A STUDY OF THE EFFECTIVENESS OF THE CURRICULA OF THE CALIFORNIA STATE COLLEGES AS A PRE-SERVICE PREPARATION TO TEACH ALGEBRA I AND GEOMETRY

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CHAPTER I

THE PROBLEM

Purpose

Recent changes in mathematics have been so extensive and profound that they have been described as a revoltuion.[1] In industry, on the farm, and in the classrooms at all levels the effect of the revolution can be seen. Many students are not only learning new concepts, but traditional ideas are being expressed in a new more precise language. The "new shape for our mathematics curriculum began to form about 1950."[2] Much of the concern expressed in the literature is centered around the junior and senior high school curricula. Some of the proposals that have been made are controversial and at times the discussions can hardly be called genteel.[3]

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

[2] Kerry Smith, ed., "The Race Against Time: New Perspectives and Imperatives in Higher Education," The Proceedings of the Fourteenth Annual National Conference on Higher Education (Washington, 1959), p. 129.

[3] Benjamin DeMott, "An Unprofessional Eye--The Math Wars," The American Scholar, XXXI (1962), 296-298.

These changes suggest the question, Do these differences imply a need for a change in the teacher-education curriculum and if they do are the teacher-education institutions making the proper adjustments? The purpose of this study is to inquire into the effectiveness of the content in mathematics of the teacher-education curriculum in preparing teachers to teach Elementary Algebra and Geometry.

Definitions

The education of the teacher of secondary mathematics is a part of total education in our society. Also the teacher of secondary mathematics is one of the active agents in total education. Hence the aspects and characteristics of education in general apply to the education of teachers of mathematics in particular and to the work assigned to them by our society. Therefore, the first and basic definition made in this study is of education in general.

> Education is the reproductive part of a culture, the process of development in the immature of the skills, attitudes, appreciations, knowledges, and understandings which constitute the culture and are, therefore, cherished by the mature of a group or society.[4]

This definition implies content and method. Each skill, attitude, appreciation, knowledge, and understanding is an "element of content." The sum total of the elements of content constitute the "universal content." The "methods" are the processes used to transmit that part of the universal content which the society has selected as of value to the immature (the student).

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[4] Millard Scherich, Reconciliation in Educational Philosophy (Stillwater, Oklahoma, 1959), pp. 3-4.

"Elementary Algebra" and "Geometry" are here defined as the beginning courses in Algebra and Geometry which have been traditionally taught in the ninth and tenth grades respectively.

Basic Assumptions

To understand the background for the need of this study five assumptions are made. They are: that the teacher of mathematics is an important member of our society; that there exists a curriculum appropriate to the preparation of teachers of Elementary Algebra and Geometry; that the teacher should be able to evaluate proposals and trends in his field; that the changes within mathematics itself and the new demands being made of it indicate a need to reconsider the teacher-education curriculum; and that it is possible to secure information pertinent to the effectiveness of the teacher-education curriculum. Each of these assumptions will be discussed in turn.

Assumption of Teacher Importance: The concern for the pre-service education of the one who teaches mathematics may be understood by noting his position in society as well as the place of mathematics in our modern way of life.

> Mathematics has become the basic fabric of our social order. The strength of that fabric--in fact the very survival of our nation--may depend upon the amount and kind of mathematics taught in the classrooms of our schools[5]

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[5]Kenneth E. Brown, "Keeping up to Date with Developments in Science, Mathematics, Modern Foreign Languages, and English Language Arts--Representing Past Position Statements of the NASSP," (summary of a presentation made at a symposium), Bulletin of the National Association of Secondary-school Principals, XLV (April, 1961), 250-251.

where "the basic ingredient is the teacher."[6] Among these teachers those who teach mathematics in grades eight, nine, and ten occupy a unique position with respect to this study.

Many small high schools do not teach any mathematics beyond Elementary Algebra and Geometry,[7] and in some schools where subsequent courses are taught the drop out rate is high after Elementary Algebra and Geometry. Therefore the teacher of these two courses in many cases is teaching the most advanced mathematics that a sizeable number of the students will ever study. It is important that these students be accorded the opportunity to experience mathematics at its best. Thus not only those who choose to go on with the study of mathematics will increase their potential to contribute to the well-being of society, but those who terminate their study in this area with either Elementary Algebra or Geometry will have had an opportunity to form favorable attitudes toward mathematics to be passed on to the next generation. Therefore, much depends on the skills and attitudes of the teacher.

The preparation of the teacher of mathematics consequently should be a matter of concern to those institutions that have been assigned the task of teacher-education--a task made more difficult because of the recent rapid changes in the world of mathematics.

Assumption of Dependence: There exists a teacher-education curricculum appropriate for the pre-service preparation of the teachers of Elementary Algebra and Geometry and it is dependent upon the content

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[6] Bruce E. Meserve, "New Trends in Algebra and Geometry," The Mathematics Teacher, LV (1962), 453.

[7] Glenadine E. Gibb, John R. Mayor, and Edith Treuenfels, "Mathematics," Encyclopedia of Educational Research (New York, 1960), p. 799.

and trends in these courses.

Fundamentally the teacher of mathematics must know the subject matter that he is to teach for no one can teach content that he does not know.[8]

During a period of curricular change or of wide-spread experimentation, as at the present time, an added responsibility devolves upon teacher-education institutions to make certain, as far as possible, that the teacher will have learned sufficient content material to cover all elements of the new curriculum.

The literature is replete with references to the existence of a teacher-education curriculum and its need for both content and method, but in contrast the author has found no references to the effect that the proper preparation of teachers of Elementary Algebra and Geometry should contain <u>no</u> mathematics beyond that which is to be taught.[9,10]

The definition of education demands an evaluation and one of the important values placed on an element of mathematics is the use to which it can be put in the further study of mathematics itself. As an example, if a teacher is to be able to evaluate the geometry he teaches he must know something of the use that subsequent mathematics

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[8] William A. Gager, "Is Your College Giving Proper Training for Teachers of Secondary School Mathematics?" <u>The Mathematics Teacher</u>, LV (1962), 494.

[9] Herman Rosenberg, "The Real Menace of the Sputniks to Mathematics Education," <u>School Science and Mathematics</u>, LIX (1959), 727.

[10] W. L. Hart and others, "Report on the Training of Teachers of Mathematics," <u>American Mathematical Monthly</u>, XLII (1935), 273.

has for that geometry for

> a teacher cannot fulfill his role as a mathematical guide to his students if he does not know where they have been and where some of them will be in the years to come. He will not have the reservoir of knowledge that contributes to a teacher's confidence and adds to his prestige with his students. Without such breadth he will not be in a position to stimulate and inspire those unusual students who ask questions that call for far more knowledge than what is in today's lesson.[11]

Therefore, there is a need for a teacher-education curriculum, but it must have direction.

In times of curricular change the prospective teacher may find that the Elementary Algebra and Geometry that he will teach will differ from that which he studied when he was in high school. It is therefore of concern to the college to provide in its teacher-education program the content necessary to prepare for the teaching of the new curriculum in mathematics.[12]

In addition to the current content, proposed curricular changes and experiments are of concern to those institutions responsible for teacher-education. The more accurately these proposals can be evaluated the more efficiently will the transition be made, for the teacher must be trained not only for the task that now is but for that which will be. In so far as is possible, "the pre-service education should include experiences which anticipate these changes in the high school

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[11]John J Kinsella, "Preparation in Mathematics of Mathematics Teachers," The Mathematics Teacher, LIII (1960), 28.

[12]Ibid.

curriculum."[13]

Assumption of Responsibility: The secondary teacher of mathematics should be able to evaluate curricular trends and proposals and read the literature of the field.

The basic definition of education implies that the society evaluates the available content and offers it to the immature. Among these elements that form the content of education are appreciations and attitudes; these also, the society strives to develop in the student. The teacher is the individual selected to guide in the development of these elements. Since appreciations are a part of the selected universal content it is the duty of teachers of mathematics to present to the students the values of (uses for) mathematics. Part of the value of an element of mathematics is found in its use to mathematics itself in the development of more mathematics. Hence for the teacher to have a mature appreciation for an element of mathematics he must know additional elements of mathematics. His pre-service preparation must contain more content than he expects to teach.

The students will become the mature of the society and they in turn become a part of those who place a value on the universal mathematical content. Since it is the teacher's assigned task to help the student mature he has a responsibility to be able to read and understand the literature so that he will know what is taking place in his field. He should also be informed of the curricular trends and recommendations in his area of teaching. The teacher should understand the

[13] Jack Wilson, "The Pre-service Education of High School Mathematics Teachers," California Journal of Secondary Education, XXXI (1956), 333.

content in mathematics well enough to be able to evaluate these trends and recommendations,

> since at any time and place that which is chosen must also be selected from that which can be taught effectively, the choice is partially determined by the teacher's knowledge and appreciation of mathematics as it is today. Hence, all teachers and supervisors have an increasing and continuing responsibility to become familiar with the changing content, emphasis, and applications of elementary mathematics throughout their active years[14]

so that they can, as far as possible, help their students to be a part of the expanding world of mathematics and be prepared for the society that will be theirs and not just that which now is.

<u>Assumption of Need</u>: There exists a need to evaluate the effectiveness of the teacher-education curriculum.

> There is greater activity in secondary school mathematics than we have ever seen before. We hear such statements as, "The old order is changing," "A new era is being ushered in," "Mathematical literacy is a must for living in today's world," and "The traditional mathematics must be pruned to make room for contemporary developments."[15]

Since these changes hold implications for teacher-education it is necessary to examine the conditions pertaining to the secondary curriculum in order to evaluate this changing situation and to assess its consequences for teacher-education. To understand this unrest in mathematics four contributing factors will be considered.

The first factor is "the explosion in mathematics" that has taken place during the twentieth century which has been called "the golden

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[14]Phillip S. Jones, "Promising Possibilities for Improving Content in the Teaching of Mathematics," <u>Virginia Journal of Education</u>, LIII (May, 1960), 15-21.

[15]Daniel W. Snader, "Secondary School Mathematics in Transition," <u>School Life</u>, XLII (March, 1960), 9-13.

age of mathematics, since more mathematics, and more profound mathematics has been created in this period than during all the rest of history."[16] In fact in the last twenty years tremendous progress has been accomplished; "no other comparable period of our history has been so rich in new ideas and results"[17] and "there is no reason to believe that this pace of acquisition of new mathematical knowledge will slow down in the foreseeable future."[18] Along with these new discoveries in mathematics have come new uses for it.

The second factor that is bringing pressure on secondary mathematics is the extended service that it is able to render to society. A number of fields, in addition to science and engineering, are using more mathematics, and more sophisticated mathematics, than ever before to solve their problems. Among these new fields are investment, insurance, government, psychology, sociology, agriculture, and others.

The third factor, automation, with the help of mathematics, is having an impact on our society. "Not only has it created the necessity for solving complicated design and development problems, but it has contributed an important tool...the large-scale, high-speed, automatic digital computing machine."[19]

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[16] Price, p. 1.

[17] Jean Dieudonne, "Recent Developments in Mathematics," The American Mathematical Monthly, LXXI (1964), 248.

[18] Joseph Landin, "The New Secondary Mathematics Curriculum and the New Teacher," School Science and Mathematics, LXIII (1963), 376.

[19] Price, p. 4.

The computer is having an influence on mathematics in at least two ways, the problems it can solve, and the mathematics needed in computer programming. It can solve problems which previously would have taken so much time that their solution would have been impractical, even though important, because of the inordinate length of time to process them. The design and operation of the computer is based on a combination of traditional and recently developed mathematics. There is a renewed interest in the binary number system because "a binary computer can provide more storage, a very desirable attribute of a computer, for the same cost as a decimal machine, or, conversely, the same amount of storage at less cost."[20]

The fourth factor has to do with the secondary school curriculum itself and its history during the past seventy years.

Near the first of this century The Committee of Ten on Secondary School Subjects (1894) made recommendations for the secondary school curriculum.

> In mathematics...it was recommended that informal geometry be introduced in the upper grades. Algebra in the ninth grade, geometry in the tenth and solid geometry and advanced algebra in the eleventh and twelfth..."[21]

In 1902 E. H. Moore in his "epoch-making address" as president of The American Mathematical Society made recommendations for the secondary curriculum in mathematics.[22]

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[20] William W. Bryan, "Some Modern Uses of Mathematics," School Science and Mathematics, LXIII (1963), 138.

[21] Lucien Blair Kinney and C. Richard Purdy, Teaching Mathematics in the Secondary School (New York, 1952), p. 22.

[22] Eliakim H. Moore, "On the Foundations of Mathematics," Science, N. S., XVII (1903), 410-413.

Other reports followed, some of which were those made by The National Committee on Mathematical Requirements (1923), The Joint Commission to Study the Place of Mathematics in Secondary Education (1940), and two reports by The Commission on Post-war Plans (1944-45).

Although a number of recommendations came from these various groups "very few new ideas have been added (to the traditional curriculum) since 1900...and there has been no real shift in direction."[23]

When the condition of the traditional secondary school curriculum is viewed against the background of a developing mathematics, as brought out in the other three factors, it becomes clear that

> the mathematics in the schools of today is practically the same mathematics found in the schools of 60 or 75 years ago. In the meantime, mathematics itself has moved forward so rapidly that it has practically lost contact with the program in the schools.[24]

This curricular lag has helped to motivate a re-evaluation of the present universal mathematical content and there has emerged a different selected mathematical content from that upon which the traditional high school curriculum was based and the portions recommended for students of all levels differ considerably from the traditional curriculum.

Are the trends and recommendations for change in the secondary curriculum important enough and do they have sufficient acceptance to constitute a basis for the reorganization of the teacher-education curriculum?

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[23] H. F. Fehr, "Breakthroughs in Mathematical Thought," The Mathematics Teacher, LII (1959), 15.

[24] Henry Van Engen, "Plans for the Reorganization of College Preparatory Mathematics," School Science and Mathematics, LVIII (1958), 278.

A number of committees and groups have studied the place of secondary mathematics in the schools and several experimental programs have emerged within a short period of time.[25] Among these are the University of Illinois Committee on School Mathematics (UICSM), the School Mathematics Study Group (SMSG), the Ball State, the University of Maryland, and the Boston College programs. All of these programs attempt to reduce this gap between the traditional mathematics in the schools and that which they consider appropriate for the school today.

The Carnegie and National Science Foundations have contributed millions of dollars to the developing of experimental curricula, the writing of textbooks, and the re-educating of teachers, most of which has been oriented to the modern approach to secondary mathematics. Several of the textbooks that were prepared for the experimental curricula have been published in a permanent form and a considerable number of other textbooks have been printed that reflect the modern point of view.

The amount of money, both government and private, that has been invested in these projects and the advanced state of the reforms reveal a concern of such proportions as to demand the attention of those who control the nature of the mathematics offered to the teachers in preparation.[26]

However, there are some voices that have been raised in varying

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[25] Snader, pp. 9-13.

[26] Loretta B. Fisher, "How Curriculum Builders View 'New Math' Ideas," School Science and Mathematics, LXIV (1964), 36.

degrees of caution and hostility to some parts of the program.[27,28,29] If these objections persist and the emphasis on modern mathematics is reduced it is not certain that there will be a return to the curriculum of fifty years ago. It is possible that a sizeable amount of the new material would become a part of the high school mathematics in the years ahead.

Therefore, it is assumed that there exists a need to investigate the effectiveness of the teacher-education curriculum in preparing teachers of secondary mathematics.

Assumption of Procedure: It is assumed that a questionnaire filled out by teachers, principals, and department heads or supervisors can be analyzed so as to yield results from which implications can be drawn regarding the efficiency of the teacher-education curriculum.

