THE MATHEMATICS CURRICULUM FOR THE SENIOR MATH PROGRAM IN IOWA HIGH SCHOOLS

A Field Report

Presented to

The School of Graduate Studies

Drake University

In Partial Fulfillment

of the Requirements for the Degree

Master of Science in Education

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by

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January 1970

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CHAPTER I

I. INTRODUCTION

The principal of the school is responsible for the curriculum in that school. It is important that, as the administrator, the principal be aware of what is being taught in each course.

In recent years, much of our mathematics curriculum has been re-structured and re-organized. Some schools now teach algebra in the eighth grade; some teach calculus at the senior level; some stress trigonometry; some say it is not important to teach trigonometry as a course. Some educators feel we should expand mathematics curriculum horizontally instead of vertically; some advocate the exact opposite.[1]

With the perfection of the computer, mathematics has blossomed like no other field. Never before in the history of man has there been a greater need for mathematicians. This has placed a stress on different phases of mathematics. To train the youth is the purpose of our schools; to guide the curriculum in the proper direction is one of the responsibilities of the principal. To meet this responsibility

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[1]Angus E. Taylor, "Convention and Revolt in Mathematics," The Mathematics Teacher, LV (January, 1962), 7-9.

the principal needs a guideline to aid him in directing his mathematics curriculum.

II. STATEMENT OF THE PROBLEM

The problem is to develop a guideline for secondary school administrators to use in evaluating their senior math program.

III. NEED

In the State of Iowa, there exists a lack of communications on what is the actual course content of the various subjects. The State Department of Public Instruction does survey the courses that are being offered in the various schools, but their research only shows the names of the courses and not the actual course content.

College professors, high school administrators, high school mathematics teachers, the public in general, and anyone else who is interested in the mathematical education of our high school students may be interested in a report such as this.

IV. DEFINITIONS OF TERMS USED

The following terms appear in the context of this study and for the sake of clarity are here defined:

Course content. Course content contains all topics and subtopics covered in the course.

Course description. Course description refers to an item analysis which lists the topics covered in the course.

Senior math. Senior math designates the course beyond that of algebra II and/or trigonometry.

V. LIMITATIONS

Research shows that high school pupils can learn many of the concepts traditionally reserved for the college students.[1] This means that most "new" topics will be introduced in the senior mathematics program.

The three major mathematics curriculum groups, S.M.S.G., U.I.C.S.M., and C.E.E.B., generally agree on curriculum content through the first half of grade twelve. Each of these three groups has developed a different course for the second half of the senior course.[2]

It is evident that the modernization of mathematics has caused problems at the senior math level. For this reason, only the senior math curriculum will be analyzed.

Since diversity, if it is to occur, will occur more readily in a larger school, research data for this study will be obtained from the forty largest high schools in the state of Iowa.

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[1]Kenneth E. Brown and Theodore L. Abell, "Research in the Teaching of High School Mathematics," The Mathematics Teacher, LIX (January, 1966), 56.

[2]John J. Kensella, Secondary School Mathematics (New York: The Center for Applied Research in Education, Inc., 1965), p. 66.

VI. REVIEW OF THE LITERATURE

The research for this study has been selected to demonstrate the variety of programs that now exist. These programs will vary in criteria used, course content, or in both.

Streitmatter and Rockwood reported on the mathematics program at Rocky River, Ohio. In Rocky River, a suburb of Cleveland, approximately 85 per cent of the high school graduates enter college. Calculus has always been offered to the mathematically mature. The problem occurred among those who were better than average and not quite mature enough to study calculus.[1]

This new high ability course was established using the rationale ". . . the process of learning mathematics is more important than the course content. Mathematics is a subject discipline that can grow, not one that should be memorized or covered."[2]

The course content that was developed contained the following:

Analytic Geometry
1. Curve sketching by use of asymptotes
2. Excluded regions
3. Transcendental curves
4. Polar coordinates
5. Parametric and empirical equations

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[1]Kenneth Streitmatter and Gerald J. Rockwood, "Twelfth Grade High School Mathematics: Calculus or ?," The Mathematics Teacher, LXI (January, 1968), 39.

