TOPICAL CONTENT FOR CERTAIN FIFTH-YEAR MATHEMATICS COURSES FOR MISSOURI SECONDARY SCHOOL MATHEMATICS TEACHERS

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CHAPTER I

INTRODUCTION

The Problem

The recognition of the importance that in-service secondary school mathematics teachers acquire additional education beyond the bachelor's degree has placed upon teacher education institutions an obligation for providing a suitable program.[1] A college faced with the task of pioneering a fifth-year program, based on a traditional sequence of courses, finds itself confronted with the question of what constitutes the most nearly ideal content at this level of teacher education. The recent advances in mathematics, interest in structure and understanding, and new and spectacular applications of mathematics must necessarily influence the pattern of subject matter content.[2] Because of the impossibility of including all mathematical topics, selections must be made. This study, therefore, is concerned with the problem: the selection of specific

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[1]Kenneth E. Brown, "Inservice Re-Education of Mathematics Teachers," American Mathematical Monthly, LXVII (1960), 918-920.

[2]Hermann Weyl, "A Half-Century of Mathematics," American Mathematical Monthly, LVII (1951), 523-553.

mathematical topics.

The Purpose of this Study

The purpose of this study is to determine a selection of content topics that can be used for the mathematical subject matter content of certain fifth-year mathematics courses for education of secondary school mathematics teachers in Missouri.

Definition of Terms

Throughout this study the following definitions of terms are used:

The term "modern secondary school mathematics teacher" refers to the instructor who teaches those sequences that have been recommended by the Commission on Mathematics, the School Mathematics Study Group, the University of Illinois Committee on School Mathematics, or the Ball State Experimental Program in grades nine through twelve.

A set of criteria is "complete" if there is no criterion (not already in the set) such that this criterion is independent of the original set of criteria.

If S is a set of criteria and C is a criterion of the set S, then C is "independent" if S and S-C (i.e. the set S with C deleted) do not discriminate an identical set of mathematical topics.

The term "coefficient of agreement" is used to denote the value of $(4S-n^2+n)/(n^2-n)$ where n is the total number of panelists responding to an item on the questionnaire; S is a number whose value is $d^2-nd+\frac{1}{2}n^2-\frac{1}{2}n$ where d is the number of panelists responding to items three and four on the questionnaire. The coefficient of agreement will be denoted by C_A.

The term "weighted response index" is used to denote the value of $(1/n)(C_a+2T_a+3T_d-4C_d)$ where C_a, T_a, T_d, and C_d represent the number of panelists marking number one, two, three, and four respectively, and n is the total number responding to an item on the questionnaire. The weighted response index will be denoted by WRI.

Need for the Study

It is an obvious tautology that the subject matter needs of the teacher are a function of the subject matter he will be expected to teach. If the present trends continue, all secondary school mathematics teachers may soon be teaching a modern mathematical sequence.[3] This implies that the Missouri secondary school mathematics instructor is required to have adequate preparation to teach a modern sequence. Since the set of inadequately prepared teachers is not the null set, and is in fact comparatively large, it is essential that educational

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[3]College Entrance Examination Board, Commission on Mathematics, Objectives of the Commission on Mathematics of the College Entrance Examination Board (New York, 1957), pp. 1-11.

opportunities be established to provide for this need.[4]

To initiate a course as a part of an educational program, fulfilling the above need, it becomes necessary to select the content material contained in the course. Acceptance of recommendations of leading professional organizations for content topics is a suitable procedure. This procedure, however, is not fruitful since in one instance (American Association for the Advancement of Science) only a specific number of semester hours is suggested.[5] The Commission on Mathematics of the College Entrance Examination Board takes the view that specific recommendations would lead to a stereotyped program.[6] In another instance (Mathematical Association of America) the recommendations provide a basic outline for an undergraduate program.[7] Because of an absence of recommendations satisfying local conditions, it is, therefore, necessary to select specific content topics.

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[4] Kirksville Daily Express, March 21, 1958, p. 6.

[5] Alfred B. Garrett, Chairman, "Recommendations for the Preparation of High School Teachers of Science and Mathematics - 1959," A Report of the Sub-Committee on Teacher Certification - The Cooperative Committee on the Teaching of Science and Mathematics of the American Association for the Advancement of Science, School Science and Mathematics, LIX (1959), 281-289.

[6] College Entrance Examination Board, Commission on Mathematics, The Education of Secondary School Mathematics Teachers (New York, 1957), pp. 1-16.

[7] "Recommendations of the Mathematical Association of America for the Training of Mathematics Teachers," American Mathematical Monthly, LXVII (1960), 982-991.

Extensions of specific course content for the undergraduate education of secondary school mathematics teachers, to the desired fifth-year education, would be a relatively simple problem if the prospective graduate student had studied these specific undergraduate topics. Local conditions in Missouri lead to the problem of providing adequate course content for needed additional education for students with an inadequate background.[8]

It is logical, following the absence of recommendations from professional organizations, to review the literature in the field of mathematics education respective to suggestions for desired content topics. The viewpoints, as expressed in the literature, are quite variable. One group would have students study traditional material.[9,10] Some advocate that the fifth-year be composed of just any mathematical topic.[11] The majority opinion is that the basic subject matter content should be based upon what is

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[8]Mary Jane Kohlenberg, "A Study of the Qualifications of Secondary School Mathematics Teachers of Northeast Missouri" (unpub. study, Northeast Missouri State Teachers College, 1954).

[9]Wallace Manheimer, "Some Heratical Thoughts from an Orthodox Teacher," Mathematics Teacher, LIII (1960), 22-26.

[10]D. M. Merrill, "Second Thoughts on Modernizing the Curriculum," American Mathematical Monthly, LXVII (1960), 76-78.

[11]"It really is not vital exactly what mathematics courses are taught, provided they are not of the "business mathematics," "mathematics in the home," or "history of mathematics" type." Letter to the writer from C. Stanley Ogilvy dated December 12, 1960.

generally called modern mathematics.[12,13,14,15]

To select content material based upon the views of one mathematical educator is an approach to this problem. The expert chosen will certainly reflect his philosophy regarding the modern mathematical sequence of his choice. Which sequence, or variation of this sequence, will be adopted in Missouri? If the chosen authority plans for a particular sequence, will the training be adaptable to teaching another sequence? If there are differences, or if there is no difference, in the preparation to teach a particular sequence, a method of reconciliation will, in either instance, provide the nucleus for a satisfactory program. Consequently, to provide for a selection of course content, it becomes necessary to study these various viewpoints to establish from this study the basic content material for preparation of Missouri secondary school mathematics teachers.

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[12] A. E. Meader, Jr., "Sets, Sinners and Salvation," Mathematics Teacher, LII (1959), 434-436.

[13] Morris Kline, "The Ancients vs. the Moderns," Mathematics Teacher, LI (1958), 418-427.

[14] P. S. Jones, "Promising Possibilities for Improving Content in the Teaching of Mathematics," Virginia Journal of Education, May, 1960, pp. 15-21.

[15] Henry Van Engen, "Plans for Reorganization of College Preparatory Mathematics," School Science and Mathematics, LVIII (1958), 277-285.

Scope of the Study

The recommendations of the faculty council of a Missouri college for teacher preparation are that the mathematics content of a fifth-year should be a total of seventeen semester hours.[16] The student is to select, as approved by his adviser, from the following (thirty semester hours): History of Mathematics (three semester hours), Advanced Calculus (six semester hours), Geometry (three semester hours), Algebra (six semester hours), Probability and Statistics (six semester hours). The completion of the seventeen semester hours in mathematics plus an additional five semester hours of electives in education and ten semester hours outside the field of mathematics will lead to the Master of Arts degree.

History of Mathematics and Advanced Calculus are established courses at the college that are of interest in this study. Topics in Mathematics as generally structured in a mathematics program will vary with various groups of students. This study, therefore, will be restricted to content topics for the non-established and non-variable courses.

The boundary conditions with respect to the assumption

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[16] Minutes of the Faculty Council, Northeast Missouri State Teachers College, December 8, 1959.

of background experiences are those determined by the content of the undergraduate major in mathematics education at a Missouri State Teachers College. Prior to 1960 the requirements are equivalent to: five semester hours in algebra and trigonometry; ten semester hours in calculus; two and one-half semester hours in college geometry; and an additional seven and one-half semester hours selected from (two and one-half semester hours for each course): arithmetic for teachers, teaching of arithmetic, mathematics of finance, theory of equations, differential equations, elementary statistics and surveying.[17]

It is to be understood that the writer does not necessarily agree that the above set of courses comprise a proper set of courses for pre-service preparation of secondary school mathematics teachers. This set of courses is used to propose a realistic approach to the problem to be investigated.

Procedure

Of the several methods of selection of content material for a given course the job-analysis approach might be considered the most logical.[18] To analyze the content recommended to be taught by a modern secondary

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[17]Bulletin of Northeast Missouri State Teachers College, Kirksville, Missouri (1958-1960), p. 156.

[18]John K. Norton and M. A. Norton, Foundations of Curriculum Building (Boston, 1936), pp. 60-91.

school mathematics teacher is a relatively easy task.[19] But the era is ended when the teacher's grasp of subject matter content consisted of successfully completing the course he is now teaching. What then are the criteria for selecting content topics? To what should a particular topic contribute in order that this topic should be selected for study? This analysis led the writer to search the literature for opinions as to what affect the study of a content topic should have upon the student. The first phase of this investigation is the result of this reasoning process.

Phase 1. The selection of a set of criteria to be used for designing the fifth-year program for preparation of secondary school mathematics teachers in Missouri has constituted the first phase of this investigation. The initial selection of criteria has been made by the writer. It is well-established that the responsibilities and characteristics of the modern secondary school mathematics teacher are different from those of a teacher who teaches a traditional sequence of courses.[20,21] To decide what

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[19]An example of one of the mathematical sequences is cited. "Summary of Content of SMSG Courses," American Mathematical Monthly, LXVIII (1961), 283-285.