The effectiveness of the teacher-education curriculum implies the effectiveness of the teacher. In turn the effectiveness of the teacher implies that the immature have developed into a society possessing a culture chosen for them by the previous generation. To attempt to measure the effectiveness of a teacher-education curriculum would take an experiment lasting over one generation of time. It is obvious that this inquiry cannot assume such proportions, therefore a modification is indicated. An acknowledged characteristic of an effective teacher

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[27] Angus E. Taylor, "Convention and Revolt in Mathematics," The Mathematics Teacher, LV (1962), 8.

[28] Lars V. Ahlfors and others, "On the Mathematics Curriculum of the High School," The American Mathematical Monthly, LXIX (1962), 192.

[29] D. M. Merriell, "Second Thoughts on Modernizing the Curriculum," The American Mathematical Monthly, LXVII (1960), 77.

is selected and the effectiveness of the teacher-education curriculum with respect to that characteristic is studied.

A teacher must have confidence. He must feel that he is ready to do what is necessary to carry out the assignment that he has accepted. It is the duty of the teacher-education institutions through their curriculum to give this prospective teacher the content and methods that will produce this confidence within the teacher. Since confidence is a feeling it can be assessed by questioning.

In carrying out his duties the high school principal must make judgments based on his opinions of the effectiveness of the teacher. In a similar way the head of the department of mathematics in the high school or the curriculum adviser for mathematics finds it in the line of his duty to have opinions with respect to the efficiency of the teacher. These opinions may also be assessed by a questionnaire.

> The questionnaire can be most fruitfully used for highly select respondents with a strong interest in the subject matter, greater education, and higher socioeconomic status.[30]

Therefore a questionnaire is an effective means for collecting the data for this inquiry.

Limitation of the Study

The limitation of this study to Elementary Algebra and Geometry may be justified by the fact that many small high schools do not teach

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[30]William J. Goode and Paul K. Hatt, Methods in Social Research (New York, 1952), p. 182.

any mathematics beyond these two courses.[31] Additional justification comes from the fact that Elementary Algebra is already taught in the junior high schools and that Geometry eventually will be if the experiment of allowing the more capable eighth grade student to take Elementary Algebra proves its feasability. This would eventually permit this student to take mathematics for advanced standing in the twelfth grade.

Since the teacher-education curricula vary from state to state throughout the Union, and since the author is connected with an accredited teacher-education institution in California, this investigation will be limited to that state.

Summary and Preview

The purpose of this study is to determine the effectiveness of the mathematical content of the teacher-education curricula of the State Colleges of California in preparing teachers of Elementary Algebra and Geometry. Assumptions were made with respect to the position of teachers of mathematics in the society and the pre-service preparation they need to fill effectively their places. Attention was given to the peculiar circumstances currently surrounding the high school curriculum in mathematics with the resulting need to keep the teacher-education curriculum abreast of the changing demands made upon it. Limitations were placed on the problem to bring it within the scope of a suitable and meaningful study.

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[31] E. Glenadine Gibb, John R. Mayor, and Edith Treuenfels, p. 799.

A study of the background of the problem is presented in the next chapter and in the remaining chapters are found a description of the methods employed in carrying out the study, a presentation and treatment of the data, as well as a discussion of the conclusions which may be drawn from an analysis of the data.

CHAPTER II

BACKGROUND OF THE PROBLEM

Introduction

Since the present increased activity surrounding the secondary curriculum in mathematics began about 1950 this date is taken as a starting point for a selective review of the literature. There is very little in the literature that bears directly on the preparation of teachers of Elementary Algebra and Geometry as such but there are several findings which deal with junior high schools and the secondary schools and these are considered to determine their implications for the preparation of teachers of Elementary Algebra and Geometry.

The material reviewed in this chapter falls quite naturally into three categories: research, committee findings, and related material. These topics will be considered in the reverse order.

Related Material

A review of the literature reveals that several individuals have expressed their beliefs regarding topics in mathematics that concern the preparation of secondary teachers of mathematics.

Brown[1] recommends a five year collegiate preparation for teachers of junior high school mathematics. This curriculum would include six hours of pre-calculus mathematics, eight hours of calculus, and one course each in modern algebra, mathematical statistics, foundations of arithmetic, history of mathematics, geometry, theory of numbers, statistics, foundations of geometry, advanced calculus, topics in junior high school mathematics, and methods. This would be forty-seven hours. This curriculum of forty-seven hours is somewhat heavier than other recommendations for the junior high school teacher.

In contrast to the above program Pingry would have the junior high school teacher prepared to teach more than one subject. He is

> in agreement with the basic idea that a junior-high school student should be with one teacher for more than one period if possible...Under a well qualified mathematics and science teacher both the mathematics and the science could be supplemented and helped by the study in the other subject.[2]

Pingry proposes that the pre-service preparation of junior high school teachers of mathematics should include at least twelve hours in college mathematics. Conant would insert a word of caution regarding "the assumption that secondary teachers ought to be prepared to teach at least two different subjects" and that this supposition "needs careful examination <u>state by state</u>."[3]

Another curriculum for preparing junior high school teachers, as

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[1] John A. Brown, "Promising Practices in Mathematics Teacher Education," <u>School Science and Mathematics</u>, LVIII (1958), 35.

[2] R. E. Pingry, "For a Better Mathematics Program in the Junior High School," <u>The Mathematics Teacher</u>, XLIX (1956), 119-120.

[3] James B. Conant, <u>The Education of American Teachers</u> (New York, 1963), p. 168.

outlined by Fehr, would consist of fourteen to twenty hours of mathematics, two semesters of algebra and three semesters of "co-ordinate geometry, differential and integral calculus, and elementary differential equations with applications."[4]

Conant, in his report on the education of secondary teachers in the United States, proposes that a teacher teach in only one field. One of the factors influencing this recommendation is the

> increase in the number of six-year high schools (grades 7 through 12 inclusive). More pupils attend six-year high schools than any other kind, and these schools outnumber all other kinds of secondary school in the nation.[5]

In contrast to Conant's findings about the predominance of six-year high schools in the United States as a whole, statistics for California[6] show that the ratio of the four-year high school (grades nine to twelve) to the six-year high schools is eight to one. The number of pupils attending these six-year high schools is relatively small compared to those attending the four-year high schools. Considering these facts it cannot be assumed that the recommendations in his report are valid for California and are not further considered in this study.

Committee Findings

In reviewing the literature regarding teacher-education in

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[4]Howard F. Fehr, "How Much Mathematics Should Teachers Know " _The Mathematics Teacher_, LII (1959), 300.

[5]Conant, p. 168.

[6]_California School Directory, 36th edition_ (Burlingame, November, 1961-1962).

mathematics there appear many references to the Committee on the Undergraduate Program in Mathematics, (CUPM)[7], of the Mathematical Association of America. Brown and Mayor state that the "academic training of mathematics teachers will be largely determined for the next decade or longer by recommendations" of CUPM.[8] In the CUPM report are outlined programs for the preparation of teachers of mathematics on four different levels:

Level I. Teachers of elementary school mathematics.
Level II. Teachers of the elements of algebra and geometry.
Level III. Teachers of high school mathematics.
Level IV. Teachers of the elements of calculus, linear algebra, probability, etc.[9]

The teacher-education curriculum for Level II is three courses in analytic geometry and calculus, one course each in modern algebra, geometry, and probability and statistics, and one elective, or a total of twenty-one hours beginning with analytic geometry and calculus. "One of these courses should contain an introduction to the language of logic and sets."[10]

The minimum requirements for Level III are three courses of analytic geometry and calculus and two courses each of algebra, geometry, probability and statistics, and electives, or a total of thirty-three

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[7]Mathematical Association of America, Recommendations for the Training of Teachers of Mathematics, (Mathematical Association of America, January, 1961).

[8]John A. Brown and John R. Mayor, "The Academic and Professional Training of Teachers of Mathematics," Review of Educational Research, XXXI (1961), 298.

[9]Mathematical Association of America, p. 9.

[10]Ibid., p. 13.

hours.

Other committees have suggested programs for the teacher-education curriculum which correspond to Level III. The National Association of State Directors of Teacher Education and Certification, in co-operation with the American Association for the Advancement of Science (NASDTEC)[11], makes recommendations which fall within those of CUPM, with the exception that the former recommends a major in mathematics, whereas the latter calls for a total of thirty-three semester hours.

The Sub-committee on Teacher Certification--the Co-operative Committee on the Teaching of Science and Mathematics of the American Association for the Advancement of Science, known as the "Garrett" report,[12] has made recommendations which, when compared to those of CUPM, would call for another course in analysis, one course in foundations, and two courses which make use of mathematics (science, etc.) but would only require one course each for algebra and geometry.

The Commission on Mathematics of the College Entrance Examination Board (CEEB)[13] calls for a total of thirty hours which should include courses in calculus and analytical geometry, abstract algebra, geometry, statistics, and logic. These courses, with the exception of logic would correspond closely to the recommendations of CUPM.

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[11] G. S. Young, "The NASDTEC-AAAS Teacher Preparation and Certification Study," The American Mathematical Monthly, LXVII (1960), 792-797.

[12] Alfred B. Garrett, "Recommendation for the Preparation of High School Teachers of Science and Mathematics--1959," School Science and Mathematics, LIX (1959), 287.

[13] R. E. K. Rourke, "The Commission on Mathematics of the CEEB and Teacher Education," The Bulletin of the National Association of Secondary School Principals, XLIII (1959), 178.

It is noted that if the two courses alloted to electives in the CUPM program were assigned, one to analysis and one to foundations, then this CUPM curriculum would include the other three committee programs, except for logic. The requirement for logic could be satisfied by topics from foundations, geometry, and modern algebra. The applications called for in the "Garrett" report involving non-mathematical courses could fall well within the requirements for either general education or the minor demanded by a specific school.

The agreement shown among the various committee reports is summarized below and in this study it is designated as the recommended major:

Analytic geometry and calculus	12 units (semester)
Algebra	6 units
Geometry	6 units
Probability and statistics	6 units
Foundations	3 units

Several of the committee reports allowed for a junior high school credential in their recommendations. CEEB and the "Garrett" report allow for junior high school credentials with somewhat fewer courses required. CUPM does not mention the junior high school but its Level II would qualify one to teach Elementary Algebra and Geometry.

Each of these three committees calls for comparable amounts of analysis, algebra, geometry, and probability. A reconciliation of the CUPM program and that covered by the "Garrett" report could be effected by applying the elective called for in CUPM to a foundations course. The only remaining difference between these two programs would be the one course in applications in the "Garrett" report which would likely be covered by a general education course.

As noted on page 19, Fehr's recommendations for the junior high school teachers of mathematics would also fit the pattern which is summarized below and in this study is designated as the recommended minor:

Analytic geometry and calculus	9 units (semester)
Algebra	3 units
Geometry	3 units
Probability and statistics	3 units
Foundations	3 units

Research

In recent years a number of investigations have revealed inadequacies in the teacher-education curriculum in mathematics. That some of the courses in mathematics which are offered as part of the teacher-education curriculum are not fulfilling the need is supported by the research of Nemecek[14], Bonner[15], Lohela[16], and others. They concluded that there exists a need for classes in mathematics designed especially for teachers because the classes for researchers and for scientists are not completely fulfilling the prospective teachers' needs. Also Burger[17] and Nemecek, in Kansas and Oklahoma respectively, found that,

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[14]Vivian Nemecek, "Preparation, Problems, and Practices of Mathematics Teachers in the North Central High Schools of Oklahoma" Unpublished Doctoral dissertation, The University of Oklahoma, Norman, 1955, Dissertation Abstracts, XVI (1956), 73.

[15]Sister Philippina Bonner, An Analysis of Certain Factors in the Training of Catholic High School Mathematics Teachers, (Washington, 1957).

[16]Arvo E. Lohela, "Enrollment Characteristics and Teacher Preparation in Michigan Secondary School Mathematics" Unpublished Doctoral dissertation, University of Michigan, Ann Arbor, 1958, Dissertation Abstracts, XIX (1958), 471.

[17]John M. Burger, "Academic Backgrounds of Kansas Mathematics Teachers," School Science and Mathematics, LX (1960), 139-142.

in those states, seven out of ten of the teachers of mathematics holding Master's degrees majored in education rather than in mathematics because the required courses in mathematics did not fit their needs. Burger reports that only one out of eight majored in mathematics.

In contrast to recent trends of placing calculus in the freshman year DiPietro concludes that

> the first two years of the present mathematics education program in West Virginia should be modified to include in the first year a thorough treatment of the number concept, the nature of proof, the concepts of function and measurement, as well as algebra, which would incorporate some of the elementary aspects of modern algebra, and trigonometry. Analytic geometry should be integrated with the calculus in the second year.[18]

This view might satisfy Ford who has as one of his conclusions that the

> removal of the pre-calculus sequence of courses would delete from the pre-service teacher's college mathematics experiences many topics in secondary school mathematics courses.[19]

Dissatisfaction with the teacher-education program was found by

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[18]Alphonso J. DiPietro, "A Program in Mathematics Education for West Virginia Teachers of Secondary Mathematics" Unpublished Doctoral dissertation, George Peabody College for Teachers, Nashville, 1956, Dissertation Abstracts, XVII (1957), 569.

[19]Patrick L. Ford, "The Mathematics Included in Programs for the Education of Secondary School Teachers in the Southern Association" Unpublished Doctoral dissertation, University of Missouri, Columbia, 1962, Dissertation Abstracts, XXIII (1962), 543.

both Nelson[20] and Kerr[21] with respect to the preparation of junior high school teachers. Their investigation reveals that teachers in Kansas, Arkansas, Missouri, and Oklahoma value content as being highly important or essential.

The teacher-education curricula of the various teacher-education institutions show a considerable variation in the amount of mathematics they require. Smith reports that six per cent of the institutions require three hours or less of mathematics "behond the calculus, excluding courses specially designed for prospective teachers and three per cent require more than twenty-one hours with ten to twelve hours being the median.[22]

In a survey of teachers of secondary mathematics in the state of Kansas, Burger found that sixty-two per cent of them taught in fields other than mathematics and that twenty-three per cent taught only a single class in mathematics.[23] An examination of the 1963-1964 California School Directory[24] reveals that many teachers of mathematics in

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[20]Theodora S. Nelson, "Factors Present in Effective Teaching of Secondary School Mathematics" Unpublished Doctoral dissertation, The University of Nebraska Teachers College, Lincoln, 1959, Dissertation Abstracts, XX (1960), 3207.

[21]Charles D. Kerr, "A Study of the Professional Preparation of Teachers in a Selected Group of Junior High Schools" Unpublished Doctoral dissertation, University of Arkansas, Fayettville, 1963, Dissertation Abstracts, XXIV (1963), 645.

[22]Lehi T. Smith, "Curricula for Education of Teachers," The American Mathematical Monthly, LXX (1963), 202.

[23]Burger, p. 142.

[24]California School Directory, 38th edition (Burlingame, November, 1963-1964).

California are also teaching in more than one field.

The writer concurrs with Estes when he states that it is his "opinion that future research efforts in this area [teacher-education] be conducted to determine how well the proposed requirements and recommendations really work."[25]

Summary and Conclusions

This survey of the literature on the pre-service preparation of teachers of secondary mathematics falls into three classes: first, isolated topics; second, recommendations for the curriculum as a whole (junior high school or senior high school); and third, research.

The isolated topics help one to understand the background of the problem but do not aid in its solution and are not considered further.

The recommendations for the complete mathematical content of the teacher-education curriculum which are proposed by the several committees and individuals display a considerable agreement and the differences can be reconciled in most cases.

The section on research revealed a few studies on the pre-service preparation of secondary and junior high school teachers of mathematics. Nothing was found to involve either California or the teaching of Elementary Algebra and Geometry.

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[25] Ronald V. Estes, "A Review of Research Dealing with Current Issues in Mathematics Education," <u>School Science and Mathematics</u>, LXI (1961), 630.