[2]Ibid.

Probability
1. Order (permutations-combinations)
2. Experimentation
   a. coin tossing
   b. die rolling
   c. card dealing
3. Conditional probability
4. Set theory (as related to probability)

Structural (abstract) Algebra
1. Matricies compared to real numbers
2. Properties of a group, ring, field as related to a 2x2 matrix
3. Proof of the first twelve theorems of algebra[1]

The students seemed very interested in this course. Also, many of these students placed high in their college placement tests. Streitmatter and Rockwood felt that this course has been a success.[2]

It is generally agreed that one of the finest public high schools in our nation is that in Newton, Massachusetts. The senior mathematics curriculum at Newton has evolved from the use of U.I.C.S.M. program in 1957 and the S.M.S.G. program in 1959. Their present program consists of two tracks and supporting courses.[3]

Track I is an accelerated course, so those taking it may take the C.E.E.B. advanced placement B.C. and A.B. examinations. Topics are chosen for each class to supplement where the class seems weak or where more emphasis is needed.

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[1] Ibid., p. 40.

[2] Ibid., p. 41.

[3] W. Eugene Ferguson, "Mathematics in Newton," The Bulletin of the National Association of Secondary School Principals, LII (April, 1968), 57-62.

The results of this program were not available at the time this article was written.[1]

Track II was designed for the above average student. Pre-calculus was emphasized with elementary functions, vectors, analytic geometry, limits, series, and an introduction to calculus as the main topics.[2]

The supporting courses were mostly interest courses and were made available to any student who wanted to take them. Some were scheduled two days a week for a complete school year and others were daily for one semester. The supporting courses offered were:

1. Logic (twice weekly for a school year)
2. Computers (twice weekly for a school year)
3. History of Math (twice weekly for a school year)
4. Probability and Statistics (first semester daily)
5. Matrix Algebra (second semester daily)
6. Seminar for Independent Study (once weekly for the school year)[3]

Eilber takes a different approach to the senior mathematics program. He feels the problem is to provide a meaningful high school mathematics program for the arts and humanities student. A trend toward a math emphasis in this

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[1] Ibid., pp. 57-58.

[2] Ibid.

[3] Ibid., pp. 60-61.

area is demonstrated by the increase in the number and variety of well-written reference books about mathematics in this area. He says,

> It seems little enough to expect that the educated person in any field should have had an introduction to the following before he finishes his studies in mathematics:
>
> The historical growth of major mathematical concepts.
> The growth of Greek mathematics as a model for systems of thought in every field.
> The philosophic and religious controversies raised by mathematical and related scientific discoveries.
> The influence in many fields of the great mathematical discoveries of Euclid, Kepler, Descartes, Newton, and Einstein.
> The mathematical basis of music.
> The mathematical influence in art and architecture.
> Mathematical forms in nature.
> Probability, statistics, and statistical inference in the social and biological sciences.
> Computers and their social significance.
> Physical and philosophic implications of the development of non-Euclidean geometry.
> The process of generalizing a formula from a set of empirical data.[1]

Eilber was not clear as to exactly how this was to be accomplished other than a senior math course containing these ideas as a possibility.

Hyman Gabai, a member of the U.I.C.S.M., used this material as the basis for an experimental course. Gabai used seven "bright" University High seniors for his course. His course had the following objectives:

1. To help the students gain deeper insight into fundamental math concepts.

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[1]Charles R. Eilber, "College Preparatory Mathematics: Preparation for What?," The Mathematics Teacher, (January, 1968), 47-48.

