THE UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

THE PREPARATION OF TEACHERS OF ELEMENTARY SCHOOL MATHEMATICS IN LOUISIANA

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the degree of

DOCTOR OF EDUCATION

BY

MARILYN MILLER RAY

Norman, Oklahoma

1967

THE PREPARATION OF TEACHERS OF ELEMENTARY SCHOOL MATHEMATICS IN LOUISIANA

APPROVED BY

Mary Clare Petty

Fred Sloan

Henry Angelucci

Claude Kelley

DISSERTATION COMMITTEE

ACKNOWLEDGMENTS

To Dr. Mary Clare Petty, my major professor, I express my sincere appreciation and gratitude for her guidance and untiring assistance throughout the development of this study.

To the members of the dissertation committee, Dr. Henry Angelino, Dr. Claude Kelley, Dr. William B. Ragan, who served until his retirement, and to Dr. Fred A. Sloan, who graciously agreed to serve on the committee, I extend thanks and appreciation for their constructive criticisms and encouragement at various stages of this study.

To the Southern Education Foundation, I acknowledge with gratitude the grant for graduate study which culminated with this research.

To the many thoughtful and conscientious instructors and administrators who shared their educational experiences and hopes, I express very special thanks.

To my parents, Wallace and Erelene Bradford, I express my love and gratitude for their guidance and encouragement throughout my life.

To my husband, Thomas Emanuel Ray, I am eternally grateful for his patience and encouragement during my graduate studies.

To other relatives, colleagues, and friends who have offered encouragement, I express thanks.

TABLE OF CONTENTS

Page

APPENDICES

LIST OF TABLES

THE PREPARATION OF TEACHERS OF ELEMENTARY *SCHOOL MATHEMATICS IN LOUISIANA*

CHAPTER I

THE STUDY

Within the past two decades elementary school mathematics objectives have been revised and broadened and, as the objectives have changed, there have been changes in content, materials, and methods of instruction.[1] The major reasons for these changes were the launching of Sputnik I in 1957, technological advances in science and industry, and increasing involvement of mathematicians in mathematics education.

Criticisms of traditional arithmetic programs have resulted in the production of new instructional materials and the development of programs characterized by significant changes in content and emphasis upon the development of meaning. The most influential programs have been the

---

[1]William A. Brownell, "The Revolution in Arithmetic," The Arithmetic Teacher, I (February, 1954), pp. 1-5.

School Mathematics Study Group Program, Greater Cleveland Mathematics Program, University of Illinois Project, The Madison Project, The Stanford Project, and The Minnemath Project. These programs are experimental in nature and are characterized by careful evaluation and frequent revision.

The experimental programs and some of the revised textbook programs are often referred to as "new mathematics." The new mathematics materials should not be confused with the innovations of programmed materials. The programmed materials are designed for self-instruction and remedial purposes; whereas, the new mathematics materials may be used as comprehensive programs for various grade levels and as extensive enrichment to more traditional arithmetic programs.

Although many programs use the terms "arithmetic" and "mathematics" interchangeably, their main focus is to teach the student the structure of mathematics and to develop in him a sense of discovery and inquiry. These programs concentrate on the organization of content and sequence of experiences for children and present a vocabulary of quantitative and space relationships which pupils need to understand.

Educators generally agree upon what content should be included in modern elementary mathematics programs. They recommend topics such as Sets, Number Systems, Numeration and Operations on Numbers, Geometry, and

Probability.[1]

Another essential element in all the new programs is the teaching method. The didactic approach is avoided, and the teacher seeks to elicit from the student a thoughtful response. This approach is described as follows:

> Through a kind of Socratic question-posing technique, students are gently steered into finding out for themselves about the world of numbers--into making and testing conjectures and devising rules for procedure, the premise being that what is intellectually intriguing is fun, and so learned faster and better.[2]

The discovery method involves creativity, logic, and understanding. Because it is thus expanded, this method demands much of the teacher. He needs to know more mathematics to lead students to discovery than does his more traditional counterpart who simply performs computations or justifies mathematical rules.

Hiebert has dramatically reiterated the inadequate preparation of most elementary teachers:

> In many teacher training programs, the prospective teacher has been placed in a class reviewing arithmetic. This is what he did in grade 7, grade 8, and grade 9. By the time the student reaches college, he has become so familiar with the rules, "cross multiply," "change the sign and add," "invert and multiply," that he can and does misuse them without even thinking. The short course in symbol-juggling algebra or the

---

[1]Lola J. May, Major Concepts of Elementary Modern Mathematics (Wilmette, Illinois: John Colburn, 1962), pp. 1-60.

[2]David Bergamini, Mathematics, No. 02774 of Life Science Library (New York: Time Incorporated, 1963), p. 194.

> review of arithmetic seems to be designed to kill or cure, with little real responsibility of a cure.[1]

There are fundamental principles of mathematics which, with proper definition, can be used as a foundation for mathematics instruction in elementary schools. Frequently these principles are not understood or they are not apparent to the prospective teacher. Hiebert emphasizes the importance to a prospective teacher of "precise definitions, the set terminology when it clarifies concepts being discussed, and more symbolism when it aids the thinking." He also observes that students who are planning to teach should be exposed to new teaching methods, adding that a beginning teacher will be most likely to utilize the method by which he himself was taught.[2]

Stiles discusses general preparation to teach and advocates that prospective teachers be provided with sufficient background in the content they will teach to give them an adequate reservoir of information, understanding, and intellectual skills to draw on in planning and managing students' learning activities.[3] Students should be adequately prepared by professional and academic

---

[1]Vern D. Hiebert, "Preparing Elementary Teachers in Mathematics," Educational Leadership, XIX (March, 1962), p. 383.

[2]Ibid., p. 384.

[3]Lindley J. Stiles et al., Teacher Education in the U.S. (New York: The Ronald Press Company, 1960), pp. 17-18.

staffs working cooperatively and sharing responsibility for planning programs to develop essential competencies in mathematics.

The Problem

The problem of this study was to determine the adequacy of preparatory programs in content needed to teach elementary mathematics. The three-fold purpose of this study was to determine the content of elementary school mathematics, to analyze the content offerings of college programs, and to evaluate the college programs.

Limitations of the Study

This study was not concerned with admission requirements, retention and selection of students, graduation requirements, the preparation of mathematics majors or minors, or the qualifications of the faculty of the institutions. It was limited in the following ways:

1. To mathematics content in preparatory programs for prospective elementary teachers in colleges and universities in Louisiana with at least four hundred students enrolled in teacher education.

2. To mathematics content as revealed by course outlines, teacher guides and manuals, and the instructors of college and university mathematics courses.

3. To mathematics content of pupil textbooks for the elementary grades adopted by Louisiana as of September 1966.

4. To recommendations on mathematics content for preparatory programs from the Committee on the Undergraduate Program in Mathematics of the Mathematical Association of America.

Procedures

The primary purpose of this study was to gather information which could increase the effectiveness of the preparation of prospective elementary teachers to teach mathematics. The first phase of the study included the analysis of state-adopted textbooks to establish the content of elementary school mathematics programs. The first problem in this analysis was the selection of textbooks to be analyzed. This selection was based upon information obtained from the Supervisor of Mathematics in the Louisiana State Department of Education and from school personnel in the nine cities with over 25,000 residents. The second problem was the identification of mathematical content of the selected series.

The second phase of the study was the determination of the scope of content of college courses in mathematics for elementary teachers through an analysis of textbooks and course outlines and through interviews with college instructors. The scope of content of college textbooks was compared with the composite list of mathematical content in the state-adopted textbooks. Interviews were conducted to gather additional information about the college courses.

The third phase of the study was the comparison of mathematical content offerings of preparatory programs with the recommendations of the Committee on the Undergraduate

Program in Mathematics of the Mathematical Association of America. This comparison provided a basis for evaluation of preparatory programs.

Need for the Study

Research on methods of instruction, improvement of teaching aids, special courses for teachers, and sequences of courses for teachers has been highly significant for teacher education.[1] Studies have pointed out the inadequacies of many elementary school teachers in their ability to understand basic mathematical and arithmetical concepts. Dutton indicated that this was not surprising since they were "taught by a mechanically-oriented approach in elementary school and received, in general, the same type of instruction in methods courses at the college or university levels."[2]

Typical of the many expressions of dissatisfaction with traditional teaching of mathematics is the criticism by Thorpe:

> These institutions have in the past taken too much for granted regarding competence in arithmetic when their students enter college. Teachers have gone into service poorly prepared to cope with arithmetic; and a vicious circle is created, for their pupils are no

---

[1]John A. Brown and John R. Mayor, "The Academic and Professional Training of Teachers of Mathematics," Review of Educational Research, XXXI (June, 1961), p. 302.

[2]Wilbur H. Dutton, Evaluating Pupils' Understanding of Arithmetic (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1964), p. 102.

better prepared than they themselves were in elementary school.

> Mueller seems to concur when he says: what is needed is course-work specifically designed to meet the specific mathematical demands of the elementary classroom; course-work that will provide the elementary teacher with a mature awareness and appreciation of the foundation elements, of the diversity and interrelatedness of the myriad parts which go to form the structure of arithmetic; coursework that will provide a consciousness of the whole against which one may, with security and understanding, teach the segments of the subject pertinent to the given grade level.[1]

The natural outcome of research in the area of mathematics and of changes in elementary school mathematics programs should be changes in the college curriculum. A study of the content of preparatory programs was definitely needed to determine if the curricular offerings were based upon the changing content, emphases, and applications of elementary school mathematics.

Sources of Data

The following were the sources of data for this study: pupil textbooks, college textbooks, the Committee on the Undergraduate Program in Mathematics (CUPM) recommendations, and instructors of college courses.

The five series of pupil textbooks most frequently used in Louisiana were analyzed. These textbooks were:

---

[1]Cleata B. Thorpe, Teaching Elementary Arithmetic (New York: Harper Brothers, Publishers, 1962), pp. 8-9.