[20]Mathematical Association of America, Committee on the Undergraduate Program in Mathematics, A Survey of Recommendations for the Training of Teachers of Mathematics (Buffalo, 1961), pp. 1-6.

[21]College Entrance Examination Board, Commission on Mathematics, The Education of Secondary School Mathematics Teachers, pp. 1-16.

topics make maximum contribution to the development of a teacher who can perform these tasks effectively should be the discriminatory character of the selected set of criteria.

Mathematical periodicals such as the American Mathematical Monthly, Mathematics Teacher, and School Science and Mathematics report on experimental programs and proposed changes in mathematical education policy. These sources should contain viewpoints with respect to initial selection of criteria.[22] The writer, therefore, surveyed issues of these periodicals.

To validate the set of criteria that has been used in this investigation a panel consisting of carefully selected mathematics education specialists have been asked to give their opinions regarding the selected criteria. A list of these panelists is presented on pages 27-29 for verification of the ability of these people to act as panelists. Each panelist has been asked, by means of questionnaire, to respond in one of four ways to each criterion.

The responses to the questionnaire have been analyzed. A coefficient of agreement and weighted response index was computed for each criterion. A criterion was considered valid if the coefficient of agreement was above the .500 level and the weighted response index was below the 1.75 level.

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[22]Ibid. p. 8.

Phase 2. This phase of the investigation has been aimed at the selection of the topical content for the certain courses in the fifth-year program. The justification for selection was according to the offerings in the catalogs of selected institutions of higher learning, content material in the National Science Foundation courses, mathematics textbook materials, interviews by the writer with mathematical educators, literature in the field of mathematics education, and personal experience of the writer with topical content material.

To validate the selection of content material a panel consisting of eminently qualified mathematical educators has been chosen. This class of mathematicians deemed qualified to validate the selection of content material were those persons chosen by the National Science Foundation as directors of the several (1961) Summer Institutes for Mathematics Teachers. Since these persons are concerned with the education of approximately 5,000 secondary school mathematics teachers during the summer of 1961, these people should be in a position to validate the selection of topical content.

Certain educators listed as directors of summer institutes were consulted in at least one aspect of this study. These persons were Professors Stanley J. Bezuszka, Boston College; Clifford Bell, University of California at Los Angeles; Paul B. Burcham, University of Missouri; James H. Zant, Oklahoma State University; and Carl V. Fronabarger, Southwest Missouri State College. Since these individuals had been very helpful in previous phases of this study, they were omitted from the list of prospective panelists to validate the selected topical content.

A questionnaire regarding the validation of the selected content topics for probability and statistics was sent to each institute director of institutions offering a course in probability and statistics. After having eliminated from possible selection as panelists those educators who were asked to answer a questionnaire regarding content topics for probability and statistics, (to validate the topical content material in algebra and geometry) there remained possible selections for sending questionnaires regarding content for algebra alone, for geometry alone, and for algebra or geometry. The mathematicians that were asked, by means of a questionnaire, to validated content material for algebra consisted of the directors of institutes offering courses in algebra alone and a random sample, using a table of random units, of directors of institutes who were offering courses in algebra or geometry.[23] A questionnaire regarding content material in geometry was sent to each institute director offering a course in geometry alone and to those remaining on the list developed for selecting panelists.

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[23] Charles D. Hodgman, ed., "A Table of 14,000 Random Units," Standard Mathematical Tables, (12th ed. Cleveland, 1959), pp. 237-243.

Phase 3. The final phase of this investigation has consisted of making recommendations for the topical content of the fifth-year program for secondary school mathematics teachers of Missouri. These recommendations have been based on the analysis of the data obtained in the second phase of this investigation. From the responses to the questionnaire the coefficient of correlation and weighted response index were computed. A content topic was selected for the fifth-year program if there was a positive coefficient of agreement with chi-square values greater than 3.841 with one degree of freedom or equivalent values so that the confidence level would be beyond ninety-five percent.

Statistics used in the study. The coefficient of agreement as defined by Kendall was calculated using the distinction between agreement and disagreement.[24] To obtain a trend toward agreement the weighted response index was used. Chi-square values were computed for each item on the questionnaires as in accordance with the theory that is developed by Kendall.

Limitations of the Study

Inherent in most studies are some weaknesses. This study is no exception to this general statement. The shortcomings of this study are primarily the judgment of

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[24] Maurice G. Kendall, The Advanced Theory of Statistics (London, 1947), pp. 427-4?5.

the writer with respect to the initial selection of the set of criteria and selection of content topics. The basic imperfections will be discussed in this section of the study.

Initial selection of the criteria. Now, *a priori*, there is no reason to believe that it is even possible to list a set of criteria that would imply the discrimination of all mathematical topics. Is it possible to state all educational qualities that a teacher must attain? Of course, for the sake of elegance a complete set of criteria would be desirable. In this study, however, the set of criteria is incomplete in the sense of the definition of completeness previously given.

The initial selections were validated by a set of mathematicians whose opinions are respected on the national level. While this, in no way, implies an idea of completeness, it does indicate the authenticity of those selected.

Initial selection of content topics. The initial selection of content topics for course content was to be validated by eminent mathematicians. If, therefore, the judgment of the writer was not correct, the basic course content for proposed courses was not altered. With respect to this matter the writer purposely selected a variety of content material so that validated topics could be used to constitute the nucleus of a course.

Use of the mail questionnaire. The mail questionnaire is widely used as a method of data collection in survey work. Ashortcoming of the mail questionnaire is the high proportion of non-response. The response of this questionnaire was seventy-two percent in phase one, and fifty-one percent in phase two of the study. Although there are other disadvantages to the use of a mail questionnaire, this should not constitute a great factor in this study since:

> The questionnaire can be most fruitfully used for highly select respondents with a strong interest in the subject matter, greater education, and socioeconomic status.[25]

Summary and Preview

The purpose of this study is the identification of subject matter content for certain fifth-year courses in mathematics so that Missouri secondary school teachers are prepared to teach a modern secondary school sequence. The need for the study was validated with reference to local conditions and the reference to several important national organizations of the urgency that teachers, with inadequate background experiences, be adequately prepared to teach a modern sequence. The absence of recommended content topics, with respect to local conditions and the various viewpoints of mathematical educators, pointed out the desirability of the study. Attention was given to the procedure and the limitations with respect to this framework within which the investigation was made.

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[25]W. J. Goode and P. K. Hatt, Methods of Social Research, (New York, 1952), p. 182.

The study now proceeds with selection of criteria and justification for selection in Chapter II. Chapter III contains a detailed analysis of the four-year program, as is existent in a specific locality, to serve as a basis for the fifth-year courses. Chapter IV contains the data regarding the selection of content topics as well as justification for selection of content topics. Chapter V gives the conclusions and recommendations.

CHAPTER II

THE CRITERIA FOR SELECTING CONTENT TOPICS

Introduction

In order to arrive at an analysis of the thinking of the mathematics community in regards to the problem of selection of criteria, the writer surveyed issues of those periodicals which report on the subject matter, teaching of mathematics, experimental programs and curricular proposals. Although a great deal of information was gleaned from this literature, only the discussions pertinent to the selected criteria will be noted.

In this chapter there are the preliminary selection of a set of criteria, the justification for this preliminary selection, the selection of a valid set of criteria according to the opinions of mathematical educators, and a discussion of this validated set of criteria.

Preliminary Selection and Justification for Selection of Criteria

The preliminary selected criteria are in three groups of criteria. The first nine selected are concerned with the contributions that a content topic should make to develop an effective teacher of modern secondary school mathematics.

The next two criteria are related to the previous mathematics preparation of the student and the sequential nature of mathematics. The final criterion is concerned with structuring the fifth-year to provide continuity with the traditional four-year program. The statements of criteria will be constructed with respect to the three groups.

From the preliminary analysis of the opinions of the mathematical community, a mathematical topic that is included in the fifth-year of a program designed for Missouri secondary school mathematics teachers should:

1. Contribute to the understanding of secondary school mathematics characteristic of the present and future.
2. Contribute to depth and breadth of preparation beyond the mathematics of the secondary school and four year college.
3. Contribute to the development of the ability to further the appreciation of the broad interrelationship of the secondary school mathematics with a general scheme of the unity of thought.
4. Contribute to relating mathematics to other fields of knowledge.
5. Contribute to the application of mathematics to other fields of knowledge.
6. Contribute to the development of the ability to learn new mathematics by self-instruction.
7. Contribute to the development of the ability to apply high standards of proof to a variety of mathematical problems.
8. Contribute to the development of the ability to create minor mathematical research and problem-solving.

9. Contribute to an understanding of mathematical topics taught on the elementary or college level.

10. Contribute to the development of material of appropriate difficulty.

11. Contribute to the fifth-year if the program is a basis for an important mathematical topic.

12. Contribute to the correlation with the preparation of the four-year mathematics education program.

Justification for selection of criterion number one. In a discussion of the geometry that is to be required for preparation of the modern secondary school teacher, Meserve points out that:

> Any comments upon the geometry which teachers should study must be based upon some assumptions regarding the point of view and the contents of the geometry that they will teach.[1]

One of the criteria listed by Kinsella, in regards to a good program of mathematics teacher preparation, was that the teacher should have a "mastery of secondary school mathematics characteristic of the years 1960 + x."[2] This statement can be upheld by discussions of The Commission on Mathematics of the College Entrance Examination Board,[3] the Panel

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[1]B. E. Meserve, "The Education of Mathematics Teachers: Geometry," American Mathematical Monthly, LXVI (1959), 909.

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

[3]College Entrance Examination Board, Commission on Mathematics, The Education of Secondary School Mathematics Teachers, pp. 1-2.

on Teacher Training of the Mathematical Association of America Committee on the Undergraduate Program,[4] and individual educators who have presented their views on teacher education.