2. To broaden the students' background and to provide more mathematical experience.
3. To provide the student with an introduction to college mathematics.
4. To provide the student with non-routine mathematical problems.[1]

The chapters in this course were:

I. Introduction to the Real Number System
II. Absolute Value and Inequalities
III. Mathematical Induction and Other Topics
IV. Combinations, Permutations, and Probability
V. Introduction to the Theory of Games
VI. The Complex Number System
VII. The Fundamental Theorem of Algebra
VIII. Theory of Polynomial Equations
IX. Quadratic Equations in Two Variables
X. The Completion Postulate
XI. Topological Concepts
XII. Limits and Continuity[2]

Gabai felt that the students enjoyed the course and that all of his objectives were fulfilled. He based these conclusions on his own observations.[3]

Dr. Morris Kline, of New York University, is a critic of the modern mathematics movement. According to Dr. Kline, the criteria and principles inferred upon examination of the various curriculum suggestions are:

1. Mathematics is and should be presented as a set of deductive structures.
2. Mathematics is to be presented rigorously by use of proofs instead of assumptions.
3. Mathematics is built up as an isolated, self-sufficient, pure body of knowledge.

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[1]Hyman Gabai, "An Experimental Twelfth-Grade Mathematics Course," The Mathematics Teacher, LX (April, 1967), 375-379.

[2]Ibid., p. 379.

[3]Ibid.

4. Mathematics is self-generating; that is, the axioms, theorems, and content come from purely mathematical sources, insights, and needs.
5. Students are asked to learn the abstract concepts of mathematics in the expectation that if they learn these, they will understand the concrete ideas.
6. The more terminology the better.
7. Never use words where symbols can be substituted.[1]

Dr. Kline suggests the following principles for a mathematics program:

1. Mathematics must be developed constructively.
2. Mathematics should be presented as intuitively as possible.
3. Mathematics is not an isolated, self-sufficient body of knowledge.
4. Elementary mathematics is not self-generating.
5. Concrete material should be used as much as possible.
6. Introduce as few terms as possible.
7. Use as few symbols as possible.[2]

The North Central Association suggests that content be selected in terms of the following criteria:

1. The content should be suitable to attain the objectives sought.
2. The content should emphasize broad principles, key concepts, and structures rather than minor facts and skills.
3. The mathematics must be correct and should maintain a degree of rigor proportionate to the maturity of the student.
4. The content for a given grade should be selected on the basis of its difficulty and on the phase of the mathematical sequence.
5. The content should be broad enough to provide for students of different ability, interest, and needs.[3]

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[1]Morris Kline, "A Proposal for the High School Mathematics Curriculum," The Mathematics Teacher, LIX (April, 1966), 322-323.

[2]Ibid., pp. 323-324.

[3]David C. Johnson and Donavan A. Johnson, "Evaluating a School Mathematics Program," The North Central Association Quarterly, LI (Fall, 1966), 187.

Alspaugh and Delon did a study of the secondary mathematics curriculum in Missouri. They took a random sample of fifty public secondary schools classified in the 1964-1965 Missouri School Directory. Their data was collected by interviewing one or more teachers in each school.[1]

The data from this study showed that the most common name for the twelfth grade math course was Mathematical Analysis. The major topics studied, by per cent, appear in Appendix A on pages 30 and 31. It can be seen that analytic geometry was by far the most popular twelfth grade topic. Complex numbers, statistics, algebra, and theory of equations appear in more than one-half of the curriculums. A rather surprising result is that of calculus occurring in as large a percentage of schools as circular functions.[2]

Alspaugh and Delon concluded from their study that, in college-bound curriculum, definite changes have occurred. Also, there has been a lowering of some courses, such as elementary functions and matrix algebra, from the college to the high school level.[3]

In 1955, due to the changes that were beginning to occur in mathematics curriculum, the College Entrance and

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[1]John W. Alspaugh and Floyd G. Delon, "How Modern is Today's Secondary Mathematics Curriculum?," The Mathematics Teacher, LX (January, 1967), 50.

[2]Ibid., p. 54.

[3]Ibid., p. 55.

Examination Board appointed the Commission on Mathematics. This commission was delegated to study the changes in mathematics curriculum that had occurred, review the existing secondary mathematics curriculum, and make recommendations for the modernization and improvement of the secondary school curriculum.[1]

This committee was composed of mathematicians and college and high school mathematics teachers.[2] The commission did research for four years before coming up with its recommendations in 1959.