American Book Series

Edwina Dean, Robert B. Kane and Robert A. Oesterle. Meeting Mathematics, Grade 1. New York: American Book, 1963.

Edwina Dean, Robert B. Kane and Robert A. Oesterle. Exploring Mathematics, Grade 2. New York: American Book, 1963.

Edwina Dean, Robert B. Kane and Robert A. Oesterle. Developing Mathematics, Grade 3. New York: American Book, 1963.

Edwina Dean et al. Understanding Mathematics, Grade 4. New York: American Book, 1963.

Edwina Dean et al. Learning Mathematics, Grade 5. New York: American Book, 1963.

Edwina Dean et al. Unifying Mathematics, Grade 6. New York: American Book, 1963.

Holt, Rinehart and Winston Series

Elda L. Merton and Leo J. Brueckner. Moving Ahead in Arithmetic, Grades 1-2. New York: Holt, Rinehart and Winston, 1964.

Leo J. Brueckner, Elda L. Merton and Foster E. Grossnickle. Moving Ahead in Arithmetic, Grades 3-6. New York: Holt, Rinehart and Winston, 1963.

Laidlaw Brothers Series

Bernard H. Gundlach, Ronald C. Welch and Edward G. Buffie. Sets. Numbers. Numerals, Grades 1-2. River Forest, Illinois: Laidlaw Brothers, 1965.

E. T. McSwain et al. Arithmetic, Grades 3-6. River Forest, Illinois: Laidlaw Brothers, 1965.

Scott Foresman Series

Maurice L. Hartung et al. Numbers We See, Grade 1. Chicago: Scott Foresman, 1961.

Maurice L. Hartung, Henry Van Engen, and Catherine Mahoney. Numbers in Action, Grade 2. Chicago: Scott Foresman, 1961.

Maurice L. Hartung et al. Seeing Through Arithmetic Through Discovery, Grades 3-6. Chicago: Scott Foresman, 1961.

Silver Burdett Series

Robert Lee Morton et al. Modern Arithmetic Through Discovery, Grades 1-6. Morristown, N. J.: Silver Burdett, 1964.

All college textbooks used in basic mathematics, mathematics for elementary teachers, and methods of teaching mathematics were analyzed. The textbooks used in the two basic mathematics courses were the following:

Carl B. Allendoerfer and Cletus O. Oakley. Fundamentals of College Algebra. New York: McGraw-Hill Book Co., 1967.

Daniel E. Dupree and Frank L. Harmon. Modern College Algebra. Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1965.

Benjamin E. Mitchell and Haskell Cohen. A New Look at Elementary Mathematics. Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1965.

Merlin M. Ohmer, Clayton V. Aucoin and Marion J. Cortez. Elementary Contemporary Mathematics. New York: Blaisdell Publishing Company, 1964.

Thomas L. Wade and H. E. Taylor. Fundamental Mathematics. New York: McGraw-Hill Book Company, 1961.

Edwin F. Beckenbach, Irving Drooyan and William Wooton. Essentials of College Algebra. Belmont, Calif.: Wadsworth Publishing Company, Inc., 1965.

Instructors in the third course in mathematics for teachers selected six different textbooks. These textbooks were:

J. Houston Banks. Learning and Teaching Arithmetic. Boston: Allyn and Bacon, Inc., 1964.

J. Richard Byrne. Modern Elementary Mathematics. New York: McGraw-Hill Book Company, 1966.

National Council of Teachers of Mathematics. Topics in Mathematics for Elementary School Teachers. 29th Yearbook. Washington, D. C.: The Council, 1964.

Merlin M. Ohmer, Clayton V. Aucoin and Marion J. Cortez. Contemporary Algebra. New York: Blasidell Publishing Company, 1966.

James R. Smart. Introductory Geometry. Boston: Allyn and Bacon, Inc., 1963.

School Mathematics Study Group. Studies in Mathematics Volume VII Intuitive Geometry. Stanford, Calif.: School Mathematics Study Group, 1964.

Instructors of methods courses selected four different textbooks. These textbooks were:

J. Houston Banks. Learning and Teaching Arithmetic. Boston: Allyn and Bacon, Inc., 1964.

Foster E. Grossnickle and Leo J. Brueckner. Discovering Meanings in Elementary School Mathematics. New York: Holt, Rinehart and Winston, 1963.

John L. Marks, C. Purdy and Lucien B. Kinney. Teaching Elementary School Mathematics for Understanding. New York: McGraw-Hill Book Company, 1965.

Donald E. Shipp and Sam Adams. Developing Arithmetic Concepts and Skills. Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1964.

The recommendations of the Committee on the Undergraduate Program in Mathematics were used as criteria for determining the adequacy of preparatory programs. These recommendations list the equivalent of a two-course sequence devoted to the structure of the real number system and its subsystems, a course in algebra, and a course in informal geometry as adequate preparation for teachers of elementary school mathematics.

Interviews were held with seven deans of colleges of education, two chairmen of elementary education departments, seven instructors of basic mathematics, five instructors of the third course in mathematics, and seven instructors of methods of teaching elementary mathematics at the following institutions: Grambling College, Louisiana Polytechnic Institute, Louisiana State University, Northeast Louisiana State College, Northwestern State College, Southern University, and the University of Southwestern Louisiana. Each of these institutions enrolled more than four hundred elementary education majors, and together they enrolled more than eighty per cent of the total enrollment in elementary education in seventeen teacher education programs in Louisiana. A brief description of each institution can be found in Appendix B.

CHAPTER II

REVIEW OF RELATED RESEARCH

During the past several decades educators have been pointing out weaknesses in elementary school mathematics programs. Many of their criticisms stemmed from the inability of a large proportion of high school graduates to comprehend comparatively simple arithmetic and compute problems in it.[1] These criticisms have been supported by research studies, particularly in college classes of freshmen, education majors, graduate students, and in-service teachers.

Glennon[2] reported that the general development of arithmetic understanding on the part of undergraduates in representative teacher-training institutions was very low. He stated that the teachers whom he tested seemed to understand about fifty-five per cent of the understandings basic to the computation processes commonly taught in grades one

---

[1]Cleata B. Thorpe, Teaching Elementary Arithmetic (New York: Harper & Brothers, Publishers, 1962), p. 6.

[2]Vincent J. Glennon, "A Study in Needed Redirection in the Preparation of Teachers of Arithmetic," Mathematics Teacher, XLII (December, 1949), pp. 389-396.

through six.

In another study Habel[1] concluded that thirty to forty per cent of the freshmen in most sections of the country were inferior to the average eighth grade student in computational skill. He further stated that emphasis on the development of mathematical skills in elementary and high school did not foster the retention of these skills or insure the ability to apply them, and that the failure to stress the development and understanding of mathematical concepts accounted, at least in part, for the students' meager residuum of learning.

Wilburn and Wingo[2] pointed out that arithmetic was very important to elementary teachers yet they have less insight into the content of arithmetic than into any other subject. They suggested that teacher training institutions pay more attention to providing prospective elementary school teachers with a better understanding of arithmetic and the number system.

Phillips[3] studied achievement in the meaning and

---

[1]E. A. Habel, "Deficiencies of College Freshmen in Arithmetic," School Science and Mathematics, L (June, 1950), pp. 480-482.

[2]D. B. Wilburn and G. M. Wingo, "Inservice Development of Teachers of Arithmetic," National Society for the Study of Education, Fiftieth Yearbook, Part II (Chicago: University of Chicago Press, 1951), p. 253.

[3]Clarence Phillips, "Background and Mathematical Achievement of Elementary Education Students in Arithmetic for Teachers," School Science and Mathematics, LIII (January, 1953), p. 52.

understanding of arithmetic of elementary education majors. He found that meaning and problem solving achievement involving measurement, fractions, and per cent were very low.

Orleans and Wandt[1] reporting on undergraduates, classroom teachers and others, revealed that: (1) Being prepared as a teacher of arithmetic, or even having experience in teaching the subject, did not appear to guarantee a thorough understanding of arithmetic fundamentals, (2) There were apparently few processes, concepts, or relationships in arithmetic which were understood by a large per cent of teachers, and (3) The lack of understanding evidenced by the teachers was more of subject matter than of instructional procedures. They concluded:

> If the understanding of arithmetic possessed by teachers is to be increased, teacher-training institutions must make this one of their goals. The teacher-education institutions may have only an indirect influence on the program of number work in the schools, but they can directly influence the prospective teacher's knowledge and understanding of arithmetic and his preparation for his responsibilities in getting children to learn about numbers.[2]

Schaaf[3] pointed out that there was evidence of the elementary teachers' need for more knowledge of arithmetic.

---

[1]Jacob S. Orleans and Edwin Wandt, "The Understanding of Arithmetic Possessed by Teachers," The Elementary School Journal, LIII (May, 1953), pp. 506-507.

[2]Ibid.

[3]William L. Schaaf, "Arithmetic for Arithmetic Teachers," School Science and Mathematics, LIII (October, 1953), pp. 537-543.

Furthermore he indicated that there was probably little change in per cent of understanding on the part of the teachers from that reported in the Glennon study.

Another study[1] concluded that graduate students in Education showed a lack of competence in arithmetical computations, accompanied by a lack of confidence, that caused them to fear courses in statistics. The investigators added that it would not be difficult to obtain similar data from other graduate students.

Weaver's study[2] corroborated the findings of Glennon's research, and he concluded that the undergraduates who were sampled appeared to have mastered a disturbingly small proportion of the understandings tested--understandings that are vital to meaningful arithmetic instruction in the elementary school grades. He also stated that many undergraduates in our teacher training institutions appeared to be weak in their background of mathematical understandings in areas such as Decimal Systems of Notation, Basic Understandings of Integers and Processes, Fractions and Processes, Decimals, and of the Rationals of Computation. He listed the following reasons for the

---

[1]Jacob S. Orleans and Julia B. Sperling, "The Arithmetic Knowledge of Graduate Students," Journal of Educational Research, XLVIII (November, 1954), pp. 177-186.