CHAPTER III

METHODS AND PROCEDURES

In this study four different approaches were taken to the problem. Each approach was designated as a phase. Therefore, this study consisted of a four-phase investigation of the effectiveness of the teacher-education curriculum in mathematics as a preparation to teach Elementary Algebra and Geometry. It is the purpose of this chapter: to introduce the four phases, to identify the groups and colleges that participated, to describe the preparation of the instrument, to explain how it was used in the collection of the data, and to outline the statistical procedures employed.

The four phases of this study were: first, an evaluation of the teacher-education curricula in mathematics by three groups of educators; second, a comparison of the content of representative curricula with a list of rated topics; third, a comparison of the content of the teacher-education curricula in mathematics with the content of Elementary Algebra and Geometry; and last, a comparison of the representative curricula in mathematics with the recommended curricula of Chapter II.

Before further discussion of the four phases of the study, the colleges and groups must be identified and the questionnaire must be described. It is to be understood that the terms major and minor refer to the teaching major in mathematics of the California State Colleges and the teaching minor in mathematics of the California State Colleges respectively.

Selection of Participating Colleges

Of the eighteen California State Colleges[1], the six at Fullerton, Hayward, Turlock, Cotati, Inglewood, and San Bernadino were recently established and were not invited to participate in this study. A seventh was not involved in this investigation because at the time of the writer's visit to the campus the designated administrative officer was not available to release the needed information. The eleven remaining State Colleges participated by furnishing necessary data needed to identify the three groups of educators: principals, supervisors, and teachers.

Selection of Teachers

The participating colleges were requested to supply the names of teachers recommended by them for California State certification to teach high school mathematics. The records made available by some of the participating colleges gave the teaching major and teaching minor of the prospective teacher. In some cases only the teaching major was listed and in others neither the teaching major nor teaching minor was indicated. When incomplete information was given it was necessary to list the names of all persons who had been recommended for the general secondary credentials in all fields. At one college the only source

[1] California State Polytechnic College Bulletin, Catalog Issue, (San Luis Obispo, July, 1964), p. 13.

of information available was through a list of assignments to student teaching. This initial list of teachers contained over 700 names.

The California School Directory for 1963-1964 was checked for each name on the initial list of teachers. If the directory indicated that the person was currently teaching mathematics in a public high school in California and if, judging from the classes listed for him, there was a possibility that he had had experience in teaching Algebra and Geometry his name was placed on the working list of teachers. This final working list contained 158 names.

Selection of Principals

When a teacher's name was recorded on the working list of teachers, the name of the principal of the high school where this teacher was employed was placed on the working list of principals. In several cases, two or more teachers selected for this study taught at the same high school, therefore, only 134 names are on the working list of principals.

Selection of Supervisors

The working list of supervisors was made up largely of names of heads of departments of mathematics of the schools where the teachers on the working list of teachers were employed. When the California School Directory did not list the name of the head of the department of mathematics that was needed for the working list of supervisors, a letter was written to an administrative officer, other than the principal, asking for the name of the department head or, if no one was designated as the department head, for the name of a qualified alternate. The letter stated that this individual should be a curriculum adviser or a supervisor who was versed in mathematics, and understood the needs of those who taught mathematics in the school in question. A copy of this letter is in Appendix D, page 114. If a name was supplied in answer to this request it was included in the working list of supervisors, a list of 123 names.

The principal was not asked to supply the name of a supervisor because he was already being asked to fill out one of the questionnaires. It was thought that to contact a principal twice within so short a period of time would reduce the number of useable responses.

Description of Questionnaire

After a general discussion of the form and purpose of each section of the questionnaire the mechanics of its construction will be considered. A copy of the questionnaire is found in Appendix D, pages 107 to 113.

The questionnaire was designed for use in gathering information to be utilized in the evaluation of the major and the minor as an effective preparation for teaching Elementary Algebra and Geometry. The questionnaire consisted of three sections.

The first two pages of the questionnaire, designated as section one, contained two parts, Part A and Part B. Part A was designed to obtain an evaluation of the effectiveness of the major as a preparation to teach traditional Elementary Algebra, traditional Geometry, modern Elementary Algebra, and modern Geometry. For each of the four courses in mathematics listed above, the respondent was asked to indicate if the major was (1) "adequate," (2) if the major had a "few small inadequacies," or (3) if the major had "some serious inadequacies." If the respondent felt that some inadequacies existed he was asked to indicate the areas in mathematics in which they occurred.

The purpose of Part B was to evaluate the minor. The design of Part B was the same as that of Part A.

Section two contained a list of 126 representative topics in mathematics. The respondent was asked to rate these topics as to their value to the minimum but adequate preparation for teaching Elementary Algebra and Geometry. Each topic was to be rated on the following scale: (A) "essential," (B) "of considerable value," or (C) "of little value." At the end of this section spaces were provided for the inclusion of any topics in mathematics that the respondent felt should be added.

The last section of the questionnaire, designated as section three, contained several general questions regarding the teacher's preparation to teach mathematics, his undergraduate degree, and the year he received his teaching credential. This section also sought information regarding the high school courses in mathematics the respondent had taught and whether he had had experience in teaching traditional and/or modern courses in mathematics.

All three sections of the questionnaire were sent to each teacher whose name was on the working list of teachers, whereas, only sections one and two were sent to the persons whose names were on the working list of supervisors. The principals concerned in this study received only Parts A and B.

Preparation of Questionnaire

The questionnaire was developed in three stages: the preliminary instrument was constructed; it was administered to a test group; the preliminary form was revised for final use.

In the construction of the preliminary form of the questionnaire material and help were obtained from several sources.

Committee Report. A report by CUPM[2] dealing with teacher-education was studied and topics that were recommended to be included in the preparation of teachers of secondary mathematics were included in the topics listed in section two of the questionnaire.

Textbook. Since the CUPM report did not give details regarding topics in analytic geometry and calculus[3] supplementary textbook material by Taylor[4] was used.

> "This text is an excellent text for use in a first course in analytic geometry and the calculus...The author has been successful in presenting a substantial course in subject matter...."[5]

State College Bulletin. Several of the topics of section two were found in course descriptions.

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[2]Course Guides for the Training of Teachers of Junior High and High School Mathematics. (Mathematical Association of America, 1961), pp. 8-34.

[3]Ibid., p. 5.

[4]Angus E. Taylor, Calculus with Analytic Geometry (Englewood Cliffs, N. J., 1959).

[5]Lloyd L. Lowenstein, "Recnt Publications," The American Mathematical Monthly, LXVII (1960), 394.

Teachers. Dr. Lysle Mason, an experienced teacher of university mathematics, offered a number of helpful suggestions which were incorporated into the preliminary form of the questionnaire.

Through the kindness of Doctor Mason, a test run of the preliminary questionnaire was made on his class of sixteen teachers that were attending a National Science Foundation Summer Institute in Mathematics at Oklahoma State University. The class consisted of junior high school and high school teachers of mathematics. Four of these teachers had had recent experiences in teaching both Elementary Algebra and Algebra II, three more had taught Elementary Algebra, and another had taught Geometry. The rest of the class had not had recent experience in Elementary Algebra or Geometry. When these forms were given to the teachers for the test run they were told that it was a test run and they were asked to consider it carefully and to criticize it freely. As a result of the test run changes were made in the format of Parts A and B.

During the development of this investigation Dr. James H. Zant, a member of the advisory committee for this study, introduced the writer to Mr. Frank Lindsay of the California State Department of Education, and as a result of this meeting Mr. Lindsay wrote the introductory letter which was used with the questionnaires when they were mailed to the persons whose names were on the three working lists.

The material that was mailed to each of the persons who were chosen to participate in this study consisted of a letter of introduction, a letter of instruction, and the questionnaire. A follow-up card was sent to each of those who delayed replying. Copies of these materials are in Appendix D, pages 103 to 115.

Selection of Responses

Out of the 158 questionnaires sent to the persons whose names were on the working list of teachers eight-eight were returned; however, twenty-three of these were considered unuseable as shown in Table I. The replies from sixty-five teachers were utilized in this study.

TABLE I

DISTRIBUTION OF TEACHERS ACCORDING TO PARTICIPATING COLLEGES

Participating College	Number of Teachers: Receiving Questionnaires	Number of Teachers: Returning Questionnaires	Number of Teachers: Returning Useable Questionnaires
A	40	23	18
B	33	13	9
C	22	14	11
D	20	12	8
E	14	9	7
F	12	8	7
G	7	4	3
H	4	2	1
I	6	1	0
		2*	1*
Totals	158	88	65

*Note: Identifying number was not on returned form.

Some of the reasons for declaring questionnaires of the teachers unuseable were as follows: two were returned without being filled out; two were returned by the post office as being undeliverable; a few were not used because the respondent stated that they did not consider themselves qualified to answer; some were filled out by respondents who had received their first credential before 1958; some were rejected because the respondent had taught no course in mathematics other than General Mathematics and Algebra I.

All of the returns used were from teachers who had received their first teaching credential during 1958 to 1963. Each teacher on the working list was teaching in a public high school in California as a qualified teacher of mathematics one year before he filled out the questionnaire. It cannot be assumed that all of those who were recommended by the participating colleges for certification in mathematics during 1958-1963 were on the working list of teachers.

A composite picture of the sixty-five contributing teachers, compiled from Appendix E, page 117, reveals that:

1. he checked the questionnaire from the point of view of teachers of both traditional and modern courses in Elementary Algebra and Geometry

2. he had a teaching major in mathematics (83.1%)

3. his major consisted of 44.2 credit hours (or in case of those who had a minor, 25.5 credit hours)

4. he received his four-year degree in 1959, and one and one half years later he received his first secondary teaching credential

5. he had taught "modern" mathematics courses, and he had considerable experience with the teaching of SMSG courses (72.3%)

6. he had taught Algebra and Geometry (100% and 98% respectively)

7. his credential was recommended by a California State College

Ninety-four principals returned useable questionnaires. Thirteen of the forms returned by them were not used for various reasons, among which were: some were returned un-marked; a few seemed to be self-contradictory (checked the major or minor as adequate and then checked in the spaces below indicating that there existed areas of serious inadequacy); one was disqualified because the principal had asked one of the teachers to fill it out for him.

Sixty-eight of the supervisors returned questionnaires that were considered useable. Among the reasons for rejecting seven of the supervisors' responses were: some were not filled out; one was received after a considerable amount of the data had been processed.

Tables II to VI show that the principals, supervisors, and teachers were employed in California public schools of a variety of sizes and grade groupings located in various parts of the state.

The following discussion of the four phases of this study is based on the groups that have been identified and the instrument that has been described.

First Phase

In this phase of the study the three groups rated the major and the minor. This evaluation was the primary purpose of the first phase. Each curriculum was rated on the following scale: (1) " adequate," (2) "has a few samll inadequacies," (3) "has some serious inadequacies." The respondent was invited to designate the areas of any inadequacies.

The position of the median was used as the measure of central

TABLE II

DISTRIBUTION OF PRINCIPALS, SUPERVISORS, TEACHERS
ACCORDING TO SIZE OF HIGH SCHOOLS

Number of Students Enrolled	Principals	Supervisors	Teachers
1- 500	6	3	4
501-1000	16	11	8
1001-1500	16	14	16
1501-2000	24	15	11
2001-2500	21	16	11
2501-3000	8	5	7
3001-3500	2	2	4
3501-4000	1	1	2
		1**	1**
			1*
Totals	94	68	65

*Returned without identifying number.
**New High School (enrollment not given).

TABLE III

DISTRIBUTION OF PRINCIPALS, SUPERVISORS, TEACHERS
ACCORDING TO TYPE OF HIGH SCHOOLS

Grades Included in School	Principals	Supervisors	Teachers
7- 9	1	1	1
9-12	55	43	35
10-12	32	21	23
7-12	1	1	2
9-11	3	2	3
7-10	1		
11-12	1		
			1*
Totals	94	68	65

*Returned without identifying number.

TABLE IV

DISTRIBUTION OF PRINCIPALS ACCORDING TO GEOGRAPHIC LOCATION OF HIGH SCHOOLS

Geog. Area and Location of H.S.	No. of Principals	Geog. Area and Location of H.S.	No. of Principals
LOS ANGELES		SAN FRANCISCO BAY	
Los Angeles	3	San Jose	5
Pasadena	3	San Francisco	4
Whittier	2	Napa	2
Alhambra	1	Newark	2
Anaheim	1	Santa Clara	2
Arcadia	1	Sunnyvale	1
Bell	1	Antioch	1
Bellflower	1	Campbell	1
Costa Mesa	1	Daly City	1
Covina	1	Larkspur	1
Downey	1	Milpitas	1
Duarte	1	Pacifica	1
Fullerton	1	San Rafael	1
Garden Grove	1	Sonoma	1
Glendora	1	Union City	1
Granada Hills	1	Vallejo	1
Harbor City	1		
La Crescenta	1	EL DORADO AND SACRAMENTO COUNTIES	
Laguna Beach	1	Sacramento	5
Lakewood	1	Auburn	1
Lennox	1	Citrus Heights	1
La Puente	1	Galt	1
Long Beach	1	Grass Valley	1
Newport Beach	1	Lincoln	1
Orange	1	Loomis	1
Paramount	1	Roseville	1
Palos Verdes Estates	1	Shingle Springs	1
Sun Valley	1	West Sacramento	1
Temple City	1		
West Covina	1	SAN JOAQUIN VALLEY	
Westminster	1	Fresno	3
		Merced	1
SACRAMENTO VALLEY			
Anderson	1	SCATTERED	
Arbuckle	1	Eureka	1
Chico	1	Ferndale	1
Corning	1	Hopland	1
Marysville	1	McKinleyville	1
Redding	1	Ventura	1
Willows	1	Yreka	1

TABLE V

DISTRIBUTION OF SUPERVISORS ACCORDING TO GEOGRAPHIC LOCATION OF HIGH SCHOOLS

Geog. Area and Location of H.S.	No. of Principals	Geog. Area and Location of H.S.	No. of Principals
LOS ANGELES		SAN FRANCISCO BAY	
Anaheim	2	San Francisco	5
Garden Grove	2	San Jose	5
Lakewood	2	Santa Clara	2
Alhambra	1	Sunnyvale	2
Arcadia	1	Daly City	1
Bellflower	1	Larkspur	1
Belmont	1	Los Gatos	1
Costa Mesa	1	Milpitas	1
Culver City	1	Pacifica	1
Downey	1	Sonoma	1
Duarte	1	Union City	1
El Monte	1	Vallejo	1
Fullerton	1		
Los Angeles	1	SAN JOAQUIN VALLEY	
Newark	1	Fresno	2
Newport Beach	1	Fowler	1
Norwalk	1	Merced	1
Pasadena	1	Visalia	1
Palos Verdes Estates	1		
Sun Valley	1	SACRAMENTO VALLEY	
Temple City	1	Anderson	1
Tustin	1	Chico	1
West Covina	1	Corning	1
		Redding	1
EL DORADO AND SACRAMENTO COUNTIES			
Auburn	1	SCATTERED	
Del Paso Heights	1	Lancaster	1
Galt	1	Ukiah	1
Grass Valley	1	Lone Pine	1
Sacramento	1	McKinleyville	1
West Sacramento	1		

TABLE VI

DISTRIBUTION OF TEACHERS ACCORDING TO GEOGRAPHIC LOCATION OF HIGH SCHOOLS

Geog. Area and Location of H.S.	No. of Teachers	Geog. Area and Location of H.S.	No. of Teachers
LOS ANGELES		SAN FRANCISCO BAY	
Pasadena	4	San Jose	4
Lakewood	2	Santa Clara	3
Buena Park	1	Los Gatos	2
El Monte	1	San Francisco	2
La Puente	1	Vallejo	2
Long Beach	1	Daly City	1
Norwalk	1	Larkspur	1
Palos Verdes Estates	1	Milpitas	1
Sun Valley	1	Newark	1
Temple City	1	Pacifica	1
Tustin	1	Richmond	1
Westminster	1	San Rafael	1
Whittier	1	Sonoma	1
		Sunnyvale	1
SACRAMENTO VALLEY		Union City	1
Chico	1		
Los Molinos	1	SAN JOAQUIN VALLEY	
Redding	1	Fresno	7
Willows	1	Bakersfield	1
		Merced	1
EL DORADO AND SACRAMENTO COUNTIES		Visalia	1
Auburn	1		
Citrus Heights	1	SCATTERED	
Del Oro	1	Hopland	1
Loomis	1	Lancaster	1
N. Highlands	1	Yreka	1
Roseville	1		
Shingle Springs	1		

tendency to locate the concensus of the groups as they evaluated the major and the minor.