The commission developed a nine point program for college-capable students:

1. Strong preparation, both in concepts and in skills, for college mathematics at the level of calculus and analytic geometry.
2. Understanding of the nature and role of deductive reasoning, in algebra as well as in geometry.
3. Appreciation of mathematical structure ("patterns") for example; properties of natural, rational, real, and complex numbers.
4. Judicious use of unifying ideas--sets, functions, and relations.
5. Treatment of inequalities along with equations.
6. Introduction of coordinates and vectors in plane geometry and in trigonometry.
7. Space perception and essentials of solid geometry incorporated with plane geometry.
8. Twelfth-grade mathematics centered on elementary functions--polynomial, exponential, circular.
9. Additional twelfth-grade material recommended: either introductory probability and statistical reasoning,

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[1]Commission on Mathematics, Program for College Preparatory Mathematics (New York: College Entrance Examination Board, 1959), pp. xi-xii.

[2]Ibid.

or an introduction to modern algebra (fields and groups).[1]

The commission suggests three possible programs:

1. Elementary functions, first semester; Probability with Statistical Application, second semester.
2. Elementary functions, first semester; Introduction to Modern Algebra, second semester.
3. Elementary functions, first semester; Selected Topics the second semester.[2]

The commission recommends probability, abstract algebra, or topics related to the extension of the elementary functions; it does not recommend teaching calculus unless it is treated in as rigorous a manner as it is in college.[3]

VII. METHOD

The criteria for establishing the guidelines were obtained from the following:

1. The Report by the Commission on Mathematics (College Entrance Examination Board).
2. A curriculum study of the forty largest high schools in the state of Iowa.

The curriculum study was carried out by personally contacting thirty-two of the schools and by writing a letter

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[1]National Association of Secondary-School Principals, New Developments In Secondary School Mathematics (Washington: National Council of Teachers of Mathematics, 1959), p. 26.

[2]Commission on Mathematics, op. cit., p. 42.

[3]National Association of Secondary-School Principals, op. cit., pp. 24-25.

(see Appendix B, page 32) to the eight remaining schools involved and requesting a copy of their senior math course content. Any schools not having a course content available were asked to provide a course description of the above mentioned courses. The information received was classified under its proper topics as suggested by the Commission on Mathematics or, if not included by the commission, by the State Department of Public Instruction.

In Chapter II, the curriculum study will be presented and tabulated.

CHAPTER II

PRESENTATION OF DATA

I. POPULATION

This study researched the forty largest high schools in the state of Iowa. The average daily attendance of each school was determined from information on school size gathered by the Iowa High School Athletic Association[1] and by the State Department of Public Instruction.[2]

Both of these sources were necessary, as the State Department of Public Instruction lists only the size of school districts and the Iowa High School Athletic Association deals only with boys' athletics. By combining the information available from both sources, it was possible to determine the forty largest schools.

The forty largest schools were selected for two reasons. First, the schools were large enough to allow for diversity in curriculum. Secondly, the size of Iowa high schools drops sharply beyond the fortieth largest.

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[1]Iowa High School Athletic Association Board of Control, "128 Largest Schools to Participate in the Class AA 1969 District Basketball Tournaments Starting March 3, 1969," Iowa High School Athletic Association, Bulletin No. 333 (October, 1968), 12.

[2]State Department of Public Instruction, Data On Iowa Schools 1967-1968 School Year (Des Moines: State of Iowa, 1968), pp. 18-57.

II. METHOD

Thirty-two of the forty schools involved in the study were contacted personally. Time and geographic location prevented the visitation of the remaining eight schools; therefore, these schools were contacted by letter.

Information was obtained by requesting a copy of the mathematics curriculum for the senior math course in each school. This material was then tabulated according to topic as suggested by the Report of the Commission on Mathematics.[1] Topics which were not listed in the Report of the Commission on Mathematics were categorized as advised by the Iowa Department of Public Instruction. In cases where questions arose concerning the curriculum of a particular school, an attempt was made to contact the principal or a mathematics staff member of that school to clarify the items in question.