Justification for the selection of criterion number two. Basic to the selection of any criterion is the fundamental objectives of the institution of higher learning of which a given program is a part. The stated fundamental objectives of the college of interest is that the fifth-year of study "should be broad, thorough, and based upon genuine scholarship."[5] A further clarification is the statement that the mathematics teacher "must have depth and breadth of understanding of that which he wishes to teach."[6] Professional organizations and individuals also have stressed the necessity of the selection of this criterion.

Justification for the selection of criterion number three. The college of interest in this study asserts, in its statement of the fundamental objectives of the college, that the secondary school mathematics teacher needs "an appreciation of the broad interrelationships of that which he teaches with a general scheme of the unity of thought."[7]

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[4]Mathematical Association of America, Committee on the Undergraduate Program, pp. 3-6.

[5]Bulletin of Northeast Missouri State Teachers College, Kirksville, Missouri (1960-1962), p. 6.

[6]Ibid.

[7]Ibid.

Justification for the selection of criterion number four. The secondary school teacher will be teaching students whose fields of interest are varied. To perform this task effectively he must be capable of presenting various relationships among the many other disciplines. Kinsella remarks that in his many years of teaching the above statements are correct. He further states: "that the learning process of most adolescents requires contact with the world of tangibles, or at least relevancy to other fields of human knowledge."[8] The instructor who expects to motivate his pupils only by his personal knowledge and love of the subject, and detests, or is unaware of, the connection of the subject matter he is teaching to the various areas of knowledge is a "displaced person."

The recommendations of the Mathematical Association of America are that the secondary school teacher "must be able to convey to our students a new insight into the nature of mathematical thought and of its role in our culture."[9] This implies the selection of topics that contribute to relating mathematics to other fields of knowledge.

Justification for the selection of criterion number five. The increase in the number of applications of mathematics has placed more demands on the secondary school teacher.

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[8]Kinsella, p. 29.

[9]Mathematical Association of America, Committee on the Undergraduate Program, p. 4.

> Word of new advances spreads by newspapers, magazines, public lectures, and television. This stimulates the curiosity of students who then seek answers to many questions. Teachers must be prepared to stimulate further the interest in such questions, to provide sound answers for them, and to direct effective reading at the level of the student's background. The course work taken by the teachers should prepare them to keep abreast of the new developments which are often highly complex, to answer questions about them and to direct discussion of them.[10]

Justification for the selection of criterion number six. Since growth is very likely to continue in mathematics, it is impossible to develop breadth of understanding of all developed mathematics topics in the short span of one year.[11] It is impossible to predict the changes that will occur in the topics taught in the secondary school as a result of present and future developments in mathematics.[12] It then becomes necessary that the teacher be able to learn new mathematics without the guidance of a professor.[13] Hence, topics studied by the teacher in the fifth-year should contribute to the development of the ability to learn new mathematics by self-instruction.

Justification for the selection of criterion number seven. Interest in structure and understanding on the

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[10]Garrett, p. 288.

[11]Mathematical Association of America, Committee on the Undergraduate Program, p.6.

[12]Andre Weil, "A Half-Century of Mathematics," American Mathematical Monthly, LVIII (1951), 523-553.

[13]Mathematical Association of America, Committee on the Undergraduate Program, p.4.

secondary school level forces the teacher to present rigorous proofs. Intuitive proofs are to be replaced, where possible, in the secondary school sequence. The instructor must, as a consequence, be familiar with what constitutes high standards of proof. Busemann says that "modern mathematics is too advanced or intricate for intuition."[14] This implies that the teacher should have the ability to apply high standards of proof to a variety of mathematical problems.

<u>Justification for the selection of criterion number eight</u>. The mathematics teacher is not completely educated unless he can do more than perform operations and recall proofs.

> Poincare once said "...it is by logic we prove, by intuition that we discover. To know how to criticize is good, but to know how to create is better." His statements have been echoed by distinguished mathematicians like Hadamard, Felix Klein, and Polya.[15]

Consequently the teacher is inadequately prepared to pass on to secondary school students the education they deserve if his mathematical maturity is inadequate. The present secondary school program demands that the students be challenged to discover the structure of mathematics; the repetition of proofs is inadequate. If the instructor has had little experience in methods of discovery, that is

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[14]Herbert Busemann, "The Role of Geometry for the Mathematics Student," <u>American Mathematical Monthly</u>, LXVII (1960), 284.

[15]Kinsella, p. 29.

reflected in his classroom. His content material becomes that of imitation of the theorems that other mathematicians have developed. An atmosphere of initative and creativeness is lacking; the motivating force of a feeling of personal development is lost when other individual's proofs and problems are the sole challenge to study.[16]

Justification for the selection of criterion number nine. The teacher should be a leader in the classroom. To be a leader this person must know the background experiences and the future experiences that may be encountered by the student. This requires that the teacher must have abundant experiences with elementary and college mathematics.

> Similar arguments require the secondary school teacher's grasp of mathematics to exceed both the level at which he customarily teaches and the level at which his training has frequently ceased. It has been amply demonstrated in numerous experimental curricula that high school students can study successfully certain mathematical material which is now commonly postponed until college. That many high school students should study some of this material follows from our earlier discussion of the role of mathematics in our culture. Thus, within the next decade it is expected that teachers will be asked to teach material which many of our present teachers have never studied. The teacher's mastery of mathematical ideas must substantially exceed that represented by his text book if he is to teach with a spirit of enthusiasm and inquiry which stimulates his students to explore both fundamental ideas and their applications.[17]

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[16] Ibid.

[17] Mathematical Association of America, Committee on the Undergraduate Program, p. 5-6.

Justification for the selection of criterion number ten. Douglas discussed the patterns and requirements of graduate study for the education of teachers.[18] He pointed out that the graduate program should be built first upon the previous education and experiences of the individual.

Those persons with whom the writer had personal contact suggested that many persons will be enrolled in the fifth-year program with insufficient background or with background courses that have been taken several years prior to their enrollment. Therefore, it is wise to choose material that will be of appropriate difficulty. The program must start from the background experiences of the teachers in the area. Then it must develop these teacher's mathematical maturity as far as possible in the time allotted.

Justification for the selection of criterion number eleven. Because of the sequential nature of mathematics, it becomes essential to include topics that are essential to the development of other topics. For example, the engineer would seldom solve a quadratic equation by completion of the square method; however, the study of this method is essential to the understanding of the quadratic formula--in fact it is the basis for the quadratic formula. One could very well have a student who excels in grinding out solutions for the quadratic equation but who has no understanding of

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[18] H. R. Douglas, "Graduate Instruction in Institutions of Higher Education," North Central Association Quarterly, XVII (1943), 257-285.

the quadratic equation. Therefore, there may be certain topics that should be studied for understanding of other essential topics.

Justification for the selection of criterion number twelve. The fifth-year program must be planned with the four-year program taken into consideration. This view is expressed by the Commission on Mathematics of the College Entrance Examination Board.[19] Mention specifically is made by Jones. He says:

> Undergraduate and graduate programs must be planned with each other in mind. That is, the undergraduate student should be carried far enough so that he may continue with some graduate study in mathematics. At the same time, graduate programs should begin at a level such that a well-prepared teacher may continue with some mathematics at the graduate level, and graduate offerings should always be planned to offer a varied sequence of courses appropriate for the secondary school teacher.[20]

Statement Regarding the Preliminary Selection of Criteria

Mention should be made of the discriminatory character, independence, and completeness of this set of criteria. The discriminatory character is discussed with regard to the validated set of criteria that will be used in selecting content material. Completeness was discussed on page fourteen.

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[19] College Entrance Examination Board, Commission on Mathematics, The Education of Secondary School Mathematics Teachers, pp. 12-13.

[20] P. S. Jones, "Recent Research in Mathematics: Implications for Teacher Education," American Mathematical Monthly, LXVII (1960), 289.

It is to be noted that the preliminary set of criteria is not independent, in the sense of mutual exclusiveness, and, hence, the final selection will not necessarily be independent.

Selection of a Set of Criteria to be used to Select Content Material

In order to obtain as valid a set of criteria as possible a panel of twenty-five mathematical educators was chosen. The educators who were selected as panelists were asked to respond to the statements of the preliminary criteria. The statements were arranged so that the panelists could give one of four opinions regarding a criterion.

The response of these panelists was very gratifying since eighteen returned correctly marked responses. The following persons may be identified with responses to the questionnaire:

Phillip S. Jones
University of Michigan

H. P. Fawcett
Ohio State University

H. T. Karnes
Louisiana State University

B. W. Jones
University of Colorado

Henry Van Engen
University of Wisconsin

J. Houston Banks
George Peabody College for Teachers

F. Lynwood Wren
San Fernando (California) Valley State College

Gilbert Ulmer
University of Kansas

Clifford Bell
University of California at Los Angeles

John J. Kemeny
Dartmouth College

Stanley J. Bezuszka, S. J.
Boston College

H. M. Gelder
Western Washington College of Education

H. C. Trimble
Iowa State Teachers College

H. C. Parrish
North Texas State College

One of the replies specifically asked not to be identified.

The other ten panelists, four of whom returned correctly marked responses, are:

E. G. Begle
Yale University

H. M. Cox
University of Nebraska

J. C. Eaves
University of Kentucky

P. D. Edwards
Ball (Indiana) State

W. H. Hausdoerffer
Trenton (New Jersey) State College

N. H. Mewaldt
Northern (South Dakota) Teachers College

L. A. Ringenberg
Eastern Illinois University

W. J. Thomsen
Mankato (Minnesota) State College

Edith F. Whitmer
Henderson (Arkansas) State College

C. K. Wilson
Eastern New Mexico University

A copy of the letter and questionnaire sent to each panelist is given in Appendix A.