[2]Fred J. Weaver, "A Crucial Problem in the Preparation of Elementary School Teachers," The Elementary School Journal, LVI (February, 1956), pp. 253-257.

situation: (1) few undergraduates have had the benefit of truly meaningful arithmetic instruction throughout their own elementary school days, (2) many of these students received little or no additional mathematics instruction as part of their secondary school work, (3) those who did study mathematics at the secondary level generally pursued work which contributed little, if anything, to their existing background of arithmetic understanding, (4) all too many undergraduates had no work of any kind relating to content mathematics, especially arithmetic, during their college or university training programs, and (5) few students preparing to teach in the elementary schools elected to study courses in the field of mathematics, and numerous institutions had no required work in background mathematics of any type as a part of their teacher training curriculums for the elementary level.

In a study of teacher education programs,[1] opinions were received from college of education deans, liberal arts deans, school superintendents, and teachers. The respondents recommended: (1) more and better teaching of the professional skills, methods, techniques and management, (2) teaching toward the improvement of professional attitudes, (3) improved and more work in professional courses in background, history of education, theory of education,

---

[1]Adolph Unruh, "What's Needed in Teacher Education," Phi Delta Kappan, XXXVII (March, 1956), pp. 258-261.

philosophy of education, methods of teaching, and knowledge of the public schools, (4) improved general education with more education in the culture of the people, more knowledge, and correlation and interrelation of knowledge, (5) more professional education courses in terms of practical problems courses, and (6) more knowledge and subject matter specialization.

In another study[1] opinionnaires were sent to personnel of institutions of teacher education in twelve states seeking responses to questions about purpose and functions, control, support, admission, program strengths and weaknesses, and problems. A tabulation of responses revealed the following weaknesses: (1) lack of attention to needs of individual students who wish to become teachers, (2) the perpetuation of traditional subjects and methods, (3) confusing and excessive terminology in teacher education, (4) failure of teachers' colleges to work closely with the schools of their areas of service, (5) undue neutralism toward teaching of values, (6) over-emphasis upon academic achievement, (7) tendency of some institutions to produce the "mass mind" rather than independent thinking, and (8) lack of research findings upon many phases of teacher education.

Stipanowich viewed the problem of preparing

---

[1]Ellis F. Hartford, "A Look at Teacher Education," Journal of Teacher Education, VIII (March, 1957), p. 77.

teachers to teach in this manner: "Many teachers have apparently lacked an understanding of the subject necessary to interpret and implement the theory of meaning at the level of practice in the classroom." He further stated that all prospective elementary school teachers need an adult view of arithmetic in which the meanings and understandings of the subject are stressed.[1]

Students enrolled in a course designed to instruct in subject matter of arithmetic methods, trends, and current literature on the teaching of arithmetic, were given a forty-item test at the first class session by Fulkerson.[2] The data that he obtained revealed that far too many of the prospective elementary teachers had an insufficient knowledge of arithmetic to teach the subject effectively. Commenting on the findings, he stated that: (1) performance becomes better as preparation in mathematics increases, (2) those with more than two years of high school mathematics performed significantly better than did those with two years or less, and (3) those with more than four quarter hours of college credit in mathematics performed better than did those having just the prerequisite hours.

---

[1]Joseph Stipanowich, "The Mathematical Training of Prospective Elementary-School Teachers," The Arithmetic Teacher, IV (December, 1957), pp. 240-241.

[2]Elbert Fulkerson, "How Well Do 138 Prospective Elementary Teachers Know Arithmetic," The Arithmetic Teacher, VII (March, 1960), pp. 141-146.

In a study of prospective teachers' attitudes toward mathematics, Purcell[1] suggested that teaching methods as well as content are important in trying to change attitudes. He recommended that the equivalent of a year's course in content be a prerequisite to the methods course, that the content course consider the material of elementary mathematics stressing structure with emphasis on meanings and understandings, and that modern techniques and concepts of mathematics be included in both the content and methods course.

Strain[2] studied the prospective elementary school teachers' knowledge of selected content. He recommended that: (1) educators focus attention on the development of prospective teachers' knowledge of the content of school subjects, (2) teacher education programs include regular, built-in features which permit thorough measurement and evaluation of all phases of college preparation for teaching, including subject matter knowledge, and (3) attention be focused directly on the qualities developed in each individual rather than upon a set program prescribed for all prospective teachers irrespective of their unique needs.

---

[1]William J. Purcell, "Some Factors Affecting Attitudes of Prospective Teachers Toward Elementary Mathematics" (unpublished Ed.D. dissertation, Teachers' College, Columbia University, 1964).

[2]Lucille Brewton Strain, "Prospective Elementary-School Teachers Knowledge of Selected Subject Matter" (unpublished Ph.D. dissertation, College of Education, Ohio State University, 1965).

There have been a number of studies which have pointed out the importance of college mathematics in the elementary teachers' preparation for teaching mathematics. One such study by Gilbert[1] revealed that background in high school mathematics, including two courses of algebra and one course of plane geometry, produced a significantly higher level of understanding of arithmetic, and that students who completed at least three semester hours of college mathematics seemed to display fuller understanding of arithmetic than those who had a weaker background.

In a related study of the extent and effectiveness of certain characteristics of pre-service and in-service education programs designed to prepare elementary teachers to teach mathematics, Williams[2] discussed the insufficient preparation of teachers and principals. However, he concluded that there has been some improvement in mathematical preparation in the past eight years and he suggested that school districts and teacher colleges jointly encourage elementary education candidates to minor in mathematics.

---

[1]Virginia Terlinden Gilbert, "The Relationship of Certain Educational Experiences to the Understanding of Arithmetic by Prospective Elementary Teachers" (unpublished Ph.D. dissertation, College of Education, Arizona State University, 1966).

[2]Ralph Curtis Williams, "Teacher Preparation in Mathematical Arithmetic" (unpublished Ph.D. dissertation, College of Education, University of Southern California, 1966).

Stevens[1] discussed the following changes which are evident in contemporary elementary mathematics programs from an analysis of seven pupil textbook series: (1) except for grade three, the total vocabulary has increased by more than 40%; for grades two, five, and six the contemporary programs include less than 40% of what were traditional topics, (2) for grades one through three there are 29%, 38%, and 32% new topics introduced, respectively, and for grades four through six there are 42%, 63%, and 59% new topics introduced, respectively, (3) contemporary programs center around concepts related to sets, numbers, numerals, numeration, geometry, properties of operations, and equalities and inequalities, (4) the shift in grade placement of topics ranges from 13 to 31% for grades one through six, and (5) there have been shifts in grade placement of terms and topics but the most obvious shift is the appearance of traditional terms and topics from intermediate grades as contemporary terms and topics in primary grades.

The increased vocabulary, new topics introduced, and the shift in grade placement of topics make it mandatory that the preparatory programs be reviewed and evaluated in terms of the adequacy of prospective teachers' mathematical preparation. These changes require additional

---

[1]Deon Orlo Stevens, "Analysis of Change: A Comparative Study of Mathematical Texts Published for Elementary School Children for the Eight Year Period 1956 to 1964" (unpublished Ed.D. dissertation, College of Education, University of Oregon, 1965).

preparation and competency on the part of the prospective teacher. The increased content of modern elementary school mathematics requires a concomitant increase in the material to be learned by the prospective teacher if preparation to teach and actual teaching are to harmonize.

CHAPTER III

THE CRITERIA

The content of pupils' textbooks and the recommendations of the Committee on the Undergraduate Program in Mathematics (CUPM) served as criteria for determining the adequacy of the mathematical content introduced in the teacher preparatory programs. The content introduced in pupils' textbooks was an index of the absolute minimum content that should be mastered by students. The recommendations of CUPM represented the consensus of mathematicians and educators regarding the mathematical preparation of elementary teachers.

Analysis of Pupil Textbooks

The Supervisor of Mathematics of the Louisiana State Department of Education and school personnel in the nine largest cities were consulted to determine the most frequently used textbooks. These textbooks were also used by many of the schools in smaller cities. The five series listed in Chapter I were selected for analysis.

There was a need for a comprehensive list of all significant content included in the five series of pupils'

textbooks. To insure the inclusion of all major content items and recommendations for instruction the following were included in the comprehensive list:

1. All items listed under major headings by the authors in any one of the textbooks.
2. All concepts and instructional procedures as outlined by the authors in the teachers' editions and/or the scope and sequence charts.
3. Two categories of items: basic mathematical concepts and specific instructional procedures.
4. All items from each of the six textbooks for each of the five series.

The first step in the analysis of textbooks was listing items from the six textbooks for each of the five series. This procedure resulted in thirty lists of unedited items from the teachers' editions for grades one through six. The use of teachers' editions led to a minimum of misinterpretation of the items and intent of the authors. The composite scope and sequence charts made available by the publishers were used as a check on the listing of items in the teachers' editions and minimized the omission of items that the authors considered major parts of the program. This procedure was used so that all items would be given initial consideration.

The second step was developing a composite list of the six grade level lists for each series. Items introduced on different grade levels in a common category suggested by the authors of a series were listed together. The five lists developed in this way were then analyzed and edited.

Editing was necessary because the lists were not parallel in degree of detail or in the nature of major organizational headings.

The criterion of highest order of difficulty or concept understanding was applied to some of the items. For example, one series listed separately, "place value to hundreds' place," "place value to ten-thousandths' place," "place value to nine places," and "place value to twelve places." On the series list, the highest order, "place value to twelve places" was used to incorporate the lower order items.

Editing also involved combining some of the items. For example, several series listed separately "associative law of addition" and "associative law of multiplication." On the series list, these items were combined and listed, "associative laws of addition and multiplication."