Twelve schools listed two senior math courses. In these cases, the content of each course was tabulated. This made it possible for a topic to appear more than forty times.

III. RESULTS

Thirty-four of the forty largest schools contributed material to this study. This author received the desired information from thirty of the thirty-two schools contacted

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[1]Commission on Mathematics, op. cit., pp. 42-43.

personally. Information was not available from the other two schools at the time the research was gathered. Five of the eight schools contacted by letter responded. Of these five, one sent information that could not be utilized.

The information received was tabulated under two general categories. In Table I, topics included in the area of elementary functions are listed according to the program suggested in the Report of the Commission on Mathematics.[1] Table II follows the suggestion of the State Department of Public Instruction in constructing a list of additional topics which might be utilized in the senior mathematics curriculum. These tabulations will be analyzed in accordance with the nine point program developed by the commission (see pages 11 and 12).

The elementary functions topics are considered by the Commission on Mathematics to be fundamental to the senior mathematics program and to consist of approximately one semester of material.[2] As can be seen in Table I, page 17, the topics listed under elementary functions appear in a large percentage of the senior mathematics courses.

Table I shows that sets were included as a topic in 59 per cent of the courses offered by the schools surveyed. This corresponds to the fourth recommendation of the

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[1] Ibid.

[2] Ibid., pp. 30-31.

TABLE I

ELEMENTARY FUNCTIONS TOPICS INCLUDED IN THE SENIOR MATHEMATICS COURSES IN THE FORTY LARGEST IOWA HIGH SCHOOLS AND THE NUMBER AND PERCENTAGE OF COURSES THAT INCLUDE EACH TOPIC

Topic	Number	Percentage
I. Sets and combinations		
1. Review and extension of concept of set	27	59
2. Permutations and combinations	29	63
3. Mathematical induction	30	65
II. Functions and relations		
1. Functions	43	94
2. Relations	43	94
III. Polynomial functions		
1. Analytic geometry (lines, slopes, conics, etc.)	44	96
2. Polynomial equations (theory of equations) General polynomial (ax^n) Graphing and analyzing polynomial equations	43	94
IV. Exponential functions		
1. Review definition, properties, and graph a^x.	28	61
2. Analysis of exponential functions	28	61
V. Logarithmic functions		
1. Review of definition, properties, and graph 10^x and its inverse log x	31	67
2. Extension to base a	31	67
3. Graphs of $y=\log_a x$	31	67
VI. Circular functions		
1. Radian measure	41	89
2. Review fundamental trigonometric functions	41	89
3. Graphing $y=a \sin k(x \pm c)$	41	89
4. Inverse of trigonometric functions	41	89
5. Solution of trigonometric equations	41	89
6. Polar coordinates	39	85
7. Vectors	33	72
8. Identities	37	80

commission. If the subject of sets is treated in depth, it would correspond to the commission's ninth recommendation. Permutations and combinations were taught in 63 per cent of the senior mathematics courses of the forty largest high schools in Iowa. The commission includes these topics as part of introductory probability in point nine. Mathematical induction was taught in 65 per cent of the courses surveyed. This topic is a concept that is valuable in advanced mathematics. This need for developing the appropriate concepts is stated in the first point of the commission.

Of the Iowa schools responding, 94 per cent of their senior mathematics courses included functions and relations. Point four in the recommendations of the commission states a need for these concepts to be taught.

The commission places an emphasis on the elementary functions as stated by its eighth point. The commission enumerates these functions as being exponential, polynomial, logarithmetic, and circular. The Iowa schools studied listed circular functions as a topic in 89 per cent of the senior mathematics courses, exponential functions in 61 per cent, and logarithmetic functions in 67 per cent. In listing the topics for Iowa schools, polynomial functions was divided into analytical geometry (lines, slopes, conics, etc.) and polynomial equations (theory of equations, the general polynomial ax^n and graphing-analyzing polynomial

equations). Analytical geometry was listed as being taught in 96 per cent of the courses offered by the Iowa schools in the study. The commission includes this topic in both point four and point one of its recommendations. Polynomial equations were taught in 94 per cent of the courses studied. This topic is also included in points one and four of the commission's recommendations.