The opinion responses of the panelists are presented in Table I. Column one (marked RO_w) gives the rank order with respect to the weighted response index. Column two (marked CN) gives the number of the criterion as presented on pages eighteen and nineteen. Column four (marked RO_c) gives the rank order with respect to the coefficient of agreement. Column five (marked C_A) gives the coefficient of agreement. Columns six, seven, eight and nine (marked C_a, T_a, T_d, and C_d) give the number of panelists marking columns one, two, three, and four respectively, on the questionnaire. Column ten (marked n) indicates the total number of panelists indicating an opinion on a criterion. Column eleven (marked d) gives the total of columns eight and nine. Column twelve (marked X^2) gives the chi-square values for the coefficient of agreement. Column thirteen (marked m) gives the degrees of freedom for the chi-square values. Column fourteen (marked P) indicates the approximate confidence interval.[21]

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[21]Kendall, p. 446.

A further analysis of the responses is given in Table II. The paired comparisons are between complete agreement and tending toward agreement or complete agreement. Symbols for Table II are similar to those used in Table I. In Table II the n* represents the total responses to the items C_a, T_a, and C_d.

TABLE II

C_a PAIRED WITH d

CN	C_A	C_a	T_d	C_d	d	n*	X^2	m	P
9	1.00	17	0	0	0	17	19.48	1.2	99
1	1.00	16	0	0	0	16	18.37	1.2	99
6	.75	15	1	0	1	16	14.90	1.2	99
2	.69	12	1	0	1	13	8.53	1.3	98
10	.44	11	1	1	2	13	7.47	1.3	95
3	.34	9	2	0	2	11	5.58	1.3	95
12	.34	9	1	1	2	11	5.58	1.3	95
4	.29	8	2	0	2	10	4.66	1.4	95
7	.29	8	2	0	2	10	4.66	1.4	95
8	.07	7	3	0	3	10	2.16	1.4	75
5	.33	5	1	0	1	6	4.38	1.7	78
11	.18	9	2	1	3	12	3.72	1.3	90

It may be seen from the data presented that criteria regarding the application of mathematics to other fields of knowledge (number five), the ability to create minor mathematical research and problem-solving (number eight), and the inclusion of a topic as a prerequisite topic (number eleven) should not be considered valid criteria. Table II indicates the values of P fall below the standard (ninety-five percent) acceptance level for these criteria. Although the values of P in Table I are above the acceptance level, the weighted response index indicates the trend is toward agreement (T_a) but not to complete agreement (C_a).

Discriminatory Character of the Set of Criteria

A criterion is redundant if it discriminates vacuously. Each selected criterion will be shown to discriminate at least one content topic as to exclusion for the proposed program in this portion of the study. The discrimination as to inclusion of at least one topic will be noted in the section of the study devoted to the choice of content topics.

Number one. Fundamental addition of natural numbers is normally studied in elementary school. This topic certainly would not contribute to understanding of secondary school mathematics characteristic of the future since this topic should be thoroughly understood before the student enters secondary school.

Number two. Any topic studied prior to secondary school will not contribute to depth and breadth of preparation beyond the mathematics of the secondary school and four-year college.

Number three. Study of the reduction of Hermitian matrices does not contribute to the development of the ability to further the appreciation of the broad interrelationship of the secondary school mathematics with a general scheme of the unity of thought.

Number four. A study of Peano curves would not contribute to relating mathematics to other fields of knowledge.

Number six. Topics that are computational in nature as a method of finding the area under a portion of a normal curve do not contribute to the development of the ability to learn new mathematics by self-instruction.

Number seven. Topics of a computational nature such as the procedure for calculating the standard deviation of a normal distribution do not contribute to the development of the ability to apply high standards of proof to a variety of mathematical problems.

Number nine. Generalized covariant differentiation is normally studied in advanced differential geometry courses. Therefore, this topic would not contribute to an understanding of mathematical topics taught on the elementary or college level.

Number ten. A selected topic must be of appropriate difficulty. This was pointed out to the writer in an interview with Professor Paul Rosenbloom of the University of

Minnesota. For example a study of Finsler spaces would not be of appropriate difficulty and hence would not satisfy the criterion that a selected topic should be of appropriate difficulty.

Number twelve. Many mathematical topics do not easily correlate with the preparation of the four year mathematics program of a given institution. Certainly a discussion of the fundamental theorem of algebra using complex variables would not correlate easily with the preparation of the student who has had no undergraduate preparation in complex variables.

Summary

A preliminary selection and justification for this selection of a set of criteria has been made in this chapter. From an analysis of the responses of a panel of educators there was an omission of three criteria from the preliminary selection. This omission was based on the coefficient of agreement as defined by Kendall.

The set of criteria that will be used in the selection of content topics will be designated as the validated set of criteria. This set of criteria is discriminatory in that a mathematical topic that is included in the fifth-year should be in the union of the class of mathematical topics that:

1. Contribute to an understanding of secondary school mathematic characteristic of the present and future.

2. Contribute to depth and breadth of preparation beyond the mathematics of the secondary school and four year college.

3. Contribute to the development of the ability to further the appreciation of the broad interrelationship of the secondary school mathematics with the general scheme of the unity of thought.

4. Contribute to relating mathematics to other fields of knowledge.

5. Contribute to the development of the ability to learn new mathematics by self-instruction.

6. Contribute to the development of the ability to apply high standards of proof to a variety of mathematical problems.

7. Contribute to an understanding of mathematical topics taught on the elementary or college level.

8. Contribute to the development of material of appropriate difficulty.

9. Contribute to the correlation with the preparation of the four-year mathematics education program.

It was shown that each criterion of this set of criteria did not discriminate vacuously with respect to exclusion of mathematical topics. Also a discussion was made with respect to independence and completeness and in this discussion it was noted that the chosen set of criteria was not independent or complete.

CHAPTER III

THE FOUR-YEAR PROGRAM FOR SECONDARY SCHOOL MATHEMATICS TEACHERS IN MISSOURI

Introduction

In order to apply effectively the criterion of selection of mathematical topics of appropriate difficulty and because of the sequential nature of mathematics, it becomes necessary to discuss the four-year plan whereby one may choose topics for the fifth-year. While many prospective students may enroll for the fifth-year with less than the minimum requirements for a major in mathematics at the college of interest in this study, it is essential that all students make up any deficiencies before entering the fifth-year program. Content topics will be chosen with the assumption that the assumed four-year program minimum requirements in mathematics be a prerequisite for courses in the fifth-year program.

Requirements for a Major in Mathematics Education

College Algebra. A three semester hour course in college algebra will be studied in the freshman or sophomore year. The topics studied are:

The theory of quadratic equations, complex

> numbers, progressions, determinants, partial fractions, etc.[1]

Trigonometry. Students will offer either a two or three semester hour course in trigonometry. The present course is two semester hours and is described as including topics in: "Trigonometric functions and the solution of plane triangles."[2]

Analytic geometry and calculus. A three and four-tenths semester hour course in analytic geometry plus six semester hours of calculus or a total of six semester hours of analytic geometry with calculus plus six semester hours of calculus will constitute the requirement in elementary analysis. This sequence of courses is equivalent to the course described in the recommendations of the Committee on the Undergraduate Program in Mathematics of the Mathematical Association of America. Their description of this course is as follows:

> Analytic geometry and calculus (3 course sequence). Approximately one-third of the sequence should be devoted to analytic geometry, taught either in co-ordination with calculus or after the calculus sequence. This should include the coordinate plane, functions, polar coordinates, the algebraic description of subsets of the plane—related to solutions of equations—and parametrically as the range of a function, change of coordinates and brief treatment of conic sections.
>
> The sequence should also give a thorough treatment of the calculus for functions of one variable, with stress on the basic ideas, but with adequate attention to manipulative skills. The course should introduce differentiation, integration, the rational, trigonometric, and exponential functions, as well as a brief

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[1]Bulletin of Northeast Missouri State Teachers College, Vol. LX, p. 171.

[2]Ibid. p. 170.

> treatment of series and some very elementary differential equations.[3]

College geometry. The two and one-half semester hour course in college geometry is aptly described as traditional. Meserve's comments in regards to the college geometry are apropos:

> The traditional and, from many points of view, misnamed course in college geometry extends skills in constructions and relationships among traditional geometric figures.[4]

Electives. In addition to the required courses described, an additional seven and one-half semester hours of course work (as indicated on page eight) in mathematics must be completed. These electives are to be selected with the help of an adviser. Studies by Kohlenberg indicate that a majority of the students have completed their mathematics education major by electing arithmetic for teachers and teaching of arithmetic as five semester hours of this requirement.[5]

Summary

The minimum prerequisite courses for beginning the fifth-year would be:

1. College algebra and trigonometry (five semester hours).

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[3]"Recommendations of the Mathematical Association of America for the Training of Teachers of Mathematics," p. 990.

[4]Meserve, p. 909.

[5]*Kirksville Daily Express*, March 21, 1959, p. 6.

2. Analytic geometry and calculus (ten semester hours).
3. College geometry (two and one-half semester hours).
4. Electives (seven and one-half semester hours).

It is to be noted that the above set of mathematics courses are not to be taken as those courses comprising an ideal four-year program. They are, however, the courses that form the mathematics education of the teachers that will be entering the proposed program.

CHAPTER IV

SELECTION OF TOPICAL CONTENT FOR THE CERTAIN FIFTH-YEAR COURSES

Introduction

This chapter is concerned with selection of subject matter content for courses in algebra, probability and statistics, and geometry for the fifth-year of preparation of secondary school mathematics teachers in Missouri. The initial selection of topical content for proposed courses has been based on the selected set of criteria as listed on pages thirty-four and thirty-five. Cognizance has been taken of suggested content material from the Mathematical Association of America, American Association for the Advancement of Science, National Science Foundation Institute courses, and individuals in the field of mathematics education in the selection of topics. Although the Commission on Mathematics of the College Entrance Examination Board has not specifically recommended topical content material for education of modern secondary school mathematics teachers, it is expected that the topics suggested by Lorch, Meserve, and Walter will reflect the Commission's recommendations.[1]

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[1]A. E. Meder, Jr., "The Education of Mathematics Teachers: Introduction," American Mathematical Monthly, LXVI (1959), 805.