Also, as part of the first phase, the following general question was asked: Do the evaluations of the teacher-education curricula by the three groups of educators show group differences? Stated as a null hypothesis this question would take the form:

H_o: The principals, supervisors, and teachers did not display group differences in their evaluations of the teacher-education curricula as effective preparation for the teaching of Elementary Algebra and Geometry.

This general hypothesis was made more specific by a separate consideration of each of the four courses: traditional Elementary Algebra, traditional Geometry, modern Elementary Algebra, and modern Geometry.

The Kolmogorov-Smirnov Test as used in this study is a two-sample test and was restricted to the comparison of two groups at a time. The test was applied to the following combinations of groups: principals vs. supervisors, principals vs. teachers, and supervisors vs. teachers. Each combination of groups was compared with respect to a specific course. Thus, twelve hypotheses were considered for the major and twelve for the minor. These hypotheses can be expressed as a single statement in two variables.

If X represents one of the three combinations of groups to be compared and Y represents one of the four high school courses in mathematics on which the groups are being compared then, the null hypothesis (H_o) and the alternative (H_1) would be:

H_0: The X did not differ in their evaluation of the major as an effective preparation of teachers of Y.

H_1: The X did differ in their evaluation of the major as an effective preparation of teachers of Y.

A tabulation of the twelve resulting hypotheses would be:

Number of Hypothesis	Replacement for X	Replacement for Y
M1	Principals and supervisors	Trad. Elem. Algebra
M2	Principals and teachers	Trad. Elem. Algebra
M3	Supervisors and teachers	Trad. Elem. Algebra
M4	Principals and supervisors	Trad. Geometry
M5	Principals and teachers	Trad. Geometry
M6	Supervisors and teachers	Trad. Geometry
M7	Principals and supervisors	Modern Elem. Algebra
M8	Principals and teachers	Modern Elem. Algebra
M9	Supervisors and teachers	Modern Elem. Algebra
M10	Principals and supervisors	Modern Geometry
M11	Principals and teachers	Modern Geometry
M12	Supervisors and teachers	Modern Geometry

A similar list of hypotheses was tested for the minor. For each of the above hypotheses for the major, there was a corresponding one for the minor. The only difference was that the word minor was substituted for the word major. The twelve hypotheses for the minor are also listed in tabular form.

Number of Hypothesis	Replacement for X	Replacement for Y
m1	Principals and supervisors	Trad. Elem. Algegra
m2	Principals and teachers	Trad. Elem. Algebra
m3	Supervisors and teachers	Trad. Elem. Algebra
m4	Principals and supervisors	Trad. Geometry
m5	Principals and teachers	Trad. Geometry
m6	Supervisors and teachers	Trad. Geometry
m7	Principals and supervisors	Modern Elem. Algebra
m8	Principals and teachers	Modern Elem. Algebra
m9	Supervisors and teachers	Modern Elem. Algebra
m10	Principals and supervisors	Modern Geometry
m11	Principals and teachers	Modern Geometry
m12	Supervisors and teachers	Modern Geometry

Another general hypothesis was proposed; namely, that the major was more effective than the minor in the preparation of teachers of Elementary Algebra and Geometry. Again twelve hypotheses were tested.

To reduce repetition, let W be any one of the educator groups and let Y again be one of the four high school courses in mathematics considered in this study. The twelve hypotheses in the single statement form of two variables for the null hypothesis (H_o) and its alternative (H_1) would be:

H_o: The W group did not value the major above the minor as an effective preparation of teachers of Y.

H_1: The W group did value the major above the minor as an effective preparation of teachers of Y.

A tabulation of the resulting twelve hypotheses would be:

Number of Hypothesis	Replacement for W	Replacement for Y
C1	Principals	Trad. Elem. Algebra
C2	Supervisors	Trad. Elem. Algebra
C3	Teachers	Trad. Elem. Algebra
C4	Principals	Trad. Geometry
C5	Supervisors	Trad. Geometry
C6	Teachers	Trad. Geometry
C7	Principals	Modern Elem. Algebra
C8	Supervisors	Modern Elem. Algebra
C9	Teachers	Modern Elem. Algebra
C10	Principals	Modern Geometry
C11	Supervisors	Modern Geometry
C12	Teachers	Modern Geometry

During the course of the study two other comparisons were indicated and are here stated as hypotheses.

Hypothesis A1:

H_o: The teachers who had a major did not value the major above the minor as a preparation of teachers of traditional Elementary

Algebra.

H_1: The teachers who had a major did value the major above the minor as a preparation of teachers of traditional Elementary Algebra.

Hypothesis A2:

H_0: The teachers who had a major did not value the major above the minor as a preparation to teach traditional Geometry.

H_1: The teachers who had a major did value the major above the minor as a preparation to teach traditional Geometry.

Although there were thirty-eight hypotheses proposed as part of the first phase of this study the three general questions were:

First, Did the groups involved in this study consider the major and minor effective in preparing teachers of Elementary Algebra and Geometry?

Second, Did the various groups of educators agree in their evaluation of the major and minor as effective in preparing teachers of Elementary Algebra and Geometry?

Third, Did the various groups value the major as more effective than the minor in preparing teachers of Elementary Algebra and Geometry?

Second Phase

In this phase of the study the 126 topics listed in section two of the questionnaire were rated as to their value to the "minimum but adequate" preparation for effective teaching of Elementary Algebra and Geometry. This list was submitted to the supervisors and teachers. The principals were not invited to participate in this phase of the study.

The supervisors and teachers rated the topics on the following scale: (A) "essential to," (B) "of considerable value, but not essential to," (C) "of little value to" the "minimum but adequate" preparation for effective teaching of Elementary Algebra and Geometry.

This phase also included the selection of what is here known as a representive minor and a representative major. Subsequently textbooks were assigned to the required courses in these curricula.

In the selection of the representative curricula it was noted that Colleges A, B, C, and D contributed over 72% of the names on the working list of teachers. Three of the Colleges, A, B, and D, offered similar minors. Since College A contributed more names than any other to the working list, its minor was selected as the representative minor.

Because the minor offered by College A was selected as the representative minor its major was chosen as the representative major. For the purpose of this study the writer has included the courses of the representative minor as requirements for the representative major. By telephone and by letter, information was secured from qualified personnel on the campus of College A regarding the assignment of electives in the minor as well as textbooks used in the various courses. The campus bookstore also furnished useful information.

The courses for the representative minor and those required for the representative major have been assigned fictitious course numbers and are displayed in Table VII. The prerequisites for these curricula as listed in the College A Bulletin were Trigonometry, one year of

TABLE VII

REPRESENTATIVE CURRICULA

	Courses	Semester Units Major	Minor
Math. 1	Pre-calculus Mathematics	4	4
Math. 2	Analytic Geometry and Calculus I	4	4
Math. 3	Analytic Geometry and Calculus II	4	4
Math. 4	Analytic Geometry and Calculus III	4	
Math. 105	College Geometry	3	3
Math. 106	Modern Algebra	3	3
Math. 107	History of Mathematics	2	2
Math. 208	Math. for High School Teachers	3	3
Math. 209	Math. for High School Teachers	3	
Math. 310	Methods of Teaching Mathematics	2	2
	Analysis or foundations	3	
	Electives	9	

geometry, and two years of algebra.

With but one possible exception the college textbooks listed for these courses for the minor and major are textbooks that have been used for the respective courses. Because of the availability of the first edition of Allendorfer, it was used in this investigation in the place of the second edition. In the following list the textbooks are designated by the names of the authors. The titles are given in the bibliography.

Math. 1	Allendorfer
Math. 2	Thomas
Math. 3	Thomas
Math. 4	Thomas
Math. 105	Davis
Math. 106	McCoy
Math. 107	Eves
Math. 208	Meserve and Sobel, Courant and Robbins
Math. 209	Meserve and Sobel, Courant and Robbins
Math. 310	Butler and Wren

The college textbooks were searched for each of the 126 topics of section two of the questionnaire to determine if that topic was covered by these textbooks.

The writer does not assume that the assignment of a textbook to a course guarranteed that the instructor presented each topic adequately. By the use of his academic freedom the instructor may have made substitutions, changes or deletions in the textual material. For the undergraduate courses, and especially the lower division courses, there is a wide choice of textbooks and there would be less need to deviate from the textual material.

It is not the sole purpose of this study to criticize the way in which a given curriculum functioned at a given time in the past. One important question is: Does the credit allotment and the course content of the teacher-education curriculum make it potentially adequate?

Third Phase

In this phase of the study the content of Elementary Algebra and Geometry was compared with the content of the representative teacher-education curriculum in mathematics.

The topics contained in high school textbooks for Elementary Algebra and Geometry were compared with the content of the college textbooks described under the discussion of the second phase.

The high school textbooks used in this phase of the study were determined by data furnished by the teachers and will be further discussed in Chapter IV.

Fourth Phase

This phase of the study consisted of a comparison of the representative curricula with the recommended curricula of Chapter II.

Statistical Analysis

Because of the non-parametric nature of the data of this study the position of the median was used as a measure of central tendency. Since the rating scales used in the questionnaire were ordinal scales, medians falling between two intervals were meaningful and were recorded as such.

The Kolmogorov-Smirnov Two-sample Test[6] (designated as the K-S Test) was used to test whether or not the null hypothesis (H_0) should be accepted or rejected with respect to an alternative hypothesis (H_1). In the use of the K-S Test calculations are based on the cumulative step functions:

if A, B, C, are the column designations on the rating scales,

if K_j = the cumulative frequency for j = A, j = B, or j = C,

if n_1 = the number of individuals in the first of the two groups being compared,

if n_2 = the number of individuals in the second group being compared,

then the cumulative step function for each group is

$$S_{n_i}(X) = \frac{K_j}{n_i} \qquad \text{where} \begin{cases} K_j = \text{number of scores} \leq X \\ i = 1, 2 \\ j = A, B, C \end{cases}$$

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[6]Sidney Siegel, Nonparametric Statistics for the Behavioral Sciences (New York, 1956), pp. 127-136, 249, 279.

The K-S Test focuses attention upon a quantity D_k, where $k = 1,2$, defined by the following equations:

$$D_1 = \text{maximum}\left[S_{n_1}(X) - S_{n_2}(X)\right] \text{ for testing } H_o \text{ against } H_1,$$

when H_1 is stated in terms of a difference in a stated direction and

$$D_2 = \text{maximum}\left|S_{n_1}(X) - S_{n_2}(X)\right| \text{ for testing } H_o \text{ against } H_1,$$

when H_1 is stated in terms of a difference irrespective of direction.

When D_1 is used, $\chi^2 = 4(D_1)^2 \frac{n_1 n_2}{n_1 + n_2}$ has a distribution approximately equal to that of chi-square with two degrees of freedom.

When D_2 is used it is compared with the critical values for various levels of significance given in Table VIII.

TABLE VIII[a]

Level of significance	Value of D_2 so large as to call for rejection of H_o at the indicated level of significance
.10	$D_2 = 1.22\sqrt{\frac{n_1 + n_2}{n_1 n_2}}$
.05	$D_2 = 1.36\sqrt{\frac{n_1 + n_2}{n_1 n_2}}$
.01	$D_2 = 1.63\sqrt{\frac{n_1 + n_2}{n_1 n_2}}$

[a]Siegel, p. 279.

The applications of these methods and procedures are discussed in Chapter IV.

CHAPTER IV

RESULTS OF THE STUDY

Because of the changes that have taken place in secondary mathematics in the past ten years successful teacher-education practices of the past may not be adequate for the present. It was the purpose of this study to investigate the effectiveness of the teaching major and teaching minor in mathematics of the California State Colleges as a preparation to teach Elementary Algebra and Geometry. In this chapter the results of the investigation are presented and the data on which they are based are found in Appendix A, pages 80 to 89.

First Phase

In the first phase of this study the K-S Test was used to determine if the three groups of educators agreed among themselves in their evaluation of the major (hypothesis M1 - M12) and minor (hypotheses m1 - m12) as a preparation to teach Elementary Algebra and Geometry. The results of these tests for the major, found in Table IX, indicate that for each course versus each pair of educator groups H_o could not be rejected. H_o in the single statement form of two variables was:

H_o: The X groups did not differ in their opinion as to the value of the major as a preparation for the effective teaching of Elementary Algebra and Geometry.

TABLE IX

AGREEMENT BETWEEN GROUPS (X) ON VALUE OF MAJOR AS PREPARATION TO TEACH HIGH SCHOOL COURSES (Y)

No. of Hypoth.	Replacement for X	Replacement for Y	D	Critical Value for D .10 Level	Result Test for H_o	Level of Sig.
M1	Prin. and Sup.	Trad. Alg. I	.007	.200	Retain	ns
M2	Prin. and Teach.	Trad. Alg. I	.041	.200	Retain	ns
M3	Sup. and Teach.	Trad. Alg. I	.048	.219	Retain	ns
M4	Prin. and Sup.	Trad. Geom.	.088	.200	Retain	ns
M5	Prin. and Teach.	Trad. Geom.	.039	.200	Retain	ns
M6	Sup. and Teach.	Trad. Geom.	.049	.219	Retain	ns
M7	Prin. and Sup.	Mod. Alg. I	.108	.200	Retain	ns
M8	Prin. and Teach.	Mod. Alg. I	.072	.199	Retain	ns
M9	Sup. and Teach.	Mod. Alg. I	.098	.218	Retain	ns
M10	Prin. and Sup.	Mod. Geom.	.146	.200	Retain	ns
M11	Prin. and Teach.	Mod. Geom.	.120	.199	Retain	ns
M12	Sup. and Teach.	Mod. Geom.	.067	.218	Retain	ns

Since H_0 could not be rejected for each of the twelve hypotheses, the null form of the general hypothesis could not be rejected. Therefore, the conclusion was that the three groups of educators did not differ in their opinions as to the value of the major as a preparation to teach Elementary Algebra and Geometry effectively.

Table X reveals that the same conclusion was reached with respect to the minor. Therefore, the following more general conclusion was drawn: The three groups of educators did not differ in their opinions as to the value of the teacher-education curricula in mathematics of the California State Colleges as a preparation to teach Elementary Algebra and Geometry effectively.

The median position of the responses to Parts A and B of section one of the questionnaire are shown in Table XI. The results are given for the total of the three groups as well as for each individual group. The three groups as a whole considered the minor as well as the major adequate preparation to teach the traditional courses. The groups collectively rated both the major and the minor as having a "few small inadequacies" as a preparation for teaching the modern courses.

An examination of the data summarized in Table XII reveals that for every course and for every group the number of individuals checking the curriculum as "adequate" was greater for the major than for the minor.

The data were analyzed to determine if the above mentioned differences indicated a significant preference of the major over the minor by the individual groups (Hypotheses C1 - C12). The K-S Test was again used for this purpose.