The additional topics that were taught in the senior mathematics courses of the forty Iowa high schools studied appear in Table II on page 20. Solid geometry is listed as being taught in 13 per cent of the courses. The commission recommends in point six that solid geometry be incorporated with plane geometry. Teaching this as a topic at the senior mathematics level does not comply with the recommendation of the commission.

Probability was listed as being taught in 67 per cent of the courses studied, and statistics in 26 per cent of the courses studied. In point nine, the commission recommends that an introductory probability with statistical application unit be taught as an alternative to modern algebra.

The commission does not recommend that calculus be taught at the high school level unless the course is as rigorous as it would be in college. This study shows that four per cent of the courses surveyed included advanced topics in calculus. These courses would be the only courses that would satisfy the recommendation of the commission.

TABLE II

ADDITIONAL TOPICS INCLUDED IN THE SENIOR MATHEMATICS COURSES IN THE FORTY LARGEST IOWA HIGH SCHOOLS AND THE NUMBER AND PERCENTAGE OF COURSES THAT INCLUDE EACH TOPIC

Topic	Number	Percentage
I. Solid Geometry	6	13
II. Probability	31	67
III. Statistics	12	26
IV. Calculus		
1. Limits	18	39
2. Basics of derivative	29	63
3. Basics of integral	19	41
4. Applications of derivative and/or integral	29	63
5. Advanced topics in calculus	2	4
V. Algebra		
1. Abstract	11	24
2. Matrix	8	17
3. Vectors	6	13
VI. Logic	7	15
VII. Computer related courses	5	11
VIII. Slide rule	2	4

Limits were taught in 39 per cent of the courses; the basics of the integral were included in 41 per cent of the courses; and applications of the derivative and/or the integral were included in 63 per cent of the courses studied. These topics would be considered elementary concepts of the calculus and would not be rigorous nor extensive enough to satisfy the recommendations of the commission.

The courses of study obtained from the forty largest Iowa high schools contain three types of algebra for senior mathematics: (1) abstract algebra; (2) matrix algebra; and (3) vector algebra. Abstract algebra was included in 24 per cent of the courses, matrix algebra in 17 per cent, and the algebra of vectors in 13 per cent. These topics would correspond to the recommendations of the commission stated in points two, three, and nine.

Logic was listed in 15 per cent of the courses in the study. The commission does not list this topic specifically, but logic would support some of the concepts suggested by the commission in points one, two, and three.

A course devoted to the slide rule was taught in two of the schools studied. This topic was not mentioned by the commission.

Computer related courses appeared in the content of 11 per cent of the courses studied. This topic was not mentioned by the commission, but courses on computer mathematics were not available at the time the commission undertook its

study.

Chapter III includes a summary of Chapters I and II, and presents the conclusions and recommendations drawn from this study.

CHAPTER III

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

I. SUMMARY

The problem is to develop a guideline for secondary school administrators to use in evaluating their senior math program. This author has researched the main topics being taught in the forty largest high schools in the state of Iowa to use as part of the criteria for these guidelines. The remainder of the criteria for establishing these guidelines comes from the Report of the Commission on Mathematics.

The research gathered from the forty largest high schools in the state of Iowa shows that almost all of the high schools include the elementary functions as part of their senior course. The remainder of the senior course comes from a variety of topics, the most popular being probability, calculus, and some form of algebra.

This study thus shows that the curriculums of the forty largest Iowa high schools agree with what the commission recommends. The elementary functions, which the commission regards as being essential, is the common denominator of the curriculum in the Iowa schools. The commission recommends probability, abstract algebra, or topics related to the extension of the elementary function. The forty

largest Iowa schools follow these recommendations in every area except that of calculus.