Topical Content for a (six semester hour)

Courses in Algebra

Immediately after the listing of initially selected topics the number (as listed on pages thirty-four and thirty-five) of the criterion that the particular selected topic does not satisfy will be listed in parentheses. If a particular topic satisfies all criteria the symbol Ø will be noted in the parentheses. Sources suggesting the particular content topic will be noted next as follows: Lorch,[2] L; Kinsella,[3] Ki; McCoy,[4] M; Kelly,[5] Ke; American Association for the Advancement of Science,[6] AAAS; Mathematical Association of America,[7] MAA; National Science Foundation Institutes,[8] NSF; and NSF notations where specific credit is given.

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[2]E. R. Lorch, "The Education of Mathematics Teachers: Algebra," American Mathematical Monthly, LXVI (1959), 806-808.

[3]Kinsella, p. 31.

[4]N. H. McCoy, Introduction to Modern Algebra (Boston, 1960), pp. 1-299.

[5]J. L. Kelley, Introduction to Modern Algebra (Princeton, 1960), pp. 1-332.

[6]Garrett, p. 288.

[7]Mathematical Association of America, Committee on the Undergraduate Program, p. 990.

[8]Minutes of the Regional Conference of Directors and Lecturers for NSF 1960 Summer Institutes for Teachers of High School Mathematics. Chicago, April 9-10; Washington, April 8-9; San Francisco, April 8-9; St. Louis, May 6-7; and New York, April 29-30, 1960.

Content topics initially selected are as follows:

1. Some properties of the field of rational numbers. (∅); L; Ki; M; Ke; AAAS; MAA; NSF.

2. Definition and some properties of groups. (∅); L; Ki; M; Ke; AAAS; MAA; NSF.

3. Algebraic operations on matrices. (∅); Ke; AAAS; M; NSF.

4. Determinants. (∅); L; M; AAAS; Ke; NSF.

5. Linear transformations. (∅); MAA; L; M; AAAS; Ke; NSF.

6. Inverse of a matrix. (∅); MAA; L; M; AAAS; Ke; NSF.

7. Sets and sentences. (∅); L; Ki; M; Ke; NSF.

8. Equivalence relations and equivalence classes. (∅); M; Ke; NSF.

9. Isomorphisms. (∅); MAA; M; Ke; NSF.

10. Definition and some properties of a field. (∅); MAA; L; Ki; M; Ke; NSF.

11. Construction of the rational numbers from the integers. (∅); L; Ki; M; Ke; NSF.

12. Construction of the complex numbers. (∅); L; M; NSF.

13. Modular number systems. (∅); L; M; Ke; NSF.

14. Fundamental theorem of arithmetic and applications. (∅); M; NSF.

15. Permutation groups. (∅); MAA; L; M; Ki; AAAS; NSF.

16. Special matrices, zero, identity, nilpotent, idempotent. (∅); MAA; L; M; AAAS; K; NSF.

17. Definition and some properties of an integral domain. (∅); M; NSF.

18. Mathematical induction. (Ø); M; Ke; NSF.

19. Divisors and the division algorithm for integers. (Ø); M; NSF.

20. Different bases for the number system. (Ø); L; M; Ke; NSF.

21. Linear dependence of vectors. (Ø); MAA; M; AAAS; Ke; NSF.

22. Solutions of systems of linear equations. (Ø); MAA; M; AAAS; Ke; NSF.

23. Mappings. (Ø); M; Ke; NSF.

24. Definition and some properties of a ring. (Ø); MAA; L; M; AAAS; Ke; NSF.

25. Geometric representation and trigonometric form of complex numbers. (Ø); M; Ke; NSF.

26. The n n'th roots of a complex number. (Ø); M; K; NSF.

27. Subgroups. (Ø); MAA; L; M; AAAS; Ke; NSF.

28. Ordered integral domains. (Ø); M; NSF.

29. Construction of the integers from the natural numbers. (Ø); M; Ke; NSF (W. R. Scott, University of Kansas).

30. Boolean algebra as a model of propositional logic. (Ø); L; Ke.

31. Polynomial rings. (Ø); MAA; L; M; AAAS; NSF.

32. Divisors and the division algorithm for polynomials. (Ø); M; NSF.

33. Vectors and analytic geometry of space. (Ø); MAA; M; AAAS; Ke; NSF.

34. Some properties of real numbers. (Ø); Ki; M; NSF.

35. Unique factorization in $F[x]$. (Ø); M; NSF(University of Illinois).

36. Coordinate systems in space. (Ø); AAAS; Ke; NSF.

37. Bases and dimension of vector spaces. (Ø); MAA; M; AAAS; Ke; NSF.

38. Subspaces of vector spaces. (Ø); M; AAAS; Ke; NSF.

39. Arithmetic of cardinals. (Ø); L; Ki.

40. Partial fractions. (Ø); M; NSF.

41. Cyclic groups. (Ø); M.

42. Cosets and Lagrange's theorem. (Ø); M.

43. Well-ordering principle. (Ø); M; Ke.

44. Quotient field of an integral domain. (Ø); M; NSF.

45. Homomorphisms of a group. (Ø); M.

46. Peano postulates. (Ø); M; NSF.

47. Cauchy sequences. (Ø); NSF(W. R. Scott, University of Kansas).

48. Quotient groups. (Ø); NSF.

49. Construction of the real numbers using Cauchy sequences. (Ø); NSF(W. R. Scott, University of Kansas).

50. Quarternions. (Ø); Ke.

The opinions, of the panelists, regarding the selected content topics are presented in Table III. Column one, marked CTN, indicates the content topic number as listed above. Other column designations are identical with those given in Table I.

TABLE III

PANELISTS RESPONSES TO CONTENT TOPICS IN ALGEBRA

CTN	CA	d	n	X^2	m	P
1	1.000	0	16	18.37	1.2	99
2	1.000	0	16	18.37	1.2	99
3	1.000	0	15	17.40	1.2	99
4	1.000	0	15	17.40	1.2	99
5	1.000	0	15	17.40	1.2	99
6	1.000	0	15	17.40	1.2	99
7	0.750	1	16	14.08	1.2	99
8	0.750	1	16	14.08	1.2	99
9	0.750	1	16	14.08	1.2	99
10	0.750	1	16	14.08	1.2	99
11	0.750	1	16	14.08	1.2	99
12	0.750	1	16	14.08	1.2	99
13	0.533	2	16	10.37	1.2	99
14	0.516	1	15	13.09	1.2	99
15	0.516	1	15	13.09	1.2	99
16	0.516	1	15	13.09	1.2	99
17	0.350	3	16	7.22	1.2	95
18	0.350	3	16	7.22	1.2	95
19	0.317	2	15	9.40	1.2	98
20	0.317	2	15	9.40	1.2	98
21	0.317	2	15	9.40	1.2	98
22	0.317	2	15	9.40	1.2	98
23	0.314	3	15	6.32	1.2	95
24	0.314	3	15	6.32	1.2	95

TABLE III (Continued)

CTN	C_A	d	n	X^2	m	P
25	0.314	3	15	6.32	1.2	95
26	0.314	3	15	6.32	1.2	95
27	0.314	3	15	6.32	1.2	95
28	0.200	4	16	4.65	1.2	95
29	0.200	4	16	4.65	1.2	95
30	0.162	4	15	3.86	1.2	90
31	0.162	4	15	3.86	1.2	90
32	0.162	4	15	3.86	1.2	90
33	0.162	4	15	3.86	1.2	90
34	0.104	4	12	2.31	1.2	80
35	0.047	5	15	2.01	1.2	80
36	0.047	5	15	2.01	1.2	80
37	0.047	5	15	2.01	1.2	80
38	0.047	5	15	2.01	1.2	80
39	-0.028	6	15	0.78	1.2	50
40	-0.028	6	15	0.78	1.2	50
41	-0.028	6	15	0.78	1.2	50
42	-0.028	6	15	0.78	1.2	50
43	-0.050	7	16	0.37	1.2	40
44	-0.050	7	16	0.37	1.2	40
45	-0.183	7	15	0.17	1.2	30
46	-0.183	8	15	0.17	1.2	30
47	0.000	6	16	1.22	1.2	70
48	0.047	5	15	2.01	1.2	80
49	0.083	5	16	2.65	1.2	85
50	0.314	3	15	6.32	1.2	95

Table III shows that, in the opinion of the panelists, the first twenty-nine suggested content topics should be considered as a nucleus for a course in algebra. The listing of the topics will be noted in the next chapter.

Topical Content for a (three semester hour) Course in Geometry

Content topics are listed as described for a course in algebra. Additional source suggestions are made by Meserve,[9] and Sherk,[10] denoted respectively by Me and S.

The preliminary selections of content topics for a course in geometry are as follows:

1. Structure of an axiomatic system. (∅); Me; S; Ki; NSF.
2. A set of postulates for geometry. (∅); Me; S; NSF (C. B. Allendoerfer, University of Washington).
3. Methods of proof in an axiomatic system. (∅); Me; S; NSF.
4. Historical discussion of "The Elements" stressing the logical shortcomings and the attempts to make the system more rigorous. (3, 5, 6); Me; S; Ki; NSF.
5. Analysis of secondary school geometry. (2, 4, 5, 6); MAA; NSF.
6. Non-Euclidean geometries discussed in relationship to the postulates given in number two. (∅); NSF.

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[9] Meserve, pp. 909-911.

[10] F. A. Sherk, _An Integrated Introduction to Geometry_ (Stillwater, 1959), pp. 1-90.

7. Axioms of analytic geometry and their relationship to the postulates given in number two. (2); Me; MAA; NSF.

8. Introduction to projective geometry. (∅); Me; S.

9. History of attempts to prove Euclid's parallel postulate. (5,6); NSF.

10. Hyperbolic geometry. Poincare model for hyperbolic geometry. (∅); Me; S; Ki; AAAS; NSF.

11. Introduction to affine geometry. (∅); Me; S; AAAS; NSF.

12. Introduction to topology. (∅); Me; S; Ki; AAAS; NSF.

13. Analytic approach to transformation groups. (∅); Me; S; Ki.

14. Elliptic geometry. (∅); Me; S; Ki;AAAS; NSF.

15. Some classical problems of antiquity connected with ruler and compass constructions. (3,4); S.

16. Differential geometry. (∅); Me; S; Ki; AAAS.

The opinions, of the panelists, regarding the selected content topics, are presented in Table IV. The notations are identical with those of Table III.