TABLE X

AGREEMENT BETWEEN GROUPS (X) ON VALUE OF MINOR AS PREPARATION TO TEACH HIGH SCHOOL COURSES (Y)

No. of Hypoth.	Replacement for X	Replacement for Y	D	Critical Value for D .10 Level	Result Test for H_o	Level of Sig.
m1	Prin. and Sup.	Trad. Alg. I	.112	.205	Retain	ns
m2	Prin. and Teach.	Trad. Alg. I	.113	.210	Retain	ns
m3	Sup. and Teach.	Trad. Alg. I	.225	.229	Retain	ns
m4	Prin. and Sup.	Trad. Geom.	.104	.205	Retain	ns
m5	Prin. and Teach.	Trad. Geom.	.033	.209	Retain	ns
m6	Sup. and Teach.	Trad. Geom.	.142	.229	Retain	ns
m7	Prin. and Sup.	Mod. Alg. I	.120	.205	Retain	ns
m8	Prin. and Teach.	Mod. Alg. I	.073	.210	Retain	ns
m9	Sup. and Teach.	Mod. Alg. I	.058	.229	Retain	ns
m10	Prin. and Sup.	Mod. Geom.	.132	.207	Retain	ns
m11	Prin. and Teach.	Mod. Geom.	.141	.210	Retain	ns
m12	Sup. and Teach.	Mod. Geom.	.011	.230	Retain	ns

TABLE XI

POSITION OF THE MEDIAN RESPONSE IN EVALUATION OF THE TEACHING MAJOR (M) AND MINOR (m)

Groups	Courses	Adequate	Few Small Inadequacies	Some Serious Inadequacies
Principals:				
	Traditional Algebra I	Mm		
	Traditional Geometry	Mm		
	Modern Algebra	M	m	
	Modern Geometry	M	m	
Supervisors:				
	Traditional Algebra I	Mm		
	Traditional Geometry	M	m	
	Modern Algebra		Mm	
	Modern Geometry		M	m
Teachers:				
	Traditional Algebra I	Mm		
	Traditional Geometry	Mm		
	Modern Algebra	M	m	
	Modern Geometry		M	m
All Three Groups Combined:				
	Traditional Algebra I	Mm		
	Traditional Geometry	Mm		
	Modern Algebra		Mm	
	Modern Geometry		Mm	

TABLE XII

NUMBER OF INDIVIDUALS RATING THE MAJOR AND MINOR ADEQUATE

	Principals		Supervisors		Teachers	
	Major	Minor	Major	Minor	Major	Minor
Trad. Elem. Algebra	84	63	55	35	58	45
Trad. Geometry	81	53	48	29	51	33
Mod. Elem. Algebra	49	24	26	9	32	11
Mod. Geometry	49	21	24	8	26	7

In this test the "one-tailed" form was used because H_o was tested against H_1 which stated that the major was valued above the minor as a preparation for effective teaching of Elementary Algebra and Geometry.

The general statements of H_o and H_1 are:

H_o: The educators of this study did not value the major above the minor as a preparation for effective teaching of Elementary Algebra and Geometry.

H_1: The educators of this study valued the major above the minor as a preparation for effective teaching of Elementary Algebra and Geometry.

If W represents an educator group and Y represents a high school mathematics course then expressed in single statements with two variables the hypotheses are:

H_o: The W group did not value the major above the minor as a preparation for effective teaching of the Y course.

H_1: The W group did value the major more highly than the minor as a preparation for effective teaching of the Y course.

The results of these tests are shown in Table XIII. In all but two of the tests the difference was significant at the .05 level indicating the rejection of H_0 in favor of H_1. Therefore, the principals and supervisors valued the major above the minor as an effective preparation of teachers of both traditional and modern Elementary Algebra and Geometry.

The teachers also valued the major above the minor for the modern courses in Elementary Algebra and Geometry but at the .05 level they did not value the major above the minor as a preparation for traditional Elementary Algebra and Geometry.

The results of the test for hypotheses A1 and A2 are shown in Table XIV. The teachers with a major did not value the major above the minor as a preparation for teaching traditional Elementary Algebra but they did value the major above the minor as a preparation to teach traditional Geometry.

As each respondent evaluated the major in Part A, he checked an area of inadequacy if he felt that any existed. The combined responses of the principals, supervisors, and teachers are found in Table XV. An examination of these areas of inadequacy revealed that the areas of greatest concern were Logic and Sets, Foundations of Mathematics, Modern Mathematics, and Probability and Statistics. The areas of least concern were Calculus and Algebra.

A study of the responses to Part B evaluating the minor, as recorded in Table XVI, showed that the areas of concern were the same as those for the major. One significant difference was that the number

TABLE XIII

RESULTS OF TESTING HYPOTHESES C1-C12: MAJOR VS. MINOR BY GROUPS

No. of Hypoth.	Replacement for W	Replacement for Y	χ^{2*}	Result of Test for H_0	Level of Sig.
C1	Principals	Trad. Alg. I	6.49	Reject	.05
C2	Supervisors	Trad. Alg. I	10.40	Reject	.01
C3	Teachers	Trad. Alg. I	1.60	Retain	.50
C4	Principals	Trad. Geom.	12.94	Reject	.01
C5	Supervisors	Trad. Geom.	9.62	Reject	.01
C6	Teachers	Trad. Geom.	5.80	Retain	.10
C7	Principals	Mod. Alg. I	11.67	Reject	.01
C8	Supervisors	Mod. Alg. I	9.55	Reject	.01
C9	Teachers	Mod. Alg. I	12.10	Reject	.01
C10	Principals	Mod. Geom.	15.25	Reject	.001
C11	Supervisors	Mod. Geom.	7.96	Reject	.02
C12	Teachers	Mod. Geom.	13.10	Reject	.01

*df = 2

TABLE XIV

COMPARISON OF MAJOR WITH MINOR BY TEACHERS HAVING MAJORS IN MATHEMATICS (H_1: MAJOR VALUED ABOVE MINOR)

	χ^{2*}	Result of Test for H_o	Level of Sig.
A1 Traditional Elem. Algebra	2.16	Retain	.50
A2 Traditional Geometry	8.01	Reject	.02

*df = 2

TABLE XV

FREQUENCY DISTRIBUTIONS OF COMBINED RESPONSES OF PRINCIPALS, SUPERVISORS AND TEACHERS TO PART A OF THE QUESTIONNAIRE (TEACHING MAJOR)

	Adequate	A Few Small Inadequacies	Some Serious Inadequacies
COURSE			
Traditional Algebra	197	21	
Traditional Geometry	180	36	2
Modern Algebra I	107	81	30
Modern Geometry	99	76	42
AREA OF INADEQUACY			
Algebra	176	34	6
Modern Mathematics	122	61	33
Geometry	149	45	23
Calculus	179	25	11
Logic and Sets	127	48	40
Probability and Statistics	148	34	34
Foundations of Mathematics	127	48	39
Areas Added by Respondents:			
History of Mathematics			3
Applications			2
Modern Geometry			1
Integrated Mathematics			1
Theory of Equations		1	
Analytic Geometry		1	

TABLE XVI

FREQUENCY DISTRIBUTIONS OF COMBINED RESPONSES OF PRINCIPALS, SUPERVISORS AND TEACHERS TO PART B OF THE QUESTIONNAIRE (TEACHING MINOR)

	Adequate	A Few Small Inadequacies	Some Serious Inadequacies
COURSE			
Traditional Algebra I	143	42	17
Traditional Geometry	115	64	24
Modern Algebra I	44	78	80
Modern Geometry	36	75	89
AREA OF INADEQUACY			
Algebra	129	48	16
Modern Mathematics	69	59	68
Geometry	95	50	49
Calculus	131	26	35
Logic and Sets	71	44	79
Probability and Statistics	94	32	66
Foundations of Mathematics	82	35	77
Areas Added by Respondents:			
History of Mathematics		4	3
Applications		1	1
Analytic Geometry		1	
Theory of Numbers			1
Inequalities		1	
Introd. to Modern Abstract Alg.		1	
Depth of Background			1

of check marks indicating serious inadequacies for the minor were approximately twice those for the major.

Second Phase

The 126 topics of section two of the questionnaire were rated by both the supervisor group and the teacher group. The frequency distributions are shown in pages 80 to 89 in Appendix A. The comparison of these topics with the textbooks for the representative minor revealed that seven of the twenty-six topics not covered in the textbooks were rated as "essential" by at least one group. Eight more were rated "of considerable value, but not essential" by both groups. Eleven of the topics were rated "of little value" by at least one group. These topics with their ratings are listed in Table XVII.

Meserve and Sobel, along with Courant and Robbins, was used in both Math. 208 and Math. 209 but only Math. 208 was in the minor. In order to evaluate the minor the following was noted:

1. Many of the topics found in chapters one to nine and thirteen of Meserve and Sobel are also in Allendorfer or Thomas.
2. Courant and Robbins was needed to supply material for only four topics:

    a. Cardinal numbers
    b. Desargues' theorem
    c. Postulational reasoning
    d. Introduction to non-Euclidean geometry.

The writer assumed that in a one semester course it would be possible to cover the four topics from Courant and Robbins along with portions of Meserve and Sobel which were not in Allendorfer or Thomas. Therefore, there would be time enough in Math. 208 to present the

TABLE XVII

RATINGS BY SUPERVISORS (S) AND TEACHERS (T)
OF TOPICS NOT ADEQUATELY COVERED
BY REPRESENTATIVE MINOR

		Median Position	
Topics	Essential	Of Considerable Value	Of Little Value
1. Operations other than +, -, x, ÷	ST		
2. Axioms of collinearity	ST		
3. Structure of deductive systems	ST		
4. Planes and lines	ST		
5. New applications of mathematics	ST		
6. New branches of mathematics	ST		
7. Modern aspects of calculations	S	T	
8. Introduction to linear programming		ST	
9. Finite geometries		ST	
10. Analytic projective geometry		ST	
11. Quadric surfaces		ST	
12. Indeterminant forms		ST	
13. Independent trials		ST	
14. Combinational theory		ST	
15. Transfinite numbers		ST	
16. Functions on a sample space		S	T
17. Poisson distribution		S	T
18. Operations with power series		S	T
19. Chi-square		S	T
20. Correlation		S	T
21. Regression		S	T
22 Markov chains			ST
23. Ideals			ST
24. Topological spaces			ST
25. Double integral			ST
26. Triple integral			ST

essential material from both Courant and Robbins and Meserve and Sobel.

Table VII, page 46, shows that in addition to the representative minor the required courses for the representative major are Math. 4, Calculus III, and Math. 209, Mathematics for High School Teachers. The textbooks for these two courses would cover topics 4, 11, 12, 17, 18, 25, and 26 of Table XVII.

The required courses for the major would leave nineteen topics not covered. Six of these topics were rated "essential" by at least one group, six were rated "of considerable value, but not essential" by both groups, and seven were rated "of little value" by at least one group.

Because of the concentration of observed differences in certain areas the data for each topic were analyzed by a K-S Test to determine if the observed difference was significant. The results of these tests are given area by area in Appendix B, pages 91 to 95 and summarized in Table XVIII.

TABLE XVIII

CUMULATIVE DISTRIBUTION OF TOPICS BY AREA AND SIGNIFICANCE LEVEL OF SUPERVISOR-TEACHER RATING DIFFERENCES EXPRESSED IN PERCENTAGES

	Level of Significance		
Area	.10	.05	.01
Algebra and Modern Mathematics	0.0%	0.0%	0.0%
Geometry	4.0	0.0	0.0
Analytic Geometry and Calculus	48.1	46.5	20.9
Statistics	84.6	69.2	0.0
Foundations, etc.	11.1	0.0	0.0
All areas	30.2	23.0	7.1

The significant differences were concentrated in the two areas of Analytic Geometry and Calculus, and Statistics. Each of the other areas contained few if any topics displaying a significant difference.

In Appendix B, pages 91 to 95

$$A' = S_{n_1}(A) - S_{n_2}(A) \text{ and } A' + F' = S_{n_1}(B) - S_{n_2}(B)$$

where n_1 = the number of teachers

and n_2 = the number of supervisors.

The values of A' and $A' + F'$ were in some cases positive and in some cases negative. For any topic, if the number of larger absolute value was negative the supervisors placed a higher value on that topic than did the teachers. If for any topic, the number of larger absolute value was positive then the teacher group rated that topic of higher value than did the supervisors.

For the area of Analytic Geometry and Calculus, and for the area of Statistics all the numbers in both columns are negative. Therefore, each topic in these two areas was rated of higher value by the supervisor group than by the teacher group. For many of the topics the difference in the rating was significant at the .05 level. Twenty out of forty-three of the topics in Analytic Geometry and Calculus and nine out of thirteen of the topics in Statistics gave differences of ratings that were significant.

Third Phase

In this phase of the study the major and minor were again evaluaed. The textbooks used in the representative teacher-education curricula of the State Colleges were compared with selected high school textbooks used in Elementary Algebra and Geometry. The purpose of this comparison was to identify topics in the high school textbooks that were not adequately treated in the above mentioned college textbooks. In this phase of the study the prerequisites for the required courses in the major and minor were considered a part of the major and minor.

In agreement with what was shown in the first phase, it was assumed that the major and minor were adequate preparation for teaching traditional courses in Elementary Algebra and Geometry and the textbooks for these courses were not examined.

In section three of the questionnaire the teachers were asked to indicate the modern textbooks from which they had taught. A survey of the questionnaires used in this study revealed that sixty-one of the sixty-five teachers had taught courses in modern mathematics: forty-seven had used SMSG books,[1] six had used Modern Algebra by Dolciani, Berman, and Freilich,[2] and three had used the Ball State books.[3] Other modern textbooks were reported but no one of these textbooks had been used by more than two teachers. The above textbooks that were used by three or more teachers were used in this phase of the study and are the high school textbooks referred to in the remainder of this discussion.

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[1]School Mathematics Study Group, First Course in Algebra, Parts I and II (New Haven, 1961); School Mathematics Study Group, Geometry, Parts I and II (New Haven, 1961).

[2]Mary P. Dolciani, S. L. Berman, and Julius Freilich, Modern Algebra (Boston, 1962).

[3]Charles F. Brumfiel, R. E. Eicholz, and M. E. Shanks, Algebra (Reading, Mass., 1960); Charles F. Brumfiel, R. E. Eicholz, and M. E. Shanks, Geometry (Reading, Mass., 1960).

A search of the high school algebra textbooks revealed several topics that were not in the college textbooks. Some of the missing topics revealed that the differences were not in the skills or processes that were presented but rather the vocabulary used in presenting them. These differences involved the following expressions: "phrases," "clauses," "open sentences," and "compound open sentences."

Other than the missing topics which involved differences of vocabulary, there were three topics in the high school books which were not found in the textbooks for the courses in the representative minor. These topics were:

1. polynomials over the integers
2. polynomial inequalities
3. systems of inequalities.

These topics were also missing from the textbooks for the representative major.

The SMSG and Ball State Geometry textbooks were compared with the textbooks for the representative minor and for the required courses in the representative major. Since there is considerable optional material in geometry textbooks the position taken for this study was that topics on trigonometry, "analytic geometry,...solid geometry and philosophy of mathematics provided supplementary material beyond the standard course."[4] The "standard course" in geometry was used in this investigation.

Neither the Birkoff and Beatly postulate set used in the SMSG

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[4] Ibid., p. ix.

textbooks nor the set of Hilbert's postulates found in the Ball State Geometry were found in the content of either the representative minor or the required courses for the representative major. The differences between the theorems proved in traditional courses and the modern courses (SMSG and Ball State) reflected the differences in the postulate sets and the various degrees of rigor used by the authors.

Fourth Phase

In this last phase of the study, the representative curricula were compared with the recommended curricula of Chapter II, pages 22-23. This comparison for the representative minor and the recommended minor is shown in Table XIX. The representative minor did not include a course in probability and statistics and another in foundations which were a part of the recommended minor.

TABLE XIX

COMPARISON OF COURSES COMPRISING THE REPRESENTATIVE MINOR AND THE RECOMMENDED MINOR

Courses	Representative Curriculum in Semester Units	Recommended Curriculum in Semester Units
Pre-calculus Mathematics	4	
Analytic Geometry and Calculus	8	9
Algebra	3	3
Geometry	3	3
History of Mathematics	2	
Elem. Math. from an Adv. Pt. of View	3	
Probability and Statistics		3
Foundations		3
Methods of Teaching Mathematics	2	assumed

Because of the elective courses in the representative major a variety of curricula could be constructed. The comparison of one of the possible forms of the representative major with the recommended major is shown in Table XX.

