
5. Differential Calculus		
6. Integral Calculus		
7. Spherical Trigonometry		
8. History of Mathematics		

Course	A. Required	B. Recommended
9. Theory of Equations		
10. Advanced or Higher Algebra		
11. College Geometry		
12. Projective Geometry		
13. Number Theory		
14. Differential Equations		
15.		
16.		
17.		
18.		
19.		
20.		

4. In what minor teaching fields do:
   a. you suggest the future mathematics teacher prepare?
   b. most mathematics students in your school prepare?
5. Do you have any courses especially designed to give future teachers applications of mathematics to everyday life such as insurance, banking procedures, taxation, and consumer and installment buying (Yes, No)

   What are they?

6. What new courses do you have planned especially for mathematics teachers?

7. What should be the next steps in planning a college curriculum for high school mathematics teachers?