The third step was developing a comprehensive list from the five series lists. Categories and the organizational scheme to be used in combining the five lists were determined, and items on each of the five series lists were placed in the appropriate categories. Duplicate items were listed only once. Finally, items introduced in three or more series were compiled to form the final comprehensive list.

The major areas of content that were revealed in an analysis of content were: (1) Sets, Numbers, Numerals,

(2) Addition, Subtraction, Multiplication, Division, (3) Geometry, (4) Measurement, (5) Fractions, (6) Problem Solving, (7) Per Cent, Proportion, Ratio, Rates, and (8) Graphs, Charts, Tables, Scale Drawing.

A number of instructional procedures and teaching aids were listed in the pupil textbooks and on the scope and sequence charts. These were listed under the appropriate heading on the comprehensive list of specific instructional procedures. Some of the aids were Venn diagrams, abacuses, lattices, grids, arrays, number rays, number lines, maps, and calendars.

The composite lists for the series have been placed in Appendix A. The comprehensive list included the following items:

Mathematical Content

Sets, Numbers, Numerals

One-to-One Correspondence; One-to-Two; Two-to-One
Sets, Subsets, Infinite and Solution Sets; Equivalent and Nonequivalent Sets
Variety of Symbols as Placeholders; Zero; Parentheses
True-False and Open Sentences; Patterns, Equations, and Polynomial Form
Hindu-Arabic Number System; Numbers to 999,999,999,999
Egyptian, Greek, and Roman Numerals
Other Bases of Numeration
Decimal Numeration System
Addition, Subtraction, Multiplication, and Division of Whole Numbers
Concept of Place Value
Idea of Ordinal and Cardinal Numbers
Terms of Comparison

Addition, Subtraction, Multiplication, Division

Associative and Commutative Laws of Addition and Multiplication
Property of One and Zero in Addition, Multiplication, Division
Subtraction as an Inverse of Addition
Subtraction and Division as Non-Commutatives
Addition and Subtraction in Other Bases
Addition and Subtraction with Fractions and Decimals
Distributive Law of Multiplication
Multiplication as Successive Addition
Division as Successive Subtraction
Division as an Inverse of Multiplication
Concept of Integers
Composite, Prime Numbers, and Prime Factorization

Geometry

Lines, Line Segments; Parallel and Intersecting Lines
Points, Rays, Angles, Planes
Solid, Closed and Open Planes and Figures
Meaning of Volume and Area; Geometric Region
Radii, Diameter, Circumference
Perimeter, Dimension, Hemisphere

Measurement

Meaning of Terms of Measurement; Standard Units
Measures: liquid, dry, linear, time, weight, distance, produce, temperature, volume, degrees
Precision of Measurement; Estimation in Measurement
Use of Standardized Measuring Instruments
Equivalent Money Values
Time Zones and the Calendar
Metric System

Fractions

Meaning of Fractions and Fractional Parts
Kinds of Fractions: decimal, equivalent, improper, mixed
Addition and Subtraction of Like and Unlike Fractions
Addition, Subtraction, Multiplication, Division of Decimal Fractions
Greatest Common Factor
Reducing Fractions to Lowest Terms
Changing Fractions to Higher Terms

Changing to a Common Denominator
Computing Interest
Commission, Mark Up

Problem Solving

Problems Using Addition, Subtraction, Multiplication, Division
Introduction to n as a Placeholder; Placeholders for Numerals
Multiple-Step Problems
Averages and Finding Areas in Problem Situations
Scientific Applications
Solving, Choosing and Writing Equations; Mathematical Sentences
Planning Solutions
Determining Known and Unknown Facts
Selecting and Recognizing Relevant and Essential Data
Supplying Missing and Additional Information
Estimating Answers, and Solving Story and Verbal Problems
Interpreting Number Stories
Checking as the Final Step
Generalizing the Use of Symbolism

Per Cent, Proportion, Ratio, Rates

Introduction to Per Cent and Proportion
Introduction to Rate Pairs (Ratios)
Idea of Equivalent Rate Pairs
Per Cent of Change and Reduction
Ratio as Expression of Rates and Comparison
Fraction Numerals as Terms of Ratios
Reduction of Ordered Pairs of Numbers
Per Cent and Discount in Sale Prices

Graphs, Charts, Tables, Scale Drawing

Introduction to Graphs: meaning, purpose, and kinds of graphs
Introduction to Statistical Tables: meaning and uses of tables
Idea of Probability
Understanding Scale as Ratio
Scale Drawing: Distance in Maps, Floor Plans, Dimension
Tables of Sale Results and Scores

Specific Instructional Procedures

Sets, Numbers, Numerals

Naming Sets
Recognizing and Describing Sets, Sets Within Sets
Grouping and Regrouping
Understanding Place Value and Zero
Comparing and Rounding Numbers
Using a Venn Diagram and an Abacus
Using the Counting Man and Mr. 0

Addition, Subtraction, Multiplication, Division

Renaming in Addition and Subtraction
Regrouping for Carrying and Borrowing
Finding Averages
Using the Number Line, Number Tree, and Arrays
Using Addition and Multiplication Tables, and Magic Squares
Using a Lattice in Multiplication
Using a Grid in Multiplication and Division

Geometry

Naming and Constructing Figures
Finding a Perimeter and a Dimension
Understanding a Diameter
Using Compasses and Rulers

Measurement

Adding, Subtracting, Multiplying and Dividing Measures
Using a Protractor to Measure Angles and Degrees
Comparing Amounts of Money
Telling Time
Using a Calendar
Finding Areas

Fractions

Renaming Fractions; Parts of a Whole and a Set
Regrouping of Fractional Numbers
Finding Fractional Parts
Adding, Subtracting, Multiplying, and Dividing Fractions

Problem Solving

Solving, Choosing, and Writing Equations
Writing Mathematical Sentences for Problems

Planning Solutions
Interpreting Number Stories

Per Cent, Proportion, Ratio, Rates

Using Per Cent and Ratios in Solving Problems
Using Per Cent in Comparison
Using Ratio to Find Per Cent; Per Cent as Ratio
Determining Equivalent Ratios
Distinguishing Among Fractions and Rates
Using Decimals in Ratios

Graphs, Charts, Tables, Scale Drawing

Reading Graphs
Using Mean, Median, Mode
Using a Number Ray
Using a Map

The Committee on the Undergraduate Program in Mathematics Recommendations

Although educators have agreed that mathematics be required of all elementary teachers, there has been no agreement on what the content and nature of the courses should be. The most influential guideline on mathematics courses of the sixties has been the report of Recommendations for Level I (Teachers of Elementary School Mathematics) of the Committee on the Undergraduate Program in Mathematics.[1]

The recommendations of CUPM were used in this study because they represented the consensus of mathematicians as well as educators about sound and workable guidelines for curriculum improvement and implementation. They provided

---

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

a common ground upon which general decisions could rest. These recommendations are:

> As a prerequisite for the college training of elementary school teachers, we recommend at least two years of college preparatory mathematics, consisting of a year of algebra and a year of geometry, or the same material in integrated courses. It must also be assured that these teachers are competent in the basic techniques of arithmetic. The exact length of the training program will depend on the strength of their preparation. For their college training, we recommend the equivalent of the following courses:
>
> (A) A two-course sequence devoted to the structure of the real number system and its subsystems.
>
> (B) A course devoted to the basic concepts of algebra.
>
> (C) A course in informal geometry.
>
> The material in these courses might, in a sense, duplicate material studied in high school by the prospective teachers, but we urge that this material be covered again, this time from a more sophisticated college-level point of view.

The evaluation of the preparatory programs of the seven institutions in terms of the recommendations of the Committee on the Undergraduate Program in Mathematics involved the listing of courses in mathematics which each offered and comparing the course offerings with the recommendations.

CHAPTER IV

THE COLLEGE PROGRAM

The scope of the content introduced in college courses was determined through an analysis of college textbooks and through interviews with each instructor of the mathematics and methods of teaching mathematics courses required of elementary education majors. General information about the college programs was obtained from administrative personnel.

Analysis of College Textbooks

The sixteen college textbooks listed in Chapter I were analyzed. These textbooks were of three types: six textbooks used in the two basic mathematics courses, six textbooks used in the third mathematics courses, and four textbooks used in methods of teaching elementary mathematics courses.

The comprehensive list of mathematical content in the state-adopted pupil textbooks was used as a checklist for determining the scope of content of college textbooks. The following guidelines were used in estimating coverage adequacy of each major category by each college textbook:

1. The explanations of concepts should be clear and facilitate an understanding of the major theorems and principles.

2. The topics should have meaning and purpose for the students. Number and number operations should be meaningful to the students.

3. The topics should contribute to the development of skills of communication, i.e., reading should lend itself to easy interpretation.

4. There should be a sufficient number of exercises for practice and review.

5. The methods of organizing the topics should be reasonable and easy to follow.

6. The discussions should stress an understanding of mathematical structure and interpretation of quantitative ideas.

Based upon a consideration of the above criteria, of modern trends in content of elementary mathematics textbooks, and of standards for evaluating mathematics textbooks for all grade levels,[1] the following descriptive categories were set up for college textbook analysis: "depth coverage," "adequate coverage," and "limited coverage." If the textbook material satisfied all of the above criteria, it was judged "depth coverage." If the textbook material satisfied all except criteria 4 and 5, it was judged "adequate coverage." If the textbook material satisfied only one or two of the criteria, it was judged "limited coverage." The results of this analysis have been summarized in Table 1.

---

[1] Aids for Evaluators of Mathematics Textbooks, National Council of Teachers of Mathematics (Washington, D. C.: The Council, 1965).