The recommended major would contain two courses in probability and statistics while the representative major would have one course in that area. Otherwise the above form of the representative major would include all of the courses of the recommended major.

TABLE XX

COMPARISON OF COURSES COMPRISING THE REPRESENTATIVE MAJOR* AND THE RECOMMENDED MAJOR

Courses	Representative Curriculum in Semester Units	Recommended Curriculum in Semester Units
Pre-calculus Mathematics	4	
Analytic Geometry and Calculus	12	12
Algebra	6	6
Geometry	6	6
History of Mathematics	2	
Elem. Math. from an Adv. Pt. of View	6	
Probability and Statistics	3	6
Foundations	3	3
Methods of Teaching Mathematics	2	assumed

* Representative major with assigned electives.

The representative major and minor each contained courses in Pre-calculus Mathematics, History of Mathematics, and Elementary Mathematics from an Advanced Point of View which were not in the recommended curricula.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Review of the Study

It was the purpose of this study to evaluate the teaching major and minor in mathematics of the California State Colleges as a preparation to teach Elementary Algebra and Geometry.

The three groups of educators involved in this study were:

1. A selected group of teachers of mathematics in California public high schools who completed the requirements for their General Secondary Credentials during the years 1958-1963.
2. The high school principals where these teachers taught.
3. The mathematics department supervisors of these same high schools.

There were four phases, or approaches, to the evaluation. First, the three groups rated the teaching major and the teaching minor and indicated areas of weakness. Second, the supervisors and teachers evaluated a list of topics in mathematics as to whether or not they were essential to the teacher-education curricula. A representative teaching major and minor were established and textbooks for these curricula were identified and compared with the topics evaluated to determine if they were included in the curricula. In the third phase the high school textbooks for Elementary Algebra and Geometry were compared with the textbooks for the representative curricula. The purpose of this comparison was to ascertain if the content of Elementary Algebra and Geometry was covered by the teacher-education curricula and their prerequisites. In the last phase the representative curricula was compared with a recommended curricula.

Conclusions

Based on the data gathered and its statistical analysis several conclusions were drawn. These conclusions must be interpreted within the limitations of this study.

1. The principals and supervisors considered the major of more value than the minor as a preparation for teaching both traditional and modern Elementary Algebra and Geometry courses.

2. The teachers rated the major above the minor as a preparation for teaching modern Elementary Algebra and modern courses in Geometry.

3. Although the teachers rated the major above the minor as a preparation for teaching traditional Elementary Algebra and Geometry the difference was not significant.

4. As a preparation to teach modern Elementary Algebra and Geometry the minor has a few small inadequacies.

5. Twelve per cent of the topics rated as essential to the preparation for teaching Elementary Algebra and Geometry were not covered by the textbooks for the teaching minor.

6. The supervisors and teachers disagreed regarding the value of many topics in Analytic Geometry and Calculus, and Statistics as a

preparation to teach Elementary Algebra and Geometry. For every topic in the areas of Analytic Geometry and Calculus, and Statistics evaluated in this study the teacher group rated that topic of less value than did the supervisors and in many cases the difference was significant.

7. Although the teachers that had a teaching major in mathematics rated the major above the minor as a preparation for teaching traditional Elementary Algebra and Geometry the difference was significant for Geometry but it was not significant for Elementary Algebra.

8. When compared to the recommended minor the representative minor is deficient in the areas of probability and statistics and foundations but is strong in the history of mathematics and in elementary mathematics from an advanced point of view. The representative minor would give the student a stronger background for Analytic Geometry and Calculus than would the recommended minor.

9. By the proper choice of electives the representative major could approximate the recommended curriculum. This representative major would be weak in probability and statistics but would be strong in history and considerably stronger in elementary mathematics from an advanced point of view. The representative major would give the student a stronger background for Analytic Geometry and Calculus than would the recommended major.

10. Both the major and the minor provide an adequate preparation for teaching the traditional courses of Elementary Algebra and Geometry; however, for the modern courses, they have a few small inadequacies in the areas of logic and sets, foundations, modern mathematics, probability and statistics, and geometry.

Recommendations

The teacher-education curriculum is an important link in the orderly progress of education. In a time of unrest in the high school program in mathematics it is important that the high school curriculum and the teacher-education curriculum of the colleges be studied together to discover implications for the teacher-education program.

In harmony with this need and based on the results of this study the writer makes the following recommendations:

1. The minor provides an acceptable preparation for teaching Elementary Algebra and Geometry but for the teaching of the modern courses it should, for the present, be supplemented by some type of inservice experience comparable to that afforded by National Science Foundation Institutes.

2. Experimentation is needed to determine the pattern of courses that would produce improved teacher-education curricula which would have a maximum coverage of essential topics.

3. Further research is needed to determine the causes of the divergence of opinion shown by the teachers and supervisors for the topics in Analytic Geometry and Calculus, and Statistics. The implications of this divergence for the teacher-education curricula should be investigated.

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APPENDIX A

SUMMARY OF DATA

FREQUENCY DISTRIBUTION OF SUPERVISORS' AND TEACHERS' RESPONSES TO THE EVALUATION OF THE TOPICS OF SECTION TWO[a]

Topics	Supervisor				Teacher			
	A	B	C	N	A	B	C	N
ALGEBRA AND MODERN MATHEMATICS								
Sets	58	10	0	0	56	5	2	2
Ratio	59	7	1	1	54	6	2	3
Variation	50	16	2	0	41	19	0	5
Proportion	58	8	1	1	54	8	1	2
Inequalities	55	11	0	2	57	6	0	2
Progression	30	27	10	1	20	32	11	2
Logic	45	19	4	0	46	15	1	3
Cardinal numbers	32	22	14	0	21	26	12	6
Mapping	21	27	19	1	11	33	16	5
Relations	45	13	3	7	31	24	4	6
Operations other than +, -, x, ÷	39	24	5	0	32	24	5	4
Equivalence	54	12	2	0	46	14	2	3
Groups	14	32	19	3	15	29	15	6
Isomorphisms	10	21	30	7	5	24	26	10
Integral domain	23	27	14	4	15	23	21	6
Rational numbers	66	2	0	0	61	3	0	1
Complex numbers	42	18	8	0	32	23	9	1
Function concept	52	15	1	0	46	17	1	1
Finite induction	17	28	19	4	13	33	14	5
Binomial theorem	30	28	10	0	32	22	8	3
Combinations and permutations	19	33	15	1	14	35	15	1
Probability	16	31	19	2	14	33	16	2
Markov chains	1	15	40	12	4	5	29	27
Axiomatic foundations for algebra	53	14	1	0	54	7	1	3
Rings	9	22	32	5	5	19	33	8
Ideals	3	18	40	7	6	12	32	15
Fields	20	16	27	5	7	22	27	9
Development of real numbers	53	13	1	1	49	9	3	4
Polynomials over a field	27	17	19	5	15	18	22	10
Determinants	18	31	17	2	17	29	17	2
Linear dependence	20	29	14	5	18	24	17	6
Topological spaces	3	19	43	3	2	19	30	14
Intro. to the theory of equations	28	28	10	2	38	20	3	4
Systems of linear equations	52	12	3	1	44	14	2	5
Intro. to linear programming	13	30	23	2	9	20	21	15
Solution on non-algebraic equations	13	28	20	7	11	18	19	17

[a]In this table the columns A, B, C, and N are to be read as follows: (A) Essential (B) Of considerable value (C) Of little value (N) Number of respondents not checking this item.

(continued)

Topics	Supervisor A	Supervisor B	Supervisor C	Supervisor N	Teacher A	Teacher B	Teacher C	Teacher N
GEOMETRY								
Fundamental concepts from a modern point of view	50	8	2	8	41	6	0	18
Order or betweenness	53	12	0	3	41	15	3	6
Congruence	64	1	1	2	59	4	0	2
Axioms of collinearity	53	11	0	4	37	15	3	10
Ceva's theorem	11	24	19	14	5	26	19	15
Menelaus' theorem	9	22	22	15	5	26	19	15
Desargue's theorem	13	21	23	11	8	24	20	13
Loci	61	5	0	2	46	15	0	4
Transformations of a plane	28	25	9	6	17	27	12	9
Selected topics on circles	46	14	4	4	30	25	5	5
Selected topics on triangles	47	13	4	4	33	22	5	5
Similarity	62	3	1	2	56	6	0	3
Area	57	8	1	2	52	9	0	4
Volume	53	9	3	3	47	13	1	4
Structure of deductive systems	58	6	2	2	44	13	1	7
Parallelism	58	8	0	2	46	12	0	7
Affine geometry	18	25	14	11	8	20	15	22
Introduction to non-Euclidean geometry	27	33	6	2	19	34	9	3
Finite geometries	23	32	11	2	15	30	10	10
Synthetic projective geometry	11	36	19	2	5	25	23	12
Analytic projective geometry	17	31	19	1	8	21	21	15
Harmonic arrays	4	23	34	7	3	21	29	12
Systems of circles	15	27	23	3	17	21	13	14
Inversion	14	31	19	4	10	25	20	10
Constructions	56	10	0	2	54	6	0	5
ANALYTIC GEOMETRY AND CALCULUS								
Functions of one variable, slope, intercept, etc.	63	3	1	1	49	8	5	3
Conic sections and their properties	53	11	3	1	35	23	4	3
Parametric equations	39	21	7	1	19	28	12	6
Hyperbolic functions	33	15	18	2	15	17	27	6
Functions of two variables	57	9	1	1	38	16	7	4
Planes and lines	56	8	2	2	47	11	4	3
Surfaces of revolution	34	24	9	1	17	23	20	5
Quadric surfaces	23	26	14	5	8	26	18	13
General equation of second degree	60	6	1	1	41	14	5	5
Functions and limits	52	11	3	2	29	23	8	5
Continuity	45	14	7	2	20	28	11	6
Derivatives of algebraic functions	39	14	14	1	18	20	22	5
Derivatives of polynomial curves	37	15	15	1	12	23	25	5
The differential	36	15	15	2	15	22	24	4
Derivatives of trig. functions	36	15	16	1	13	22	24	6
Derivatives of exponential and logarithmic functions	35	14	18	1	14	20	24	7

(continued)

Topics	Supervisor A	B	C	N	Teacher A	B	C	N
ANALYTIC GEOMETRY AND CALCULUS (cont.)								
Applications of the derivative:								
Maximum-minimum	44	13	9	2	24	18	18	5
Slope	51	11	5	1	35	18	8	4
Rate of change	47	14	6	1	25	20	16	4
Curvature	31	17	18	2	17	21	20	7
Indeterminant forms	32	14	19	3	10	24	23	8
Curve tracing	25	22	16	5	11	27	16	11
Newton's method of approximating real roots	23	29	15	1	5	32	22	6
Curve fitting	20	25	22	1	9	21	20	15
Partial differentiation and applications	17	23	24	4	7	19	32	7
Fundamental integration formulas	30	17	17	4	10	20	29	6
Integration by substitution	23	24	18	3	8	19	32	6
Integration by parts	23	22	20	3	7	21	31	6
Integration of rational fractions	24	21	20	3	9	18	32	6
Definite integrals	30	20	15	3	10	19	28	8
Improper integrals	17	29	17	5	7	20	30	8
Applications of integration:								
Volume	34	17	15	2	14	22	22	7
Arc length	31	16	18	3	12	23	23	7
Surface area	34	16	15	3	13	22	23	7
Plane area	33	19	14	2	14	20	23	8
Centroids	23	22	19	4	10	24	25	6
Moments of inertia	23	19	23	3	9	25	25	6
Double integral	16	15	33	4	5	18	35	7
Triple integral	11	19	33	5	3	19	34	9
Series of constant terms	21	16	25	6	12	17	26	10
Power series	23	18	23	4	13	19	25	8
Operations with power series	19	18	27	4	11	15	28	11
Approximate integration	13	18	30	7	9	16	26	14
STATISTICS								
Independent trials	27	19	15	7	14	13	23	15
Organization of data	33	17	11	7	15	11	24	15
Descriptive measures	27	18	16	7	10	14	24	17
Sampling	28	19	14	7	14	11	24	16
Functions on a sample space	23	16	19	10	9	9	30	17
Poisson distribution	14	21	22	11	6	8	30	21
Normal distribution	28	19	13	8	13	12	27	13
Binomial distribution	26	20	15	7	11	11	26	17
Statistical inference	27	16	17	8	11	30	8	16
Testing hypotheses	27	15	16	10	11	10	27	17
Chi-square	13	21	23	11	7	7	31	20
Correlation	25	15	18	10	10	7	31	17
Regression	13	20	23	12	5	6	31	23

(continued)

Topics	Supervisor				Teacher			
	A	B	C	N	A	B	C	N
FOUNDATIONS OF MATHEMATICS, ETC.								
Postulational reasoning	45	16	5	2	35	7	7	16
Development of number systems	54	10	2	2	42	5	6	12
Combinational theory	29	25	8	6	10	19	13	23
Algebra as a logical system	55	10	2	1	40	5	6	14
Modern aspects of calculation	48	16	2	2	20	20	9	16
Classical problems	31	27	8	2	21	17	10	17
Transfinite numbers	18	25	22	3	7	25	15	18
New applications of mathematics	47	17	3	1	32	9	6	18
New branches of mathematics	46	15	6	1	27	13	8	17

FREQUENCY DISTRIBUTIONS OF PRINCIPALS' RESPONSES
TO PART A OF THE QUESTIONNAIRE
(TEACHING MAJOR)

	Adequate	A Few Small Inadequacies	Some Serious Inadequacies
COURSE			
Traditional Algebra I	84	10	
Traditional Geometry	81	13	
Modern Algebra I	49	30	14
Modern Geometry	49	27	16
AREA OF INADEQUACY			
Algebra	76	15	2
Modern Mathematics	56	23	14
Geometry	70	16	7
Calculus	78	9	6
Logic and Sets	57	21	14
Probability and Statistics	64	18	11
Foundations of Mathematics	61	19	13
Areas Added by Respondents:			
History of Mathematics			2
Applications			1
Theory of Equations		1	
Modern Geometry			1
Integrated Mathematics			1

FREQUENCY DISTRIBUTIONS OF SUPERVISORS' RESPONSES
TO PART A OF THE QUESTIONNAIRE
(TEACHING MAJOR)

	Adequate	A Few Small Inadequacies	Some Serious Inadequacies
COURSE			
Traditional Algebra I	55	7	
Traditional Geometry	48	13	1
Modern Algebra I	26	25	11
Modern Geometry	24	23	15
AREA OF INADEQUACY			
Algebra	47	12	3
Modern Mathematics	32	19	10
Geometry	40	13	9
Calculus	49	8	4
Logic and Sets	31	15	15
Probability and Statistics	43	4	14
Foundations of Mathematics	30	17	14

FREQUENCY DISTRIBUTIONS OF TEACHERS' RESPONSES
TO PART A OF THE QUESTIONNAIRE
(TEACHING MAJOR)

	Adequate	A Few Small Inadequacies	Some Serious Inadequacies
COURSE			
Traditional Algebra I	58	4	
Traditional Geometry	51	10	1
Modern Algebra I	32	26	5
Modern Geometry	26	26	11
AREA OF INADEQUACY			
Algebra	53	8	1
Modern Mathematics	34	19	9
Geometry	39	16	7
Calculus	52	8	1
Logic and Sets	39	12	11
Probability and Statistics	41	12	9
Foundations of Mathematics	36	12	12
Areas Added by Respondents:			
History of Mathematics			1
Applications			1
Analytic Geometry		1	

FREQUENCY DISTRIBUTIONS OF PRINCIPALS' RESPONSES
TO PART B OF THE QUESTIONNAIRE
(TEACHING MINOR)