An analysis of Table IV indicates that only the first six topics are basic to a course in geometry. It should be noted that there is not a clear general outline for this course.

Topical Content for a (six semester hour) Course in Probability and Statistics

The preliminary selection of content topics for probability and statistics will be noted in the same fashion

TABLE IV

PANELISTS RESPONSES TO CONTENT TOPICS IN GEOMETRY

CTN	C_A	d	n	X^2	m	P
1	1.000	0	19	21.30	1.2	99
2	0.778	1	18	16.07	1.2	99
3	0.602	2	19	13.30	1.2	99
4	0.602	2	19	13.30	1.2	99
5	0.602	2	19	13.30	1.2	99
6	0.298	4	19	7.18	1.2	99
7	0.088	6	19	2.96	1.2	90
8	0.059	6	18	2.32	1.2	80
9	0.018	7	19	1.54	1.2	75
10	0.006	7	18	1.07	1.2	65
11	0.006	7	18	1.07	1.2	65
12	0.006	7	18	1.07	1.2	65
13	-0.046	8	18	0.32	1.2	40
14	-0.046	8	18	0.32	1.2	40
15	-0.059	8	17	0.14	1.2	30
16	0.088	13	19	2.96	1.2	90

as the content topics for algebra and geometry. Additional source material was obtained from Walter,[11] Goldberg,[12] and Mosteller, Rourke, and Thomas.[13] These will be noted by W, G and MRT, respectively.

Initial selections of content topics for probability and statistics are as follows:

1. Joint probability functions. (∅); G; MRT; NSF.

2. Binomial distribution. (∅); W; Ki; G; MRT; NSF.

3. Events and sets. (∅); W; G; MRT; MAA; NSF.

4. Permutations and combinations. (∅); G; MRT; NSF.

5. Sample spaces. (∅); W; G; MRT; NSF.

6. Central limit theorem for binomial distribution. (∅); G; MRT; NSF.

7. Poison distribution. (∅); NSF.

8. Normal approximation to the binomial distribution. (∅); G; MRT; NSF.

9 Mean and standard deviation of binomial distribution. (∅); G; MRT; NSF.

10. Markov chains. (∅); W.

11. Normal distribution. (∅); W; Ki; G; MRT; NSF.

12. Confidence intervals. (∅); MRT; NSF.

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[11] R. M. Walter, "The Education of Mathematics Teachers: Probability and Statistics," American Mathematical Monthly, LXVI (1959), 911-91[illegible].

[12] S. Goldberg, Probability: An Introduction (Englewood Cliffs, 1960), pp. 1-315.

[13] F. Mosteller, R. E. K. Rourke, and G. B. Thomas, Jr, Probability and Statistics (Reading, 1961), pp. 1-364.

13. Testing null and alternative hypotheses. (Ø); W; Ki; MRT; NSF.

14. Bayes' formula. (3); G; MRT; NSF.

15. Tree measure. (Ø); W; G; MRT; NSF.

16. Mean and standard deviation of binomial distribution. (Ø); G; MRT; NSF.

17. Covariance and correlation. (Ø); G; NSF.

18. Random variables and discrete probability functions. (Ø); W; G; MRT; NSF.

19. Completely and finitely additive set functions. (Ø); W.

20. Binomial theorem. (2); G; MRT.

21. Conditional probability. (Ø); G; MRT; NSF.

22. Chebyshev's inequality. (3); G.

23. Generalized binomial coefficients. (Ø); G.

24. Chi-square distribution. (Ø); NSF.

25. "Student's" t-distribution. (Ø); NSF.

The responses, of the panelists, regarding the selected content topics are presented in Table V. The notations are identical with those of Table IV.

The opinions of the panelists, as indicated by Table V, are that the first nineteen, as listed, content topics are suitable for the desired course in probability and statistics.

Summary

This chapter was concerned with the selection of topical content for the certain courses. The initial selection was made by the writer. This initial selection was evaluated from the reactions of mathematics educators responding to a mail questionnaire. A particular content topic was considered to be acceptable if the coefficient of agreement was positive toward agreement and the chi-square values indicated that the standard ninety-five percent acceptance level was obtained.

TABLE V

PANELISTS RESPONSES TO CONTENT TOPICS IN PROBABILITY AND STATISTICS

CTN	C_A	d	n	X^2	m	P
1	1.000	0	19	21.30	1.2	99
2	1.000	0	19	21.30	1.2	99
3	0.787	1	19	17.06	1.2	99
4	0.787	1	19	17.06	1.2	99
5	0.787	1	19	17.06	1.2	99
6	0.787	1	19	17.06	1.2	99
7	0.787	1	19	17.06	1.2	99
8	0.787	1	19	17.06	1.2	99
9	0.787	1	19	17.06	1.2	99
10	0.602	2	19	13.30	1.2	99
11	0.602	2	19	13.30	1.2	99
12	0.602	2	19	13.30	1.2	99
13	0.602	2	19	13.30	1.2	99

TABLE V (Continued)

CTN	c_A	d	n	X^2	m	P
14	0.438	3	19	10.00	1.2	99
15	0.298	4	19	7.18	1.2	99
16	0.298	4	19	7.18	1.2	99
17	0.298	4	19	7.18	1.2	99
18	0.181	5	19	4.83	1.2	95
19	0.088	6	19	2.96	1.2	90
20	0.088	6	19	2.96	1.2	90
21	0.088	6	19	2.96	1.2	90
22	0.088	6	19	2.96	1.2	90
23	0.017	7	19	1.54	1.2	75
24	0.006	7	18	1.07	1.2	65
25	-0.046	8	18	0.32	1.2	40

CHAPTER V

SUMMARY AND CONCLUSIONS

In this study there has been established a set of criteria to select the topical content of fifth-year courses in mathematics for secondary school teachers of Missouri. A mathematical topic selected should be in the union of the class of topics that:

1. Contribute to an understanding of secondary school mathematics characteristic of the present and future.
2. Contribute to depth and breadth of preparation beyond the mathematics of the secondary school and four year college.
3. Contribute to the development of the ability to further the appreciation of the broad interrelationship of the secondary school mathematics with the general scheme of the unity of thought.
4. Contribute to relating mathematics to other fields of knowledge.
5. Contribute to the development of the ability to learn new mathematics by self-instruction.
6. Contribute to the development of the ability to apply high standards of proof to a variety of mathematical problems.
7. Contribute to an understanding of mathematical topics taught on the elementary or college level.

8. Contribute to the development of material of appropriate difficulty.

9. Contribute to the correlation with the preparation of the four-year mathematics education program.

The criteria were initially selected by the writer. These selections were validated from a statistical analysis of responses to a questionnaire sent to a panel of carefully selected mathematics education specialists.

The second phase of this study concerned itself with the selection of topical content for courses in algebra, probability and statistics, and geometry. The preliminary selection of content material was made by the writer. This selection was evaluated, using a coefficient of agreement, from the reactions of mathematical educators who are concerned with the education of secondary school mathematics teachers.

Topics that were validated for inclusion in the certain courses were:

Algebra (six semester hours). Some properties of the field of rational numbers, definition and some properties of groups, algebraic operations on matrices, determinants, linear transformations, inverse of a matrix, sets and sentences, equivalence relations and equivalence classes, isomorphisms, definition and some properties of a field, construction of the rational numbers from the integers, construction of the complex numbers, modular number systems, fundamental theorem of arithmetic and applications, permutation groups, special matrices, definition and some properties of an integral domain, mathematical induction, divisors and the division algorithm for integers, different bases for the number system, linear dependence of vectors, solutions of systems of linear equations, mappings, definition and some properties of a ring. geometric representation and trigonometric form of complex numbers, the nth roots of a complex number, subgroups, ordered integral domains, construction of the integers from the natural numbers.

Probability and statistics (six semester hours). Joint probability functions, binomial distribution, events and sets, permutations and combinations, sample spaces, central limit theorem for binomial distribution, Poisson distribution, normal approximation to the binomial distribution, mean and standard deviation of binomial distribution, Markov chains, normal distribution, confidence intervals, testing null and alternative hypotheses, Bayes' formula, tree measure, mean and standard deviation of binomial distribution, covariance and correlation, random variables and discrete probability functions, completely and finitely additive set functions.

Geometry (three semester hours). Structure of an axiomatic system, a set of postulates for geometry, methods of proof in an axiomatic system, historical discussion of "The Elements" stressing the logical shortcomings and the attempts to make the system more rigorous, analysis of secondary school geometry, non-Euclidean geometries discussed in relationship to the given set of postulates for Euclidean geometry.

Content topics for any program of teacher education should not be developed once and then remain constant. They should be fluid, "partly restricted by the over-all pattern in use at the moment, and always varied by the teacher handling the job at the moment."[14] These topical contents suggested are not to be taken as the ultimate but as a pioneer program based upon the present preparation of the student. Several individuals and professional groups who have recommended topics for teacher preparation have noted that several of the selected topics should be studied in the undergraduate program; therefore, it is logical to recommend that the entire secondary school mathematics teacher education program at the college of interest be studied with respect to these recommendations.

It was noted in a report of a Conference on the Mathematics Curricula in NSF Institutes for High School Teachers that the "general outline of geometry courses is not as clear as in the case of algebra."[15] This statement is verified in this study. Therefore, the topical content for a course in geometry deserves considerable further study.

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[14]Harold Spears, The Teacher and Curriculum Planning (New York, 1951), p. 87.

[15]"A Conference on Mathematics Curricula in Institutes," American Mathematical Monthly, LXVIII (1961), 33.