TABLE 1

ANALYSIS OF CONTENT OF COLLEGE TEXTBOOKS

	Content Areas							
Basic Math Textbooks	1	2	3	4	5	6	7	8
Allendoerfer & Oakley	D	D	-	-	D	A	-	-
Dupree & Harmon	D	D	-	-	L	A	-	-
Mitchell & Cohen	D	D	D	-	A	L	-	D
Ohmer, Aucoin & Cortez	D	D	-	-	D	A	L	-
Wade & Taylor	D	D	-	-	A	A-	-	-
Beckenbach et al.	D	D	-	-	-	L	L	L
Math for Elementary Teachers Textbooks								
Banks	D	D	-	D	D	D	A	-
Byrne	D	D	-	D	D	D	A	-
NCTM--29th Yrbk.	D	D	-	-	D	L	L	-
Ohmer, Aucoin & Cortez	D	D	-	-	A	A	L	-
Smart	D	D	D	A	D	D	A	-
SMSG--Geometry	D	D	D	A	D	D	A	-
Methods of Teaching Textbooks								
Banks	D	D	-	D	D	D	A	-
Grossnickle & Brueckner	A	D	D	D	D	D	A	D
Marks et al.	A	D	D	D	D	D	A	-
Shipp & Adams	D	D	A	D	D	D	L	D

Key:
D - depth coverage
A - adequate coverage
L - limited coverage
- - no coverage

1 - Sets, Numbers, Numerals
2 - Addition, Subtraction, Multiplication, Division
3 - Geometry
4 - Measurement
5 - Fractions
6 - Problem Solving
7 - Per Cent, Proportion, Ratio, Rates
8 - Graphs, Charts, Tables, Scale Drawing

In all of the basic mathematics textbooks, sets, numbers, numerals, addition, subtraction, multiplication, and division received depth coverage. Per cent, proportion, ratio, rates, graphs, charts, tables, and scale drawing received limited coverage. Geometry was excluded from all textbooks except one. Measurement was not covered in this group of textbooks.

In all of the mathematics for elementary teachers textbooks, sets, numbers, numerals, addition, subtraction, multiplication, and division received depth coverage. Fractions, problem solving, per cent, proportion, ratio, and rates received adequate coverage. Graphs were not covered. In only two textbooks did geometry and measurement receive depth coverage, and these textbooks were used in geometry courses.

In all of the methods textbooks, addition, subtraction, multiplication, division, measurement, fractions, and problem solving received depth coverage. Sets, numbers, numerals, per cent, proportion, ratio, and rates received adequate coverage in all textbooks. Graphs, charts, tables, scale drawing, and geometry received depth coverage in only two textbooks.

A review of Table 1 indicated that textbooks used in the three types of courses tended to be highly similar in coverage of many content areas. Excluding the textbooks used in geometry and methods courses, many textbooks tended

to nelgect coverage of geometry. Many textbooks also tended to neglect the areas of graphs, charts, tables, and scale drawing, and the area of measurement. The methods textbooks covered four content areas in depth; whereas, the textbooks used in mathematics courses covered only two areas in depth.

Topics which were not of specific concern to this study were also covered in the college textbooks. Some of these topics were: (1) logic, (2) functions, (3) equalities and inequalities, (4) determinants, (5) linear and quadratic equations, and (6) the binomial theorem.

Interviews

College personnel were interviewed to gather information about the content and conduct of college courses offered to elementary education majors. All nineteen instructors of content and methods courses were interviewed.

The Interview Instrument

It was necessary to construct an instrument to be used in the planned interviews. A tentative form was prepared with two major headings, "the preparatory program" and "mathematics courses." Four college instructors were asked to react to this tentative form. Their suggestions were incorporated into the revised instrument.

The first part of the instrument consisted of nine

questions about the mathematics courses. These questions focused upon: (1) textbook used, (2) role of the textbook, (3) proportion of time devoted to mathematical content and to methods of teaching, (4) major purposes of courses, (5) work-study requirements, (6) instructional procedures, (7) evaluation instruments, (8) mathematical content other than textbook content, and (9) the comprehensive list of content from pupils' textbooks.

The following three-point scale was used to summarize answers to these questions:

1. "Most Frequently" - persistent and consistent emphasis of from 50 to 100% of the class time.
2. "Moderately" - emphasis 10 to 50% of the class time.
3. "Seldom" - emphasis less than 10% of the class time.

The preceding categories were found to be the most explicit for defining the frequency and/or emphasis of class activities.

The second part of the instrument consisted of two questions about the preparatory program. These questions were designed to get unstructured responses from the instructors about the major problems in preparing teachers to teach mathematics, and the major changes in the preparatory program which they would suggest. The complete interview instrument and a general information sheet can be found in Appendix C.

Planning the Interviews

A letter was sent to the deans of colleges of education explaining the purpose of the study, its sponsorship, how the institution was selected, and how the findings were to be used. A request was also made for an appointment to discuss the preparatory program and the mathematics courses. All of the deans responded promptly, granted interviews, and sent the names of instructors who taught basic mathematics, mathematics for elementary teachers, or methods of teaching elementary mathematics.

A second letter was sent to confirm the appointment with the deans and instructors at the various institutions. All visits were scheduled during the month of April.

The interviews with the deans of colleges of education consisted of obtaining information about the total enrollment in differentiated programs and the sequence of courses at their respective institutions.

The interviews with instructors of basic mathematics, mathematics for elementary teachers, and methods of teaching elementary mathematics courses began with introductions and a brief explanation of the purpose of the study. Then the instructors were asked the prepared set of questions in a structured interview setting. The interviews were held without leading or suggesting responses to the instructors.

It was not the purpose of the interviews to rate

the institutions or instructors, but to determine to what extent the institutions offered mathematics course content and to what extent this content reflected the content introduced in the elementary schools as revealed by an analysis of pupil textbooks. This was carefully explained to each instructor.

Enrollment

The total enrollment of elementary education majors in the seven colleges and universities included in this study was 4,122. The enrollment in these institutions ranged from 433 to 790. All of the deans indicated that they had no special program for students to major in early or later childhood, or mathematics education. They did indicate, however, that a student could take electives in nursery education, speech, science, or mathematics. Several institutions had plans for a differentiated program effective with the beginning of the 1968 school session. Only two deans indicated that separate methods courses were provided for lower and upper elementary education majors.

Sequence of Courses

In each of the seven institutions elementary education majors were required to take two three-hour courses in basic mathematics. In five of the seven institutions students were also required to take a three-hour course in mathematics for elementary teachers; however,

only two of these courses were geometry courses and only one was an algebra course. One institution planned to require a three-hour course in mathematics for elementary teachers beginning in September 1967. The seventh institution had no plan for offering a course in mathematics for elementary teachers. Two of the seven institutions also offered a second or advanced course in mathematics for elementary teachers which elementary education majors could take as an elective. One institution planned to require such a course beginning in September 1967.

Four institutions required elementary education majors to take a three-hour course in methods of teaching elementary mathematics, one institution offered a combination methods of mathematics and science course, one offered a general methods course in which elementary mathematics was emphasized for approximately three weeks of an eighteen-week seminar course, and one offered a combination methods of mathematics, science, and social studies course. Only two institutions offered differentiated courses in methods, one for the lower grades and one for the upper grades. All institutions required that the mathematics courses and methods of teaching elementary mathematics courses be taken in the following sequence: basic mathematics, mathematics for elementary teachers, and methods of teaching elementary mathematics.

Textbooks

A list of the textbooks used in the mathematics courses and methods courses has been presented in Table 2. For the basic mathematics courses, two of the seven instructors used Elementary Contemporary Mathematics by Ohmer, Aucoin, and Cortez. The other five instructors used five different textbooks. All of the instructors indicated that they used one textbook for both of the courses in basic mathematics.

For the mathematics for elementary teachers courses, six different textbooks were used. One of the instructors used the twenty-ninth yearbook of the National Council of Teachers of Mathematics, Topics in Mathematics. Another instructor used the SMSG textbook, Intuitive Geometry.

For the methods of teaching elementary mathematics courses, the textbook Teaching Elementary School Mathematics for Understanding by Marks, Purdy, and Kinney was used by four instructors. Learning and Teaching Arithmetic by Banks was used in both a mathematics for elementary teachers course and in a methods of teaching elementary mathematics course.

Role of the Textbook

All instructors of the basic mathematics, mathematics for elementary teachers, and methods of teaching elementary mathematics courses indicated that the role of the textbook in course organization was that of structuring

TABLE 2

TEXTBOOKS USED IN COLLEGE COURSES

	Author	Title of Textbook	Frequency
Basic Mathematics	Allendoerfer & Oakley	Fundamentals of College Algebra	1
	Dupree & Harmon	Modern College Algebra	1
	Mitchell & Cohen	A New Look at Elementary Mathematics	1
	Ohmer, Aucoin & Cortez	Elementary Contemporary Mathematics	2
	Wade & Taylor	Fundamental Mathematics	1
	Beckenbach et al.	Essentials of College Algebra	1
Mathematics for Elementary Teachers	Banks	Learning and Teaching Mathematics	1
	Byrne	Modern Elementary Mathematics	1
	National Council of Teachers of Mathematics	Topics in Mathematics for Elementary Teachers--29th Yearbook	1
	Ohmer, Aucoin & Cortez	Contemporary Algebra	1
	Smart	Introductory Geometry	1
	SMSG	Intuitive Geometry--Volume VII	1
Methods of Teaching Mathematics	Banks	Learning and Teaching Mathematics	1
	Grossnickle & Brueckner	Discovering Meanings in Elementary School Mathematics	1
	Marks, Purdy & Kinney	Teaching Elementary School Mathematics for Understanding	4
	Shipp & Adams	Developing Arithmetic Concepts and Skills	1

or outlining the mathematical content to be emphasized in the courses and that the textbook was the main resource book. The instructors also indicated that the textbooks were chosen as required textbooks for their organization and content.