	Adequate	A Few Small Inadequacies	Some Serious Inadequacies
COURSE			
Traditional Algebra I	63	16	9
Traditional Geometry	53	25	11
Modern Algebra I	24	33	31
Modern Geometry	21	34	32
AREA OF INADEQUACY			
Algebra	58	17	8
Modern Mathematics	33	27	25
Geometry	50	18	16
Calculus	56	9	17
Logic and Sets	34	22	28
Probability and Statistics	44	15	24
Foundations of Mathematics	40	20	25
Areas Added by Respondents:			
History of Mathematics		1	2
Applications		1	1
Inequalities		1	
Introduction to Mod. Abstract Alg.		1	

FREQUENCY DISTRIBUTIONS OF SUPERVISORS' RESPONSES
TO PART B OF THE QUESTIONNAIRE
(TEACHING MINOR)

	Adequate	A Few Small Inadequacies	Some Serious Inadequacies
COURSE			
Traditional Algebra I	35	18	6
Traditional Geometry	29	22	8
Modern Algebra I	9	23	27
Modern Geometry	8	21	29
AREA OF INADEQUACY			
Algebra	31	17	7
Modern Mathematics	17	15	24
Geometry	22	15	19
Calculus	38	4	13
Logic and Sets	16	11	28
Probability and Statistics	28	4	23
Foundations of Mathematics	18	9	28
Areas Added by Respondents:			
History of Mathematics		2	
Theory of Numbers			1
Depth of Background			1

FREQUENCY DISTRIBUTIONS OF TEACHERS' RESPONSES
TO PART B OF THE QUESTIONNAIRE
(TEACHING MINOR)

	Adequate	A Few Small Inadequacies	Some Serious Inadequacies
COURSE			
Traditional Algebra I	45	8	2
Traditional Geometry	33	17	5
Modern Algebra I	11	22	22
Modern Geometry	7	20	28
AREA OF INADEQUACY			
Algebra	40	14	1
Modern Mathematics	19	17	19
Geometry	23	17	14
Calculus	37	13	5
Logic and Sets	21	11	23
Probability and Statistics	22	13	19
Foundations of Mathematics	24	6	24
Areas Added by Respondents:			
History of Mathematics		1	1
Analytic Geometry		1	

APPENDIX B

SIGNIFICANCE OF DIFFERENCES OF OPINION BETWEEN SUPERVISORS AND TEACHERS IN SECTION TWO

DIFFERENCES BETWEEN TEACHERS' AND SUPERVISORS' DISTRIBUTIONS AT THE VARIOUS INTERVALS AND THEIR LEVELS OF SIGNIFICANCE OF THE TOPICS LISTED UNDER ALGEBRA AND MODERN MATHEMATICS

Topics	A'	A'+F'	Level of Significance			
			ns	.10	.05	.01
Relations	-.213	-.019	ns			
Intro. to the theory of equations	+.199	+.102	ns			
Fields	-.192	-.053	ns			
Polynomials over a field	-.156	-.098	ns			
Integral domain	-.105	-.137	ns			
Progression	-.131	-.026	ns			
Mapping	-.130	+.017	ns			
Complex numbers	-.118	-.023	ns			
Cardinal numbers	-.115	+.003	ns			
Axiomatic foundations for algebra	-.092	-.001	ns			
Markov chains	+.087	-.049	ns			
Logic	+.080	+.043	ns			
Binomial theorem	+.075	+.018	ns			
Topological spaces	-.007	+.074	ns			
Isomorphisms	-.073	+.019	ns			
Inequalities	+.072	.000	ns			
Intro. to linear programming	-.017	+.072	ns			
Rings	-.054	-.071	ns			
Ideals	+.071	+.016	ns			
Solution on non-algebraic equations	+.016	-.068	ns			
Linear dependence	-.012	-.066	ns			
Combinations and permutations	-.065	-.010	ns			
Finite induction	-.049	+.064	ns			
Variation	-.052	+.029	ns			
Equivalence	-.052	-.003	ns			
Operations other than +,-,x,-	-.049	-.008	ns			
Function concept	-.046	-.001	ns			
Systems of linear equations	-.043	+.012	ns			
Groups	+.039	+.038	ns			
Sets	+.036	-.032	ns			
Probability	-.020	+.034	ns			
Development of real numbers	+.012	+.034	ns			
Rational numbers	-.018	.000	ns			
Ratio	-.010	-.017	ns			
Determinants	-.003	-.012	ns			
Proportion	-.009	-.001	ns			

ns = not significant

DIFFERENCES BETWEEN TEACHERS' AND SUPERVISORS' DISTRIBUTIONS AT THE VARIOUS INTERVALS AND THEIR LEVELS OF SIGNIFICANCE OF THE TOPICS LISTED UNDER GEOMETRY

Topics	A'	A'+F'	Level of Significance			
			ns	.10	.05	.01
Selected topics on circles	-.219	-.021		.10		
Selected topics on triangles	-.184	-.021	ns			
Loci	-.170	.000	ns			
Axioms of collinearity	-.155	-.055	ns			
Transformations of a plane	-.148	-.069	ns			
Synthetic projective geometry	-.073	-.146	ns			
Analytic projective geometry	-.094	-.136	ns			
Affine geometry	-.130	-.103	ns			
Order or betweenness	-.120	-.051	ns			
Structure of deductive systems	-.120	+.013	ns			
Ceva's theorem	-.104	-.028	ns			
Introduction to non-Euclidean geometry	-.103	-.054	ns			
Systems of circles	+.102	+.099	ns			
Parallelism	-.086	.000	ns			
Finite geometries	-.075	-.015	ns			
Desargue's theorem	-.074	+.019	ns			
Menelaus' theorem	-.070	+.035	ns			
Inversion	-.037	-.067	ns			
Constructions	+.051	.000	ns			
Volume	-.045	+.030	ns			
Fundamental concepts from a modern point of view	+.039	+.033	ns			
Similarity	-.036	+.015	ns			
Congruence	-.033	+.015	ns			
Area	-.012	+.015	ns			
Harmonic arrays	-.009	+.010	ns			

ns = not significant

DIFFERENCES BETWEEN TEACHERS' AND SUPERVISORS' DISTRIBUTIONS AT THE VARIOUS INTERVALS AND THEIR LEVELS OF SIGNIFICANCE OF THE TOPICS LISTED UNDER ANALYTIC GEOMETRY AND CALCULUS

Topics	A'	A'+F'	Level of Significance			
			ns	.10	.05	.01
Derivatives of polynomial curves	-.352	-.193				.01
Continuity	-.343	-.080				.01
Indeterminant forms	-.317	-.112				.01
Derivatives of trig. functions	-.317	-.168				.01
Functions and limits	-.305	-.088				.01
Fundamental integration formulas	-.300	-.226				.01
The differential	-.299	-.166				.01
Surface area	-.299	-.166				.01
Rate of change	-.291	-.172				.01
Definite integrals	-.287	-.260			.05	
Derivatives of algebraic functions	-.282	-.156			.05	
Derivatives of exponential and logarithmic functions	-.281	-.145			.05	
Volume	-.274	-.152			.05	
Arc length	-.270	-.120			.05	
Maximum-minimum	-.267	-.164			.05	
Integration by substitution	-.218	-.265			.05	
Parametric equations	-.260	-.099			.05	
Newton's method of approximating real roots	-.258	-.149			.05	
Improper integrals	-.147	-.256			.05	
Hyperbolic functions	-.246	-.185			.05	
Integration by parts	-.235	-.217		.10		
Integration of rational fractions	-.216	-.234		.10		
Functions of two variables	-.228	-.100		.10		
Conic sections and their properties	-.226	-.020		.10		
Surfaces of revolution	-.224	-.199		.10		
General equation of second degree	-.213	-.068	ns			
Quadric surfaces	-.211	-.124	ns			
Moments of inertia	-.201	-.070	ns			
Curve tracing	-.193	-.042	ns			
Plane area	-.046	-.192	ns			
Centroids	-.190	-.127	ns			
Slope	-.187	-.056	ns			
Curvature	-.177	-.072	ns			
Partial differentiation and applications	-.145	-.177	ns			
Double integral	-.164	-.087	ns			

(continued)

Topics	A'	A'+F'	Level of Significance			
			ns	.10	.05	.01
Functions of one variable, slope, intercept, etc.	-.150	-.066	ns			
Power series	-.131	-.080	ns			
Triple integral	-.121	-.083	ns			
Series of constant terms	-.121	-.070	ns			
Curve fitting	-.118	-.072	ns			
Operations with power series	-.093	-.097	ns			
Planes and lines	-.091	-.035	ns			
Approximate integration	-.037	-.018	ns			

ns = not significant

DIFFERENCES BETWEEN TEACHERS' AND SUPERVISORS' DISTRIBUTIONS AT THE VARIOUS INTERVALS AND THEIR LEVELS OF SIGNIFICANCE OF THE TOPICS LISTED UNDER STATISTICS

Topics	A'	A'+F'	Level of Significance			
			ns	.10	.05	.01
Correlation	-.223	-.336				.01
Regression	-.113	-.327			.05	
Normal distribution	-.217	-.302			.05	
Organization of data	-.241	-.300			.05	
Functions on a sample space	-.210	-.297			.05	
Poisson distribution	-.110	-.296			.05	
Binomial distribution	-.197	-.296			.05	
Testing hypotheses	-.237	-.287			.05	
Chi-square	-.072	-.285			.05	
Sampling	-.173	-.260		.10		
Descriptive measures	-.235	-.238		.10		
Statistical inference	-.226	-.120	ns			
Independent trials	-.163	-.214	ns			

ns = not significant

DIFFERENCES BETWEEN TEACHERS' AND SUPERVISORS' DISTRIBUTIONS AT THE VARIOUS INTERVALS AND THEIR LEVELS OF SIGNIFICANCE OF THE TOPICS LISTED UNDER FOUNDATIONS OF MATHEMATICS, ETC.

Topics	A'	A'+F'	Level of Significance			
			ns	.10	.05	.01
Modern aspects of calculation	-.319	-.154				.01
Combinational theory	-.230	-.181	ns			
Transfinite numbers	-.128	+.019	ns			
New branches of mathematics	-.125	-.077	ns			
Classical problems	-.033	-.087	ns			
Algebra as a logical system	-.037	-.088	ns			
Development of number systems	-.026	-.083	ns			
New applications of mathematics	-.020	-.083	ns			
Postulational reasoning	+.032	-.067	ns			

ns = not significant

APPENDIX C

POSITION OF MEDIAN RESPONSES TO TOPICS IN SECTION TWO

POSITION OF THE MEDIAN RESPONSE IN EVALUATING THE TOPICS IN ALGEBRA AND MODERN MATHEMATICS[a]

Topics	Super-visors	Teachers	Super-visors Teachers
Sets	A	A	A
Ratio	A	A	A
Variation	A	A	A
Proportion	A	A	A
Inequalities	A	A	A
Logic	A	A	A
Relations	A	A	A
Operations other than +,-,x,÷	A	A	A
Equivalence	A	A	A
Rational numbers	A	A	A
Function concept	A	A	A
Axiomatic foundations for algebra	A	A	A
Development of real numbers	A	A	A
Systems of linear equations	A	A	A
Complex numbers	A	A-B	A
Intro. to the theory of equations	B	A	A
Binomial theorem	B	A	B
Progression	B	B	B
Cardinal numbers	B	B	B
Mapping	B	B	B
Groups	B	B	B
Isomorphisms	B	B	B
Integral domain	B	B	B
Finite induction	B	B	B
Combinations and permutations	B	B	B
Probability	B	B	B
Fields	B	B	B
Polynomials over a field	B	B	B
Determinants	B	B	B
Linear dependence	B	B	B
Intro. to linear programming	B	B	B
Solution on non-algebraic equations	B	B	B
Markov chains	C	C	C
Rings	C	C	C
Ideals	C	C	C
Topological spaces	C	C	C

[a]In this table the letters A, B, and C are to be read as follows: (A) Essential (B) Of considerable value (C) Of little value.

POSITION OF THE MEDIAN RESPONSE IN EVALUATING THE TOPICS IN GEOMETRY[a]

Topics	Super-visors	Teachers	Super-visors Teachers
Fundamental concepts from a modern point of view	A	A	A
Order or betweenness	A	A	A
Congruence	A	A	A
Axioms of collinearity	A	A	A
Loci	A	A	A
Selected topics on triangles	A	A	A
Similarity	A	A	A
Area	A	A	A
Volume	A	A	A
Structure of deductive systems	A	A	A
Parallelism	A	A	A
Constructions	A	A	A
Selected topics on circles	A	A-B	A
Menelaus' theorem	B	B	B
Desargue's theorem	B	B	B
Transformations of a plane	B	B	B
Affine geometry	B	B	B
Introduction to non-Euclidean geometry	B	B	B
Finite geometries	B	B	B
Synthetic projective geometry	B	B	B
Analytic projective geometry	B	B	B
Systems of circles	B	B	B
Inversion	B	B	B
Ceva's theorem	B	B	B
Harmonic arrays	C	C	C

[a]In this table the letters A, B, and C are to be read as follows: (A) Essential (B) Of considerable value (C) Of little value.

POSITION OF THE MEDIAN RESPONSE IN EVALUATING THE TOPICS IN ANALYTIC GEOMETRY AND CALCULUS[a]

Topics	Supervisors	Teachers
Functions of one variable, slope, intercept, etc.	A	A
Conic sections and their properties	A	A
Functions of two variables	A	A
Planes and lines	A	A
General equation of second degree	A	A
Slope	A	A
Parametric equations	A	B
Hyperbolic functions	A	B
Surfaces of revolution	A	B
Functions and limits	A	B
Continuity	A	B
Derivatives of algebraic functions	A	B
Derivatives of polynomial curves	A	B
The differential	A	B
Derivatives of trig. functions	A	B
Derivatives of exponential and logarithmic functions	A	B
Maximum-minimum	A	B
Rate of change	A	B
Volume	A	B
Surface area	A	B
Plane area	A-B	B
Quadric surfaces	B	B
Curvature	B	B
Indeterminant forms	B	B
Curve tracing	B	B
Newton's method of approximating real roots	B	B
Curve fitting	B	B
Fundamental integration formulas	B	B
Definite integrals	B	B
Arc length	B	B
Centroids	B	B
Moments of inertia	B	B
Series of constant terms	B	B
Power series	B	B
Partial differentiation and applications	B	C
Integration by substitution	B	C

[a]In this table the letters A, B, and C are to be read as follows: (A) Essential (B) Of considerable value (C) Of little value.

(continued)

Topics	Supervisors	Teachers
Integration by parts	B	C
Integration of rational fractions	B	C
Improper integrals	B	C
Operations with power series	B	C
Approximate integration	B	C
Double integral	C	C
Triple integral	C	C

POSITION OF THE MEDIAN RESPONSE IN EVALUATING THE TOPICS IN STATISTICS[a]

Topics	Supervisors	Teachers
Organization of data	A	B
Independent trials	B	B
Sampling	B	B
Statistical inference	B	B
Descriptive measures	B	B-C
Functions on a sample space	B	C
Poisson distribution	B	C
Normal distribution	B	C
Binomial distribution	B	C
Testing hypotheses	B	C
Chi-square	B	C
Correlation	B	C
Regression	B	C

[a]In this table the letters A, B, and C are to be read as follows: (A) Essential (B) Of considerable value (C) Of little value.

POSITION OF THE MEDIAN RESPONSE IN EVALUATING THE TOPICS IN FOUNDATIONS OF MATHEMATICS, ETC.[a]

Topics	Supervisors	Teachers	Supervisors Teachers
Postulational reasoning	A	A	A
Development of number systems	A	A	A
Algebra as a logical system	A	A	A
New applications of mathematics	A	A	A
New branches of mathematics	A	A	A
Modern aspects of calculation	A	B	A
Combinational theory	B	B	B
Classical problems	B	B	B
Transfinite numbers	B	B	B

[a]In this table the letters A and B are to be read as follows: (A) Essential (B) Of considerable value.