II. CONCLUSIONS AND RECOMMENDATIONS

In evaluating the senior mathematics program, it is the recommendation of this researcher that the secondary school administrator follow these guidelines:

1. The following topics, which appear in more than 59 per cent of the Iowa high school courses studied and which are also recommended by the Commission on Mathematics, are essential to a senior mathematics program:

   I. Sets and combinations
      1. Review and extension of the concept of set
      2. Permutations and combinations
      3. Mathematical induction

   II. Functions and relations

   III. Polynomial functions
      1. Analytic geometry (lines, slopes, conics, etc.)
      2. General polynomial (ax^n)
      3. Graphing and analyzing polynomial equations

   IV. Exponential functions

   V. Logarithmetic functions

   VI. Circular functions

   VII. Introduction to probability and statistics

2. One of the "new" algebras and some form of calculus should be included in the curriculum. The commission recommends that abstract algebra be taught as an additional topic, and 54 per cent of the Iowa high school senior mathematics courses studied included some form of "new" algebra. The commission does not recommend that calculus be taught unless it is taught as a calculus course; however, 63 per cent of the courses studied included some form of introduction to calculus.
3. A system of evaluation must be established so that the senior mathematics curriculum is a living curriculum and is changing as the needs of the youth change.

Many questions have arisen as this paper was being developed. Some of these questions, which might serve as recommendations for further study, are:

1. How much time is being spent in teaching the various topics?
2. How much does the high school principal know about the course content of various subjects?
3. Do the administrators in larger systems ignore their curriculum due to curriculum co-ordinators, etc.?
4. To what extent are the administrators aware of the curriculum needs of their students?

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APPENDIXES

APPENDIX A

TOPICS INCLUDED IN MATHEMATICAL ANALYSIS AND THE PERCENT OF SCHOOLS THAT INCLUDE EACH TOPIC

Topics	Percent
1. Solid geometry	
(a) Lines and planes in space	17
(b) Dihedral and polyhedral angles	17
(c) Polyhedrons, prisms, and pyramids	17
(d) Cylinders and cones	17
(e) Spheres	17
2. Analytic geometry	
(a) Cartesian coordinate system	94
(b) Properties of the line in the Cartesian plane	94
(c) Graphs of algebraic functions	94
(d) Loci	44
(e) Exponential and logarithmic functions	33
(f) Parametric and polar equations	61
(g) Conic sections	67
(h) Range and domain of a function	89
3. Calculus	
(a) Limits	39
(b) Definition of derivative	39
(c) Derivative formulas for algebraic functions	39
(d) Finding maximum and minimum values using derivatives	39
(e) Second derivatives	6
(f) Differentials	6
(g) Integration of algebraic functions	33
(h) Areas by integration	22
(i) Volumes by integration	7
(j) Differentiation of circular functions	7
(k) Inverse circular functions and derivatives	7
4. Circular functions	
(a) The trigonometric functions	39
(b) Graphs of the trigonometric functions	39
(c) Relationships among trigonometric functions	39
(d) Trigonometric identities and equations	39
(e) Functions of the sum or difference of two angles	39
(f) Double-and half-angle formulas	33
(g) Laws of sines and cosines	33
(h) Inverse trigonometric functions	28
5. Complex numbers	
(a) Graphical representation of complex numbers	67
(b) Operations with complex numbers	67
(c) Polar form of complex numbers	39
(d) Multiplication, division, and roots of complex numbers in polar form	28

APPENDIX A (CONTINUED)

Topics	Percent
6. Statistics	
(a) Permutations and combinations	56
(b) Probability	56
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APPENDIX B

540-34th Street
West Des Moines, Iowa
July 29, 1969

Dear Principal,

I am a graduate student in Secondary School Administration at Drake University and am in the process of doing research for my masters' thesis. The purpose of my thesis is to establish guidelines for curriculum development in senior mathematics. Part of the criteria for these guidelines will come from a curriculum study of the forty largest Iowa high schools. I would appreciate your cooperation by providing me with the following information.

Please send me a copy of the course content of your senior mathematics course or courses. If a course content is not available, please send me a course description, curriculum guide, or some other type of information that will tell me what concepts and content are being taught.

I need this information by August 5, and I certainly would appreciate your cooperation.

I thank you for your time and effort.

Respectfully yours,

Lawrence T. Bock