Special Topics Introduced

In answer to the question, "Do you introduce any mathematical content other than the content in the textbook?," the instructors of basic mathematics courses reported that they introduced business mathematics, introductory logic, and information from their research and readings. Four instructors of the mathematics for elementary teachers courses indicated that they introduced other areas or topics for discussion, such as Set Theory, to supplement the content of the textbooks. Five of the seven instructors of methods of teaching elementary mathematics introduced students in their classes to pupils' textbooks. Other topics which these instructors introduced were: the theory of numbers and numeration, some of the experimental programs in modern mathematics, the Colonial Filmstrips, and number games.

Content and Method Emphases

Responses from instructors of the courses were the bases for ascertaining the relative emphases placed upon content and method. For all basic mathematics courses, all

of the course time was devoted to content. Of the five institutions which offered a course in mathematics for elementary teachers, two instructors emphasized content only, two emphasized approximately 80% content, and one emphasized 50% content. In three of the institutions, the instructors of methods reported that they emphasized method 100% of the course time. One instructor of methods emphasized method 80% of the course time, one devoted two-thirds class time to methods, and two emphasized method 50% of the course time.

Major Purposes of Courses

All instructors were asked to give the major purposes of the courses they taught. Responses from instructors in the basic mathematics courses were as follows:

1. to stress procedures for solving problems in algebra and geometry,
2. to upgrade competence of elementary school teachers in the field of mathematics,
3. to improve understanding of mathematical structure and of elementary concepts of number,
4. to give information needed later to teach; students will have to learn material before they can teach it,
5. to develop competence and understanding of the structure of arithmetic,
6. to have students develop understanding of set theory and the real number system, and

7. to develop understanding of the real number system, skill in using number operations and ability to apply the skills.

Responses from instructors of mathematics for elementary teachers were as follows:

1. to acquaint students with modern processes of teaching modern mathematics in elementary school,

2. to help students develop understanding of relationships in mathematics and competence in computations,

3. to develop skills, concepts, and ability to solve problems,

4. to give our students adequate background in elementary algebra and intuitive geometry to enable them to teach a modern mathematics program in elementary schools, and

5. to develop understanding of modern mathematics, set theory and numeration systems.

Responses from instructors of methods of teaching elementary mathematics were as follows:

1. to familiarize students with modern methods of teaching mathematics with emphasis on purposes, content, activities, and evaluation,

2. to lead students to discover for themselves rather than telling, to understand and realize processes and principles, to teach understanding of numbers and how they differ from numerals, seeing patterns and relationships, and getting students to see mathematics as a part of life, not apart from life,

3. to teach some new content and the many approaches and methods of teaching arithmetic at all levels,

4. to develop concepts of quantitative relationships, structure of mathematics, how to develop principles and the understanding of concepts,

5. to acquaint the prospective teacher with materials and teaching aids and methods of instruction,

6. to develop proficiency in teaching of mathematics, using new vernacular, techniques for guiding children in developing new concepts, and

7. to develop problem solving techniques and methods of applying mathematics.

Work-Study Requirements

A list of the instructors' statements about the most common work-study requirements employed in the courses have been presented in Table 3. All of the instructors of the basic mathematics courses employed discussion and/or question periods. However, none of the instructors employed individual or group reports, demonstration lessons, oral or written reports, or participation in workshops or conferences as course requirements.

All of the instructors of mathematics for elementary teachers reported that they employed discussion and/or question periods more frequently than any other work-study requirement. Individual projects and demonstration lessons were employed by three of the five instructors. Group projects, oral or written reports, and participation in workshops or conferences were not reported as requirements by any of the five instructors.

All of the instructors of methods of teaching elementary mathematics employed individual projects, demonstration lessons, discussion and/or question periods, and oral or written reports as course requirements. One of the instructors reported that elementary education majors were

TABLE 3

WORK-STUDY REQUIREMENTS OF COLLEGE COURSES

	Basic Mathematics Courses	Mathematics for Elementary Teachers	Methods Courses
REQUIREMENTS	FREQUENCY	FREQUENCY	FREQUENCY
Individual Projects	0	2	7
Group Projects	0	0	3
Demonstration Lessons	0	2	7
Participation in Workshops and Conferences	0	0	1
Discussions and/or Question Periods	7	4	7
Reports (Oral or Written)	0	2	7

required to fulfill thirty hours of participation and observation of arithmetic instruction in the elementary school. Three of the instructors reported the use of group reports as a course requirement. One instructor indicated that the students had an opportunity to participate in two workshops or conferences during the spring semester only.

Instructional Procedures

A list of the most common instructional procedures emphasized in the courses has been presented in Table 4. In all of the basic mathematics courses, the following procedures were emphasized: discovery method, questioning, reviewing or check up time, meanings and understandings, and ideas of place value through experiences in other bases.

In the mathematics for elementary teachers courses, discovery, questioning, reviewing, meanings and understandings were emphasized. Only one instructor reported that learning stages, the four step method, whole class procedure, individual pupil assignment, ability grouping, and self instruction were some of the procedures which were emphasized in the course.

In the methods courses, the discovery method, questioning, and meanings and understandings were emphasized. Consideration was also given to whole class procedures, individual pupil assignment, and ability grouping.

TABLE 4

INSTRUCTIONAL PROCEDURES OF COLLEGE COURSES

	Basic Mathematics Courses	Mathematics for Elementary Teachers	Methods Courses
INSTRUCTIONAL PROCEDURES	FREQUENCY	FREQUENCY	FREQUENCY
Discovery Method	7	5	6
Questioning	7	5	6
Reviewing or Check-Up Time	7	4	0
Meanings and Understandings	7	4	6
Ideas of Place Value Through Experiences in Other Bases	7	5	0
Learning Stages	0	1	0
Four Step Method: "See, Think, Try, Do"	0	1	0
Whole Class Procedure	0	1	7
Individual Pupil Assignment	0	1	7
Ability Grouping	0	1	7
Self Instruction	0	1	0

An inquiry about evaluation instruments revealed that none of the instructors of basic mathematics and mathematics for elementary teachers reviewed these instruments. However, in all methods of teaching elementary mathematics courses, standardized achievement tests, diagnostic tests, and teacher-made paper and pencil tests were reviewed in class.

Mathematical Content

All instructors of basic mathematics courses reported that the following mathematical content was most frequently emphasized: (1) Sets, Numbers, Numerals, (2) Addition, Subtraction, Multiplication, Division, and (3) Geometry. The following content was emphasized less frequently: (1) Fractions, (2) Per Cent, Proportion, Ratio, Rates, and (3) Probability and Statistics. The instructors reported that Measurement and Problem Solving were seldom emphasized in these courses.

The following topics not specifically defined in pupil textbooks were reported by the instructors of basic mathematics as receiving emphasis: (1) Logic, (2) Functions and Graphs of Functions, (3) Algebraic Functions, (4) Equalities and Inequalities, (5) Determinants, Vectors and Matrices, (6) Exponential and Logarithmic Functions, and (7) Progressions and the Binomial Theorem.

In the mathematics for elementary teachers courses, the following content was reported as the most frequently

emphasized: (1) Sets, Numbers, Numerals, (2) Addition, Subtraction, Multiplication, Division, (3) Fractions, and (4) Per Cent, Proportion, Ratio, and Rates. The following content was seldom emphasized in these courses: (1) Geometry, (2) Measurement, (3) Problem Solving, and (4) Graphs, Charts, Tables, and Scale Drawing. In these courses the following topics not specifically defined in pupil textbooks were also emphasized: (1) Linear and Quadratic Equations, (2) Inequalities and Inequalities, (3) Functions, and (4) Topics from Algebra and Geometry.

In the methods of teaching elementary mathematics courses, the following content was emphasized most frequently: (1) Sets, Numbers, Numerals, (2) Addition, Subtraction, Multiplication, Division, (3) Geometry, (4) Measurement, (5) Fractions, and (6) Per Cent, Proportion, Ratio, and Rates. In these courses Problem Solving and Graphs, Charts, Tables, and Scale Drawing were seldom emphasized.

The instructors of methods courses reported topics not defined in pupil textbooks which were also emphasized. Some of the topics were: (1) The Development of Arithmetic Teaching, (2) Arithmetic for the Grades, (3) Issues in Teaching Elementary School Mathematics, (4) Principles of Teaching Elementary School Mathematics, (5) Evaluation of Elementary Mathematics, (6) Guidance in the Learning of Mathematics, (7) Aims for Elementary School Mathematics, (8) Planning Effective Learning Activities, and (8) Special

Instructional Procedures.

All instructors responded to questions about the preparatory program. These responses are presented in Chapter V.

CHAPTER V

EVALUATION OF PROGRAMS

The preparatory programs were evaluated in three distinct ways. The evaluations utilized the mathematical content of textbooks for the required college courses, opinions of college instructors, and the recommendations of the Committee on the Undergraduate Program in Mathematics.

Content of College Textbooks

Estimates of coverage adequacy by college textbooks of the eight content areas identified in the analysis of pupil textbooks were used in evaluating each preparatory program. The college textbooks for all required courses in each preparatory program were listed together with the estimates of coverage adequacy which have been reported in Chapter IV. The highest rating received by any textbook for coverage of a content area was accepted as the composite rating of coverage adequacy of the preparatory program. All evaluative ratings assigned are reported in Table 5.