APPENDIX D

MAX RAFFERTY
Superintendent of Public Instruction
and Director of Education

STATE OF CALIFORNIA
DEPARTMENT OF EDUCATION
721 CAPITOL MALL, SACRAMENTO 95814

October 1, 1964

Mr. Parshall L. Howe
Pacific Union College
Angwin, California

Dear Mr. Howe:

Thank you for supplying us with the final draft of the questionnaires to be used in your study of recent preparation of mathematics teachers. We have given great emphasis in this Bureau to the improvement of mathematics instruction in California high schools. The function of the teacher is of prime importance in changes that result in program improvement. For this reason it is obvious that we are interested in the study you are pursuing. We trust that the suggestions we have had the opportunity to make concerning your study will prove to be useful as the data is collected and summarized. We have added confidence in the study by virtue of the fact that your advising professor is not only a capable mathematician but has played a leading role in the upgrading of mathematics instruction and the training of mathematics teachers.

As you are aware, the Department sponsors only those studies in which it is definitely engaged. If you believe it to be useful to have this letter duplicated as an introductory step to those from whom you are seeking responses, we would be happy to provide this small assistance.

Furthermore, we would hope that your findings, conclusions and recommendations may be reasonably available to all of the persons in California education who may profit from them. At an appropriate time we would like to hear from you with respect to possible ways of reporting upon your study.

Sincerely yours,

Frank B. Lindsay

Frank B. Lindsay, Chief
Bureau of Secondary Education

FBL:glr:mb

(Copy of the letter which accompanied the questionnaires sent to the principals)

Mr. John Doe
Franklin High School
210 Pine Street
Smithville, California

Dear Mr. Doe:

Your help is urgently needed. May I have your opinion on an important question?-- Is the beginning mathematics teacher prepared to do a good job of teaching Algebra I and Geometry? I am engaged in a research project that seeks to find out the kind and amount of mathematics needed to prepare up-to-date teachers of courses up through 10th grade Geometry.

By your check marks (two dozen or less) on the enclosed forms will you please indicate your opinion of the adequacy of the teaching major and the teaching minor in mathematics. This project is limited to an inquiry into the effectiveness of the preparation of teachers who completed the certification requirements at a California state college in the past two to six years. Also restrict your consideration to a program for teachers who are not to teach courses beyond Algebra I and Geometry.

While answering, please let the idea minimum but adequate be your guide. The program should not be unduly lengthy causing many talented persons to reject the idea of teaching mathematics. However, it should be adequate to prepare teachers who can do an effective job.

During the processing of the replies, the identifying number will be removed and the responses will not be further identified with the respondents. If you would like a summary of the results of this questionnaire, I will be glad to send you one.

Your participation in this study is needed and will be valued and greatly appreciated.

Respectfully yours,

P. L. Howe

PLH:dif

(Copy of the letter which accompanied the questionnaires sent to the supervisors)

Mr. Thomas Jones
Franklin High School
210 Pine Street
Smithville, California

Dear Mr. Jones:

Your help is urgently needed. May I have your opinion on an important question?--Is the beginning mathematics teacher prepared to do a good job of teaching Algebra I and Geometry? I am engaged in a research project that seeks to find out the kind and amount of mathematics needed to prepare up-to-date teachers of courses up through 10th grade Geometry.

By your check marks on the enclosed forms will you please indicate your opinion of the adequacy of the teaching major and the teaching minor in mathematics. Also indicate the topics in mathematics that you recommend should be included in the curriculum to prepare one to teach effectively courses up to and including Algebra I and Geometry. This project is limited to an inquiry into the effectiveness of the preparation of teachers who completed the certification requirements at a California state college in the past two to six years.

While answering, please let the idea minimum but adequate be your guide. The program should not be unduly lengthy causing many talented persons to reject the idea of teaching mathematics. However, it should be adequate to prepare teachers who can do an effective job.

During the processing of the replies, the identifying number will be removed and the responses will not be further identified with the respondents. If you would like a summary of the results of this questionnaire, I will be glad to send you one.

Your participation in this study is needed and will be valued and greatly appreciated.

Respectfully yours,

P. L. Howe

PLH:dif

(Copy of the letter which accompanied the questionnaires sent to the teachers)

Mr. Samuel Smith
Franklin High School
210 Pine Street
Smithville, California

Dear Mr. Smith:

Your help is urgently needed. May I have your opinion on an important question?--Do you feel that the teacher-education curricula are doing a completely adequate job of preparing teachers of Algebra I and Geometry? I am engaged in a research project that seeks to find out the kind and amount of mathematics needed to prepare up-to-date teachers of courses up through 10th grade Geometry.

By your check marks on the enclosed forms will you please indicate your opinion of the adequacy of the teaching major and the teaching minor in mathematics. Also indicate the topics in mathematics that you recommend should be included in the curriculum to prepare one to teach effectively courses up to and including Algebra I and Geometry.

While answering please let the idea <u>minimum but adequate</u> be your guide. The program should <u>not be unduly lengthy</u> causing many talented persons to reject the idea of teaching mathematics. However, it should be adequate to prepare teachers who can do an effective job.

During the processing of the replies the identifying number will be removed and the responses will not be further identified with the respondents. If you would like a summary of the results of this questionnaire, I will be glad to send you one.

Your participation in this study is needed and will be valued and greatly appreciated.

Respectfully yours,

Parshall Howe

PH:df

TEACHER EDUCATION IN CALIFORNIA

Part A

The Teaching Major of the State College as a Preparation for the Teaching of Algebra I and Geometry

Do you feel that the content in mathematics of the teacher-education curriculum (teaching major in mathematics) is adequate preparation for the teaching of secondary mathematics up to and including Algebra I and Geometry (traditional and "modern")? Check once for each course.

	Major is adequate	Major has a few small inadequacies	Major has some serious inadequacies
For Trad. Alg. I.			
For Trad. Geom.			
For "Modern" Alg. I			
For "Modern" Geom.			

If you feel that inadequacies in the curriculum exist, please check the areas of these inadequacies. You may add to the list and check as needed.

	A few small inadequacies	Some serious inadequacies
Algebra		
Modern Mathematics		
Geometry		
Calculus		
Logic and Sets		
Probability and Statistics		
Foundations of Mathematics		

Part B

The Teaching Minor of the State College as Preparation for the Teaching of Algebra I and Geometry

Do you feel that the content in mathematics of the teacher-education curriculum (teaching minor in mathematics) is adequate preparation for the teaching of secondary mathematics up to and including Algebra I and Geometry (traditional and "modern")? Check once for each course.

	Minor is adequate	Minor has a few small inadequacies	Minor has some serious inadequacies
For Trad. Alg. I			
For Trad. Geom.			
For "Modern" Alg. I			
For "Modern" Geom.			

If you feel that inadequacies in the curriculum exist, please check the areas of these inadequacies. You may add to the list and check as needed.

	A few small inadequacies	Some serious inadequacies
Algebra		
Modern Mathematics		
Geometry		
Calculus		
Logic and Sets		
Probability and Statistics		
Foundations of Mathematics		

Please check if you wish a summary of the results. ( )

Please check to the left if you studied the topic as a part of your credential requirement; check to the right to classify each topic as follows:

A. Essential to the "minimum but adequate" preparation for effective teaching of Algebra I and Geometry.

B. Of considerable value, but not essential to the "minimum but adequate" preparation for effective teaching of Algebra I and Geometry.

C. Of little value in the "minimum but adequate" preparation for effective teaching of Algebra I and Geometry.

C Of little value

B Of considerable value

A Essential

ALGEBRA AND MODERN MATHEMATICS

		A	B	C
	Sets			
	Ratio			
	Variation			
	Proportion			
	Inequalities			
	Progression			
	Logic			
	Cardinal numbers			
	Mapping			
	Relations			
	Operations other than $+$, $-$, $\times$, $\div$			
	Equivalence			
	Groups			
	Isomorphisms			
	Integral domain			
	Rational numbers			
	Complex numbers			
	Function concept			
	Finite induction			
	Binomial theorem			
	Combinations and permutations			
	Probability			
	Markov chains			
	Axiomatic foundations for algebra			

ALGEBRA AND MODERN MATHEMATICS (cont.)

		A	B	C
	Rings			
	Ideals			
	Fields			
	Development of real numbers			
	Polynomials over a field			
	Determinants			
	Linear dependence			
	Topological spaces			
	Intro. to the theory of equations			
	Systems of linear equations			
	Intro. to linear programming			
	Solution on non-algebraic equations			
	Add other topics, if needed, at end of questionnaire.			

GEOMETRY

	Fundamental concepts from a modern point of view			
	Order or betweenness			
	Congruence			
	Axioms of collinearity			
	Ceva's theorem			
	Menelaus' theorem			
	Desargue's theorem			
	Loci			
	Transformations of a plane			
	Selected topics on circles			
	Selected topics on triangles			
	Similarity			
	Area			
	Volume			
	Structure of deductive systems			
	Parallelism			
	Affine geometry			
	Introduction to non-Euclidean geometry			
	Finite geometries			

GEOMETRY (cont.)

		A	B	C
	Synthetic projective geometry			
	Analytic projective geometry			
	Harmonic arrays			
	Systems of circles			
	Inversion			
	Constructions			

ANALYTIC GEOMETRY AND CALCULUS

	Functions of one variable, slope, intercept, etc.			
	Conic sections and their properties			
	Parametric equations			
	Hyperbolic functions			
	Functions of two variables			
	Planes and lines			
	Surfaces of revolution			
	Quadric surfaces			
	General equation of second degree			
	Functions and limits			
	Continuity			
	Derivatives of algebraic functions			
	Derivatives of polynomial curves			
	The differential			
	Derivatives of trig. functions			
	Derivatives of exponential and logarithmic functions			
	Applications of the derivative: Maximum-minimum			
	Slope			
	Rate of change			
	Curvature			
	Indeterminant forms			
	Curve tracing			
	Newton's method of approximating real roots			
	Curve fitting			

ANALYTIC GEOMETRY AND CALCULUS (cont.)

		A	B	C
	Partial differentiation and applications			
	Fundamental integration formulas			
	Integration by substitution			
	Integration by parts			
	Integration of rational fractions			
	Definite integrals			
	Improper integrals			
	Applications of integration: Volume			
	Arc length			
	Surface area			
	Plane area			
	Centroids			
	Moments of inertia			
	Double integral			
	Triple integral			
	Series of constant terms			
	Power series			
	Operations with power series			
	Approximate integration			

STATISTICS

	Independent trials			
	Organization of data			
	Descriptive measures			
	Sampling			
	Functions on a sample space			
	Poisson distribution			
	Normal distribution			
	Binomial distribution			
	Statistical inference			
	Testing hypotheses			
	Chi-square			
	Correlation			
	Regression			

FOUNDATIONS OF MATHEMATICS, ETC.

		A	B	C
	Postulational reasoning			
	Development of number systems			
	Combinational theory			
	Algebra as a logical system			
	Modern aspects of calculation			
	Classical problems			
	Transfinite numbers			
	New applications of mathematics			
	New branches of mathematics			

The topics that you have checked in answering this questionnaire would be needed in the preparation of teachers of (check one)

( ) traditional Alg. I and Geometry
( ) "modern" Alg. I and Geometry
( ) both traditional and "modern" Alg. I and Geometry

What was the status of your credential with respect to mathematics? (Please check one)

Teaching major in mathematics ( )
Teaching minor in mathematics ( )

Approximately how many semester hours (units) in mathematics did you have when you applied for your credential? ( )

When did you receive your four-year degree? ( )

When did you receive your first secondary teaching credential? ( )

Have you attended a NSF mathematics institute? Yes ( ), No ( ).

Have you taught a modern mathematics course? Yes ( ), No ( ). If so, what text(s) did you use?

SMSG ( ), UICSM ( ), Ball State ( ), Others____________________.

What secondary mathematics classes have you taught?

Gen. Math. ( ), Alg. I ( ), Geom. ( ), Alg. II ( ), Trig. ( ),
Others____.

(Copy of the letter sent to a school officer when the California School Directory did not designate the department head)

Mr. Henry Johnson
Franklin High School
210 Pine Street
Smithville, California

Dear Mr. Johnson:

I am interested in securing the name of the head of the mathematics department of your high school. The 1963-1964 California School Directory does not give this information. If this information was omitted because there is no departmental organization, then I would like to have the name and office address of the curriculum adviser or superintendent who is versed in mathematics and understands the needs of those who teach mathematics in your school.

Your assistance in supplying this information will be appreciated. For your convenience, a self-addressed envelope is enclosed.

Respectfully yours,

P. L. Howe

PLH:dif

(Copy of reminder card sent to those who delayed in responding to the questionnaires)

Angwin, California
December 15, 1964

Dear Sir:

Did that questionnaire about teachers of Algebra and Geometry get put into a desk drawer out of sight? If it did, will you please dig it out, check it, and send it back.

Respectfully yours,

P. L. Howe

APPENDIX E

TEACHERS' PREPARATION AND EXPERIENCE

SUMMARY OF TEACHER RESPONSES TO SECTION THREE
OF THE QUESTIONNAIRE

1. Educational background:

83.1% had a major in mathematics with an average of 44.2 units

16.9 had a minor in mathematics with an average of 25.5 units

43.1 had attended a NSF institute

The average date of receiving four-year degree was 1959.5

The average date of first sec. teaching cred. was 1960.9

2. Teaching experience:

93.6% had taught modern courses in mathematics

73.3 had taught from SMSG textbooks

4.6 had taught from Ball State textbooks

3.1 had taught from UISCM textbooks

32.3 had taught from other modern textbooks

98.5 had taught Geometry

92.3 had taught Algebra I

75.4 had taught Algebra II

100.0 had taught either Algebra I or Algebra II

72.3 had taught General Mathematics

46.2 had taught trigonometry

40.0 had taught other secondary courses in mathematics

3. Point of view of respondent:

0.0% had in mind teachers of trad. Algebra I and Geometry

9.8 had in mind teachers of modern Algebra I and Geometry

91.2 had in mind teachers of both traditional and modern Algebra I and Geometry

VITA

Parshall Lyndon Howe

Candidate for the Degree of

Doctor of Education

Thesis: A STUDY OF THE EFFECTIVENESS OF THE CURRICULA OF THE CALIFORNIA STATE COLLEGES AS A PRE-SERVICE PREPARATION TO TEACH ALGEBRA I AND GEOMETRY

Major Field: Higher Education - Mathematics

Biographical:

Personal Data: Born in Otsego, Michigan, December 20, 1913, the son of Homer D. and Eva P. Howe.

Education: Received the Bachelor of Arts degree from Pacific Union College, Angwin, California, in 1936; attended summer sessions at the following California schools: Pasadena Junior College, Modesto Junior College, University of California, Berkeley, Stanford University, Palo Alto; received the Master of Arts degree from Pacific Union College, with a major in mathematics, in August, 1953; completed the requirements for the Doctor of Education degree at Oklahoma State University in May, 1966.

Professional Experiences: Taught science and mathematics at Kern Academy, Shafter, California, 1936-1937; engaged in educational and general mission work in Ruanda-Urundi for the Seventh-day Adventist church, 1937-1943; taught science and/or mathematics at Middle East College, Beirut, Lebanon, 1943-1944, Modesto Union Academy, Modesto, California, 1944-1945, Golden Gate Academy, Berkeley, California, 1945-1948, Pacific Union College Preparatory School, Angwin, California, 1948-1964, with one year leave of absence for graduate study at Oklahoma State University; currently teaching mathematics at Pacific Union College, Angwin, California.

Professional Organizations: Member of Mathematics Association of America, National Council of Teachers of Mathematics, Central Association of Science and Mathematics Teachers, Pi Mu Epsilon.