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APPENDIX A

LETTER TO PANELISTS TO VALIDATE THE SELECTED SET OF CRITERIA

Dear Prof. _______:

The establishment of the fifth-year of education for secondary school teachers of mathematics has become a concern of many of our institutions of higher learning, state departments of education, and professional organizations. At present I am making plans for the establishment of a fifth-year program for secondary school mathematics teachers of Missouri.

To determine the mathematical topics to be included in a fifth-year for a five year program of preparation of secondary school mathematics teachers of Missouri I have selected criteria based upon the objectives of the State Teachers College, discussion with certain educators, and published materials. I have selected you as an educator whose experiences places you in a position to render valid opinions on these selected criteria.

For your opinion I am enclosing the selected criteria with appropriate evaluation remarks to minimize the use of your time. It will be appreciated if you will give me your authorative opinion regarding these selected criteria and return your remarks in the self-addressed and stamped envelope.

Thanking you in advance for your help I am,

Sincerely yours,

Dale Woods

dw/crd

QUESTIONNAIRE SENT TO PANELISTS

CRITERIA FOR THE SELECTION OF MATHEMATICAL TOPICS TO BE INCLUDED IN A FIFTH-YEAR FOR A FIVE YEAR PROGRAM OF PREPARATION OF SECONDARY SCHOOL MATHEMATICS TEACHERS OF MISSOURI

Please indicate your agreement or disagreement with each item in the following manner:

1. Complete or almost complete agreement. I agree with few or no reservations.
2. Tend toward agreement. I agree more than I disagree.
3. Tend toward disagreement. I disagree more than I agree.
4. Complete or almost complete disagreement. I disagree with few or no reservations.

Place a circle around the number which represents your opinion on each statement.

A mathematical topic that is included in the fifth-year of a five year program of preparation of secondary school mathematics teachers should:

1 2 3 4 I. Contribute to understanding of secondary school mathematics characteristic of the present and future.

1 2 3 4 II. Contribute to depth and breadth of preparation beyond the mathematics of the secondary school and four year college.

1 2 3 4 III. Contribute to the development of the ability to further the appreciation of the broad interrelationship of the secondary school mathematics with a general scheme of the unity of thought.

1 2 3 4 IV. Contribute to relating mathematics to other fields of knowledge.

1 2 3 4 V. Contribute to the application of mathematics to other fields of knowledge.

1 2 3 4 VI. Contribute to the development of the ability to learn new mathematics by self-instruction.

1 2 3 4 VII. Contribute to the development of the ability to apply high standards of proof to a variety of mathematical problems.

1 2 3 4 VIII. Contribute to the development of the ability to create minor mathematical research and problem-solving.

1 2 3 4 IX. Contribute to an understanding of mathematical topics taught on the elementary or college level.

1 2 3 4 X. Contribute to the development of material of appropriate difficulty.

1 2 3 4 XI. Contribute to the fifth-year if the program is a basis for an important mathematical topic.

1 2 3 4 XII. Contribute to the correlation with the preparation of the four-year mathematics program.

APPENDIX B

LETTER TO PANELISTS TO VALIDATE THE SELECTED CONTENT TOPICS

Dear Prof. ______:

I have been studying the problem of selecting topical content material for a course in algebra (geometry, probability and statistics) to be offered in the fifth-year of a five year program of preparation of Missouri secondary school teachers. Since you are a director of a summer institute under the NSF program, I would like to have your opinions regarding the topical content of such a course.

It will be appreciated if you will assist in this study by responding to the enclosed questionnaire, and returning the questionnaire in the self-addressed and stamped envelope.

Sincerely yours,

Dale Woods

dw/crd

DIRECTION SHEET FOR COMPLETING THE QUESTIONNAIRE

I would like to thank you for your time in completing this questionnaire. I realize your time is valuable so I have tried to make the questionnaire as short and time saving as possible.

So that you may have the proper perspective regarding the proposed program there are the following details that should be basic for decisions.

I. The minimum prerequisite courses are:
   1. College algebra and trigonometry (5 semester hours).
   2. Analytic geometry and calculus (10 semester hours).
   3. College geometry (2.5 semester hours).
   4. Electives (7.5 semester hours). Selected from (2.5 semester hour courses) Business Mathematics; Arithmetic for Teachers; Teaching of Arithmetic; Mathematics of Finance; Teaching of Secondary School Mathematics; Introduction to Mathematics; Elementary Statistics; and Surveying.

II. Many of the prospective students have not attended college recently.

III. A topic selected for this program should be in the union of the class of mathematical topics that:
   1. Contribute to understanding of secondary school mathematics characteristic of the present and future.
   2. Contribute to depth and breadth of preparation beyond the mathematics of the secondary school and four year college.
   3. Contribute to the development of the ability to further the appreciation of the broad interrelationship of the secondary school mathematics with a general scheme of the unity of thought.
   4. Contribute to relating mathematics to other fields of knowledge.
   5. Contribute to the development of the ability to learn new mathematics by self-instruction.
   6. Contribute to the development of the ability to apply high standards of proof to a variety of mathematical problems.
   7. Contribute to an understanding of mathematical topics taught on the elementary or college level.
   8. Contribute to the development of material of appropriate difficulty.
   9. Contribute to the correlation with the preparation of the four-year mathematics program.

IV. The textbook reference noted after each topic is for your reference regarding a typical discussion of the topic to be presented. This is NOT to be taken as a recommendation of this text.

V. The topics are NOT ordered as they are to be presented.

VI. Indicate your agreement or disagreement with the selection of each content topic in the following manner:

1. Complete or almost complete agreement. I agree with few or no reservations that this topic satisfies the set of criteria listed in III and that this topic should be included in a course designed for secondary school mathematics teachers.
2. Tend toward agreement. I agree more than I disagree that this topic satisfies the set of criteria listed in III and that this topic should be included in a course designed for secondary school mathematics teachers.
3. Tend toward disagreement. I disagree more than I agree that this topic satisfies the set of criteria listed in III and that this topic should be included in a course designed for secondary school mathematics teachers.
4. Complete or almost complete disagreement. I disagree with few or no reservations that this topic satisfies the set of criteria listed in III and that this topic should be included in a course designed for secondary school mathematics teachers.

VII. You may agree that certain topics satisfy the set of criteria listed in III and is important in the ken of the secondary school mathematics teacher but should be in the undergraduate program. In this instance you should mark complete or almost complete agreement.

TOPICAL CONTENT FOR A (SIX SEMESTER HOUR) FIFTH-YEAR COURSE IN ALGEBRA FOR TEACHERS OF SECONDARY SCHOOL MATHEMATICS IN MISSOURI

Place a check (√) in the parenthesis which represents your judgment on each selected topic.
1. Complete or almost complete agreement. 2. Tend toward agreement. 3. Tend toward disagreement. 4. Complete or almost complete disagreement.

1 2 3 4

( )( )( )( )1. Sets and sentences.
"Introduction to Modern Mathematics" R. W. Sloan

( )( )( )( )2. Boolearn algebra as a model of propositional logic.
"Applied Boolean Algebra" F. E. Hohn.

( )( )( )( )3. Mappings.
"Linear Algebra" L. J. Paige and J. D. Swift

( )( )( )( )4. Equivalence relations and equivalence classes.
"Linear Algebra" L. J. Paige and J. D. Swift

( )( )( )( )5. Arithmetic of cardinals.
"Theory of Sets" J. Breuer

( )( )( )( )6. Definition and some properties of a ring.
"Modern Algebra" N. H. McCoy

( )( )( )( )7. Modular number systems.
"The Skeleton Key of Mathematics" D. E. Littlewood

( )( )( )( )8. Isomorphisms.
"A Concrete Approach to Abstract Algebra" W. W. Sawyer

( )( )( )( )9. Definition and some properties of an integral domain.
"Survey of Modern Algebra" G. Birkhoff and S. MacLane

( )( )( )( )10. Ordered integral domains.
"Survey of Modern Algebra" G. Birkhoff and S. MacLane

( )( )( )( )11. Well-ordering principle.
"Theory of Sets" J. Breuer

( )( )( )( )12. Mathematical induction.
"Mathematical Induction" a film by L. Henkin

( )( )( )( )13. Peano postulates.
"Foundations of Analysis" E. Landau

( )( )( )( )14. Divisors and the division algorithm for integers.
"Higher Algebra for the Undergraduate" M. Weiss

( )( )( )( )15. Different bases for the number system.
"Applied Boolean Algebra" F. E. Hohn

( )( )( )( )16. Fundamental theorem of arithmetic and applications.
"Modern Algebra" N. H. McCoy

( )( )( )( )17. Definition and some properties of a field.
"Modern Algebra" N. H. McCoy

( )( )( )( )18. Some properties of the field of rational numbers.
"Elements of Algebra" H. Levi

( )( )( )( )19. Construction of the integers from the natural numbers.
"Elements of Algebra" H. Levi

( )( )( )( )20. Quotient field of an integral domain.
"Higher Algebra for the Undergraduate" M. Weiss

( )( )( )( )21. Construction of the rational numbers from the integers.
"The Number System" H. A. Thurston

( )( )( )( )22. Cauchy sequences.
"Foundations of Mathematics" R. L. Wilder

( )( )( )( )23. Construction of the real numbers using Cauchy sequences.
"Elements of Algebra" H. Levi

( )( )( )( )24. Some properties of real numbers.
"Elements of Algebra" H. Levi

( )( )( )( )25. Construction of the complex numbers.
"Modern Algebra" N. H. McCoy

( )( )( )( )26. Geometric representation and trigonometric form of complex numbers.
"Higher Algebra for the Undergraduate" M. Weiss

( )( )( )( )27. The n nth roots of a complex number.
"Higher Algebra for the Undergraduate" M. Weiss

( )( )( )( )28. Polynomial rings.
"Fundamental Concepts of Algebra" B. E. Meserve

( )( )( )( )29. Divisors and the division algorithm for polynomials.
"Fundamental Concepts of Algebra" B. E. Meserve