TABLE 5

SCOPE OF CONTENT OF REQUIRED TEXTBOOKS

School and Content Area	Courses 1&2	3	4	Composite Rating
SCHOOL A				
Sets, Numbers, Numerals	D	D	A	D
Addition, Subtraction, Multiplication, Division	D	D	D	D
Geometry	-	-	D	D
Measurement	-	-	D	D
Fractions	D	D	D	D
Problem Solving	A	L	D	D
Per Cent, Proportion, Ratio, Rates	-	L	A	A
Graphs, Charts, Tables, Scale Drawing	-	-	-	-
SCHOOL B				
Sets, Numbers, Numerals	D		D	D
Addition, Subtraction, Multiplication, Division	D		D	D
Geometry	-	N	-	-
Measurement	-	O	D	D
Fractions	D	N	D	D
Problem Solving	A	E	D	D
Per Cent, Proportion, Ratio, Rates	L		A	A
Graphs, Charts, Tables, Scale Drawing	-		-	-
SCHOOL C				
Sets, Numbers, Numerals	D	D	A	D
Addition, Subtraction, Multiplication, Division	D	D	D	D
Geometry	-	-	D	D
Measurement	-	D	D	D
Fractions	A	D	D	D
Problem Solving	A	D	D	D
Per Cent, Proportion, Ratio, Rates	-	A	A	A
Graphs, Charts, Tables, Scale Drawing	-	-	-	-

Key: D - depth; A - adequate; L - limited; - - no coverage

Courses 1&2 - basic mathematics
3 - mathematics for elementary teachers
4 - methods of teaching elementary mathematics

TABLE 5 -- continued

School and Content Area	Courses 1&2	3	4	Composite Rating
SCHOOL D				
Sets, Numbers, Numerals	D	D	D	D
Addition, Subtraction, Multiplication, Division	D	D	D	D
Geometry	-	D	A	D
Measurement	-	A	D	D
Fractions	L	D	D	D
Problem Solving	A	D	D	D
Per Cent, Proportion, Ratio, Rates	-	A	L	A
Graphs, Charts, Tables, Scale Drawing	-	-	D	D
SCHOOL E				
Sets, Numbers, Numerals	D D	D	A	D
Addition, Subtraction, Multiplication, Division	D D	D	D	D
Geometry	- -	D	D	D
Measurement	- -	A	D	D
Fractions	D A	D	D	D
Problem Solving	A A	D	D	D
Per Cent, Proportion, Ratio, Rates	L -	A	A	A
Graphs, Charts, Tables, Scale Drawing	- -	-	-	-
SCHOOL F				
Sets, Numbers, Numerals	D	D	A	D
Addition, Subtraction, Multiplication, Division	D	D	D	D
Geometry	-	-	D	D
Measurement	-	D	D	D
Fractions	-	D	D	D
Problem Solving	L	D	D	D
Per Cent, Proportion, Ratio, Rates	L	A	A	A
Graphs, Charts, Tables, Scale Drawing	L	-	D	D

Key: D - depth; A - adequate; L - limited; - - no coverage

Courses 1&2 - basic mathematics
3 - mathematics for elementary teachers
4 - methods of teaching elementary mathematics

TABLE 5 -- continued

School and Content Area	Courses 1&2	3	4	Composite Rating
SCHOOL G				
Sets, Numbers, Numerals	D		A	D
Addition, Subtraction, Multiplication, Division	D	N	D	D
Geometry	D	O	D	D
Measurement	-	N	D	D
Fractions	A	E	D	D
Problem Solving	L		D	D
Per Cent, Proportion, Ratio, Rates	-		A	A
Graphs, Charts, Tables, Scale Drawing	D		-	D

Key: D - depth; A - adequate; L - limited; - - no coverage

Courses 1&2 - basic mathematics
3 - mathematics for elementary teachers
4 - methods of teaching elementary mathematics

The procedure described above was used only after the instructor of each course established the facts that the textbook included minimum content introduced in the course and that all portions of the textbook were introduced. Therefore the content of the textbooks for required courses was accepted as the minimum content introduced in each preparatory program.

An examination of Table 5 revealed that all institutions except one gave depth coverage to sets, numbers, numerals, addition, subtraction, multiplication, division, geometry, measurement, fractions, and problem solving. The one institution which was the exception offered only six hours of basic mathematics and the concepts of geometry were not covered in either of the courses.

There was adequate coverage of per cent, proportion, ratio, and rates in all institutions. In three of the seven institutions, graphs, charts, tables, and scale drawing received a depth rating and this area was not covered in the other four institutions.

A review of the two institutions which offered only six hours of basic mathematics revealed that in one of these institutions, there was depth coverage of all content areas except per cent, proportion, ratio, and rates, which received adequate coverage. In the other institution there also was adequate coverage of per cent, proportion, ratio, and rates; however, there was no coverage

of geometry, graphs, charts, tables, and scale drawing. The other areas received depth coverage.

Interviews with College Instructors

All college instructors interviewed were asked to respond to two questions: What do you consider to be the major problems in preparing teachers to teach mathematics? What major changes in the preparatory program would you suggest? Their responses with evaluative implications have been studied and summarized.

There was general agreement among all instructors that there is difficulty in getting students to develop interest in mathematics. The instructors reported that many students fear mathematics and they don't see the need for it. Other difficulties were expressed in such statements as, "students are not serious about mathematics," and "students are lazy." One instructor stated that teachers should not be blamed for students' disinterest and that the trend is for students to do only enough to get by or make a passing grade in their courses.

A major concern expressed by most of the instructors was related to poor preparation of students for the required courses. The instructors pointed out that many students are mathematically disoriented and lack background in high school mathematics. The meager offerings of general mathematics and senior arithmetic were named as the only required courses for graduation and they were considered to be

insufficient background for college mathematics. One instructor of the third course in mathematics mentioned that students do poorly in the first two courses of basic mathematics; therefore, they have difficulty in grasping the material of the third course.

One instructor of basic mathematics referred to the difficulty students have in developing discovery techniques and in developing a working knowledge of mathematical language, sequential topics, and rules of the sign numbers. Several instructors reported student difficulty in absorbing new ideas and concepts. They also pointed out that it is difficult to change concepts that students bring with them to the courses. They observed that students want to teach as they were taught.

Another instructor of basic mathematics suggested that a part of the problem is in getting students at the freshman level who have declared their intentions of majoring in elementary education so that they could receive adequate training in elementary mathematics. One instructor referred to the difficulty in relating material covered in basic mathematics to the elementary school curriculum and the difficulty in preparing teachers to teach all grades.

In one institution where only six hours of mathematics were required, an instructor expressed dissatisfaction with the content required of elementary education majors. He suggested that students need more than six

hours of mathematics if they are to be expected to teach effectively.

Several instructors reported limited course time as a major problem in preparing teachers. They pointed out that it is impossible to provide opportunities for many types of class activities and difficult to acquaint students with the breadth of teaching aids which are available.

All instructors offered many suggestions for changes in the preparatory program. They concurred on the need for more required hours of mathematics. One instructor suggested that students be required to take at least nine hours of basic mathematics with three of these hours related to geometry. Another instructor suggested four semesters of mathematics.

Several suggestions were given about course requirements. One suggestion was for differentiated courses so that elementary education majors would have experiences with twice as many concepts and exercises, sequence, and teaching aids. Several instructors suggested enriching the content of courses. One instructor was very enthusiastic about the SMSG materials and suggested that consideration be given to incorporating some of these materials into the program for elementary education majors.

Another concern of the instructors was the use of textbooks designed for several types of courses. One

instructor who used the textbook by Allendoerfer and Oakley suggested that another textbook be adopted for the basic mathematics course because it did not adequately serve elementary education majors. This textbook had been used in remedial mathematics courses and some courses for mathematics majors and found to serve mathematics majors better than any other group of students. An instructor of the third mathematics course in mathematics found that the textbook by Banks provided inadequate coverage of topics for the course and suggested that another textbook be adopted.

Two instructors of methods courses suggested that the program be reorganized so that more class time would be available. They were concerned about time to devote to the construction and utilization of teaching aids. One instructor who taught a combination methods course suggested that the course be offered as two two-hour courses.

An instructor of the third course in mathematics suggested that smaller enrollments would be desirable. She pointed out that in overcrowded classes there is little opportunity to allow for group work. Two other instructors suggested that time be allotted for laboratory sessions to enrich and supplement lectures.

One instructor of methods suggested that the university have films and other materials on hand rather than having to rent them when they are desired for class

consideration. This instructor used a personal file of filmstrips to supplement class lectures and discussions.

Another instructor suggested that teachers be required to take a qualifying test in mathematics. She expressed belief that the test score would give a measure of the teachers' background and comprehension and indicate the areas for further study.

Recommendations of CUPM

A comparison of the course requirements of preparatory programs in terms of the recommendations of the Committee on the Undergraduate Program in Mathematics, CUPM, was the third phase of evaluation. The course requirements of each of the seven institutions were evaluated to determine if they emphasized the real number system and its subsystems, algebra, and geometry.

Six of the seven institutions did not offer the sequence of four courses, two courses which emphasized the real number system and its subsystems, one course in algebra, and one course in geometry, as recommended by the CUPM. Only one institution offered the complete sequence of four courses in mathematics.

All institutions offered at least a two-course sequence which emphasized the real number system and its subsystems. One institution also offered a third course which emphasized algebra and another institution offered a third course which emphasized geometry. Three institutions

offered a third course which emphasized set theory, numeration systems, real and rational numbers, integers, logic, and elementary Euclidean geometry. Two institutions offered a fourth course in basic mathematics which elementary education majors could take as an elective. These institutions did not offer courses to provide background in algebra and geometry as suggested by CUPM.

CHAPTER VI

FINDINGS, CONCLUSIONS, RECOMMENDATIONS

The three-fold purpose of this study was to determine the content of elementary school mathematics, to analyze the content offerings of college programs, and to evaluate the college programs. The scope of content of preparatory programs was determined by analyzing college textbooks and course requirements and interviewing instructors of mathematics and methods courses. The comprehensive list of content of pupils' textbooks and the recommendations of the CUPM were used to evaluate college programs.

Findings

An analysis of pupil textbooks revealed that the elementary school mathematics program introduced the following content areas: sets, numbers, numerals, addition, subtraction, multiplication, division, geometry, measurement, fractions, problem solving, per cent, proportion, ratio, rates, graphs, charts, tables, and scale drawing.