( )( )( )( )30. Unique factorization in F[x].
"Fundamental Concepts of Algebra" B. E. Meserve

( )( )( )( )31. Partial fractions.
"Modern Algebra" N. H. McCoy

( )( )( )( )32. Definition and some properties of groups.
"Fundamental Concepts of Mathematics" H. Eves and C. V. Newsom

( )( )( )( )33. Permutation groups.
"Insights in Modern Mathematics"

( )( )( )( )34. Cyclic groups.
"The Skeleton Key of Mathematics" D. E. Littlewood

( )( )( )( )35. Subgroups.
"Modern Algebra" N. H. McCoy

( )( )( )( )36. Cosets and Lagrange's theorem.
"Modern Algebra" N. H. McCoy

( )( )( )( )37. Homomorphisms of a group.
"Higher Algebra for the Undergraduate" M. Weiss

( )( )( )( )38. Quotient groups.
"Modern Algebra and Matrix Theory" R. W. Ball and R. A. Beaumont

( )( )( )( )39. Coordinate systems in space.
"Introduction to Modern Algebra" J. L. Kelley

( )( )( )( )40. Vectors and analytic geometry of space.
"Introduction to Modern Algebra" J. L. Kelley

( )( )( )( )41. Bases and dimension of vector spaces.
"Modern Algebra and Matrix Theory" R. W. Ball and R. A. Beaumont

( )( )( )( )42. Linear dependence of vectors.
"A Concrete Approach to Abstract Algebra" W. W. Sawyer

( )( )( )( )43. Subspaces of vector spaces.
"Linear Algebra" L. J. Paige and J. D. Swift

( )( )( )( )44. Quarternions.
"Introduction to Modern Algebra" J. L. Kelley

( )( )( )( )45. Algebraic operations on matrices.
"Linear Algebra for the Undergraduate"
D. C. Murdoch

( )( )( )( )46. Determinants.
"Higher Algebra for the Undergraduate" M. Weiss

( )( )( )( )47. Linear transformations.
"Linear Algebra for the Undergraduate"
D. C. Murdoch

( )( )( )( )48. Solutions of systems of linear equations.
"Modern Algebra and Matrix Theory" R. W. Ball
and R. A. Beaumont

( )( )( )( )49. Inverse of a matrix.
"Introduction to Modern Algebra" J. L. Kelley

( )( )( )( )50. Special matrices, zero, identity, nilpotent,
idempotent.
"Modern Algebra and Matrix Theory" R. A. Ball
and R. A. Beaumont

TOPICAL CONTENT FOR A (THREE SEMESTER HOUR) FIFTH-YEAR COURSE IN ALGEBRA FOR TEACHERS OF SECONDARY SCHOOL MATHEMATICS IN MISSOURI

Place a check (√) in the parenthesis which represents your judgment on each selected topic.
1. Complete or almost complete agreement. 2. Tend toward agreement. 3. Tend toward disagreement. 4. Complete or almost complete disagreement.

 1 2 3 4
( )( )( )( )1. Structure of an axiomatic system.
"Foundations of Mathematics" R. L. Wilder

( )( )( )( )2. Methods of proof in an axiomatic system.
"Foundations of Mathematics" R. L. Wilder

( )( )( )( )3. Historical discussion of "The Elements" stressing the logical shortcomings and the attempts to make the system more rigorous.
"History of Mathematics" H. Eves

( )( )( )( )4. Analysis of secondary school geometry. Including a discussion of some traditional and "modern" texts.

( )( )( )( )5. History of attempts to prove Euclid's parallel postulate.
"Fundamental Concepts of Geometry" B. E. Meserve

( )( )( )( )6. A set of postulates for geometry. (22 postulates given in an OUTLINE OF A SUMMER INSTITUTE COURSE IN GEOMETRY by C. B. Allendoerfer).

( )( )( )( )7. Axioms of analytic geometry and their relationship to the axioms given in number six.
"Coordinate Geometry" L. P. Eisenhart

( )( )( )( )8. Non-Euclidean geometries discussed in relationship to the axioms given in number six.

( )( )( )( )9. Analytic approach to transformation groups.
"An Integrated Introduction to Geometry" F. A. Sherk

( )( )( )( )10. Hyperbolic geometry. Poincare model for hyperbolic geometry.
"Fundamental Concepts of Geometry" B. E. Meserve

( )( )( )( )11. Elliptic geometry.
"Non-Euclidean Geometry" H. E. Wolfe

( )( )( )( )12. Differential geometry.
"Geometry and the Imagination" D. Hilbert and S. Cohn-Vossen

( )( )( )( )13. Introduction to affine geometry.
"Modern Algebra" G. Birkhoff and S. MacLane

( )( )( )( )14. Introduction to projective geometry.
"Modern Algebra" G. Birkhoff and S. MacLane

( )( )( )( )15. Introduction to topology.
"Fundamental Concepts of Geometry" B. E. Meserve

( )( )( )( )16. Some classical problems of antiquity connected with ruler and compass constructions.
"An Integrated Introduction to Geometry" F. A. Sherk

TOPICAL CONTENT FOR A (SIX SEMESTER HOUR) FIFTH-YEAR COURSE

IN PROBABILITY AND STATISTICS FOR TEACHERS OF SECONDARY
SCH
SCHOOL MATHEMATICS IN MISSOURI

Place a check (✓) in the parenthesis which represents your judgment on each selected topic.
1. Complete or almost complete agreement. 2. Tend toward agreement. 3. Tend toward disagreement. 4. Complete or almost complete disagreement.

1 2 3 4
( )( )( )( )1. Events and sets.
"Probability and Statistics" F. Mosteller, R. E. K. Rourke and G. B. Thomas, Jr.

( )( )( )( )2. Completely and finitely additive set functions.
"Insights in Modern Mathematics"

( )( )( )( )3. Permutations and combinations.
"Theory of Probability" M. E. Monroe

( )( )( )( )4. Binomial theorem.
"Probability and Statistics" F. Mosteller, R. E. K. Rourke and G. B. Thomas, Jr.

( )( )( )( )5. Generalized binomial coefficients.
"Finite Mathematics" J. G. Kemeny, L. J. Snell and G. L. Thompson

( )( )( )( )6. Markov chains.
"Finite Mathematics" J. G. Kemeny, L. J. Snell and G. L. Thompson

( )( )( )( )7. Sample spaces.
"Probability" S. Goldberg

( )( )( )( )8. Conditional probability.
"Probability and Statistics" F. Mosteller, R. E. K. Rourke and G. B. Thomas, Jr.

( )( )( )( )9. Tree measure.
"Finite Mathematics" J. G. Kemeny, L. J. Snell and G. L. Thompson

( )( )( )( )10. Bayes' formula.
"Probability" S. Goldberg

( )( )( )( )11. Random variables and discrete probability functions.
"Modern Mathematical Methods and Models" Vol. II

( )( )( )( )12. Chebyshev's inequality.
"Statistics" D. A. S. Fraser

( )( )( )( )13. Joint probability functions.
"Theory of Probability" M. E. Munroe

( )( )( )( )14. Binomial distribution.
"Probability" S. Goldberg

( )( )( )( )15. Mean and standard deviation of binomial distribution.
"Modern Mathematical Methods and Models" Vol. II.

( )( )( )( )16. Central limit theorem for binomial distribution.
"Theory of Probability" M. E. Munroe

( )( )( )( )17. Poisson distribution.
"Theory of Probability" M. E. Munroe

( )( )( )( )18. Normal approximation to the binomial distribution.
"Modern Mathematical Methods and Models" Vol. II

( )( )( )( )19. Normal distribution.
"Statistics" D. A. S. Fraser

( )( )( )( )20. Confidence intervals.
"Probability and Statistics" F. Mosteller, R. E. K. Rourke and G. B. Thomas, Jr.

( )( )( )( )21. Mean and standard deviation of normal distribution.
"Probability and Statistics" F. Mosteller, R. E. K. Rourke and G. B. Thomas, Jr.

( )( )( )( )22. Testing null and alternative hypotheses.
"Elementary Statistics" S. F. Mack

( )( )( )( )23. Covariance and correlation.
"Probability" S. Goldberg

( )( )( )( )24. Chi-square distribution.
"Elementary Statistics" S. F. Mack

( )( )( )( )25. "Student's" t-distribution.
"Introduction to Statistics" P. G. Hoel

VITA

Dale Woods

Candidate for the Degree of

Doctor of Education

Thesis: TOPICAL CONTENT FOR CERTAIN FIFTH-YEAR MATHEMATICS COURSES FOR MISSOURI SECONDARY SCHOOL MATHEMATICS TEACHERS

Major Field: Higher Education, Mathematics

Biographical:

Personal Data: Born in Stone County, Missouri, November 1, 1922, the son of Fidlding Justice and Elizabeth Holt Woods.

Education: Attended Railey Creek Elementary School, Stone County, Missouri; graduated from Abesville High School, Galena, Missouri in 1937; attended Northwest Missouri State College, Maryville, Missouri; and received the degree of Bachelor of Science in Education from Southwest Missouri State College, Springfield, Missouri, in 1944; attended Washington University, St. Louis, Missouri; North Dakota State University, Fargo, North Dakota; Drake University, Des Moines, Iowa; University of California, Berkeley, California; received the Master of Science degree in mathematics from Oklahoma State University, Stillwater, Oklahoma in 1950; attended the University of Colorado, and completed the requirements for the Doctor of Education degree in Higher Education, Mathematics, in August, 1961.

Professional Experience: Taught mathematics in secondary schools; U. S. Navy; Instructor of Mathematics at North Dakota State University; Texas Western College; Mississippi Southern College; Assistant Professor of Mathematics at Memphis State University; Idaho State College; Associate Professor of Mathematics at Northeast Missouri State Teachers College; and part-time teaching assistant at Oklahoma State University.

Professional Organizations: Kappa Mu Epsilon; Pi Gamma Mu; Mathematical Association of America; National Council of Teachers of Mathematics; Missouri State Teachers Association.