There was great divergency in the use of three groups of college textbooks. The textbooks used in the two basic mathematics courses gave depth coverage to sets, numbers, numerals, addition, subtraction, multiplication, division, and fractions. Problem solving received adequate coverage. Limited coverage was given to per cent, proportion, ratio, rates, graphs, charts, tables, and scale drawing. Geometry and measurement were not covered in these textbooks.

Sets, numbers, numerals, addition, subtraction, multiplication, and division received depth coverage in the textbooks used in the third mathematics courses. Geometry and measurement received depth coverage in only two textbooks. Graphs, charts, tables, and scale drawing were excluded from all of these textbooks. Fractions, problem solving, per cent, proportion, ratio, and rates received either adequate or depth coverage.

The textbooks used in methods courses gave depth coverage to the concepts of sets, numbers, numerals, addition, subtraction, multiplication, division, measurement, fractions, and problem solving. Graphs and geometry received depth coverage in only two textbooks. Per cent, proportion, ratio, and rates received adequate coverage.

The textbooks used in basic mathematics courses also covered content not presented in pupils' textbooks. Some of these areas were: logic, functions, equalities

and inequalities, determinants, linear and quadratic equations, the binomial theorem, and business mathematics.

Interviews with instructors of basic mathematics courses revealed the following as major purposes of the courses: (1) to develop competence and understanding of the structure of mathematics, algebra, and geometry, (2) to develop understanding of the real number system and skill in using the operations on numbers, and (3) to acquaint students with modern processes of teaching modern mathematics in the elementary school.

All of the mathematics instructors reported that they employed the discussion technique very frequently and that individual projects and demonstration lessons were used to a limited extent. Group projects, oral or written reports, and participation in workshops or conferences were very seldom used as course requirements. All instructors recognized the contributions of the discovery method to students' understanding of mathematics. Instruments of evaluation were not emphasized in any courses. The instructors reported that they introduced content from their reading and research to supplement lectures and that students were introduced to some of the experimental elementary mathematics programs, filmstrips, and number games.

The instructors of methods courses reported the following course purposes: (1) to familiarize students

with modern methods of teaching mathematics with emphasis on purposes, content, activities, materials, and evaluation, (2) to understand processes and principles, and (3) to acquaint students with materials and the new vernacular.

In all of the methods courses, individual projects, demonstration lessons, discussions, and oral or written reports were the most frequently emphasized work-study requirements. A variety of instructional procedures were employed by the instructors. Instruments of evaluation were frequently emphasized in these courses. Students were also introduced to pupil textbooks, experimental programs in mathematics, and other teaching aids.

The instructors of both mathematics and methods reported the following as major problems in preparing teachers to teach mathematics: (1) students exhibit a lack of interest in mathematics, (3) students have difficulty in developing a working knowledge of mathematical language, sequential topics, rules of sign numbers, in absorbing new ideas and in changing old concepts, (4) preparatory programs do not provide adequate class time to cover all desirable content and use a variety of class activities, and (5) teachers have difficulty relating the content of basic mathematics courses to the elementary school curriculum and difficulty preparing students to teach all of the elementary grades.

The following changes in the preparatory program

were suggested by the instructors: (1) change textbook where the textbook is designed for a wide range of uses, (2) require at least nine hours of basic mathematics and three hours of geometry, (3) offer differentiated courses for elementary education majors planning to teach either lower or upper grades, (4) have smaller enrollments in the courses, (5) require a qualifying test in mathematics for teachers, (6) allow for more class time, including a laboratory period for the required courses, (7) enrich content using some of the suggestions of the School Mathematics Study Group, and (8) offer a course in which only methods of teaching mathematics are emphasized.

The mathematics course offerings of the seven institutions were checked in light of the recommendations of the Committee on the Undergraduate Program in Mathematics. This check revealed that only one institution offered the complete sequence of four courses as recommended by the CUPM. The institutions did not offer courses to provide background in algebra and geometry as recommended by the CUPM. All institutions offered at least a two-course sequence in which the real number system and its subsystems were emphasized. One institution offered a third course which emphasized algebra and another institution offered a third course which emphasized geometry. Three other institutions offered a third course but course emphasis was set theory and numeration rather than algebra or geometry.

Conclusions

This research led to the following conclusions:

1. The textbooks used in the college mathematics and methods of teaching mathematics courses adequately introduce the mathematical content most frequently emphasized in elementary schools, except for the limited coverage of geometry, graphs, charts, tables, and scale drawing.

2. Able students who exert a conscientious effort can develop understanding of the mathematical content of the elementary school curriculum. In the methods courses students are given a balanced program of purposes, methods, and evaluation of elementary school mathematics.

3. Administrators and instructors of all the institutions are interested in providing adequate preparation in mathematics and are likely to increase the number and kinds of required courses in the preparatory programs.

Recommendations

This research justified the following recommendations:

1. Consideration should be given to providing more background in algebra and geometry through additional courses or course emphases of these topics.

2. Consideration should be given to offering differentiated courses in methods to insure a better understanding of modern methods of teaching and teaching aids

for the lower and upper elementary grade levels.

3. Methods courses should be broadened to include more review of pupil textbooks, experimental programs, and more opportunity for laboratory sessions on a variety of teaching aids.

4. There is a need for research to determine the significance and role of "depth of preparation" in mathematics for elementary teachers. This study has been concerned with minimum content introduced in the preparatory programs.

5. Although there is evidence that preparatory programs introduce minimum mathematical content, research is needed to determine the effectiveness of required courses and the students' mastery of content introduced.

BIBLIOGRAPHY

Books

Bell, Clifford, Hammond, Clela D. and Herrera, Robert B. Fundamentals of Arithmetic for Teachers. New York: John Wiley and Sons, Inc., 1962.

Bergamini, David. Mathematics. No. 02774 of Life Science Library. New York: Time Incorporated, 1963.

Corle, Clyde G. Teaching Mathematics in the Elementary School. New York: The Ronald Press Company, 1964.

Crouch, Ralph, Baldwin, George, and Wisner, Robert J. Preparatory Mathematics for Elementary Teachers. New York: John Wiley and Sons, 1965.

Davis, Robert B. Discovery in Mathematics, A Text for Teachers. Reading, Mass.: Addison-Wesley Co., 1964.

De Vault, M. Vere (Ed.). Improving Mathematics Programs: Trends and Issues in the Elementary School. Columbus, Ohio: Charles E. Merrill Books, Inc., 1961.

Dutton, Wilbur H. Evaluating Pupils' Understanding of Arithmetic. Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1964.

_____ and Adams, L. J. Arithmetic for Teachers. Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1961.

Flournoy, Frances. Elementary School Mathematics. Washington, D. C.: The Center for Applied Research in Education, Inc., 1964.

Good, Carter V. Introduction to Educational Research. New York: Appleton-Century-Crofts, Inc., 1963.

Harris, Chester W. (Ed.). Encyclopedia of Educational Research. New York: The Macmillan Company, 1960.

Howard, Charles F. and Dumas, Enoch. Basic Procedures in Teaching Arithmetic. Boston: D. C. Heath and Company, 1963.

Jameson, Marshall C. and Hicks, William V. Elementary School Curriculum, From Theory to Practice. New York: American Book Company, 1960.

May, Lola J. Major Concepts of Elementary Modern Mathematics. Wilmette, Illinois: John Colburn Associates, Inc., 1962.

McSwain, E. T. and Cooke, Ralph J. Understanding and Teaching Arithmetic in the Elementary School. New York: Henry Holt Company, 1958.

Mueller, Francis J. Arithmetic, Its Structure and Concepts. Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1956.

Overman, James R. The Teaching of Arithmetic. Chicago: Lyons & Carnahan, 1961.

Scott, John F. A History of Mathematics. London: Taylor & Francis Ltd., 1958.

Spitzer, Herbert F. The Teaching of Arithmetic. Boston: Houghton Mifflin Company, 1961.

Stern, Catherine. Children Discover Arithmetic, An Introduction to Structural Arithmetic. New York: Harper & Brothers, 1949.

Stiles, Lindley J., Barr, A. S., Douglass, Harl R., Mills, Hubert H. Teacher Education in the U.S. New York: The Ronald Press Company, 1960.

Swenson, Esther J. Teaching Arithmetic to Children. New York: The Macmillan Company, 1964.

Sarason, Seymour B., Davidson, Kenneth S., and Blatt, Burton. The Preparation of Teachers. An Unstudied Problem in Education. New York: John Wiley and Sons, Inc., 1962.

Thorpe, Cleata B. Teaching Elementary Arithmetic. New York: Harper & Brothers, 1962.

Yearbooks and Bulletins

Aids for Evaluators of Mathematics Textbooks. National Council of Teachers of Mathematics. Washington, D. C.: The Council, 1965.

American Association of Colleges for Teacher Education. Fourth Bulletin, The Professional Sequence in Teacher Education, 1951; Twelfth Bulletin, Major Concerns in Teacher Education, 1959.

Association for Supervision and Curriculum Development, NEA. Criteria for Curriculum Decisions in Teacher Education, 1963; Teacher Education; Directions for the Sixties, 1961.

Association of Student Teaching Yearbooks. Thirty-second Yearbook, Current Trends in Teacher Education, 1953; Fortieth Yearbook, Teacher Education and the Public School, 1961.

Commission on Teacher Education, ACE. The Improvement of Teacher Education, 1946; The College and Teacher Education, 1944.

Deans, Edwina. Elementary School Mathematics. New Directions. United States Department of Health, Education and Welfare, Bulletin No. 13. Washington, D. C.: Government Printing Office, 1963.

Evanson, A. B. Modern Mathematics. Introductory Concepts and Their Implications. Chicago: Scott, Foresman and Company, 1962.

Goals for School Mathematics. A Report of The Cambridge Conference on School Mathematics. Boston: Houghton Mifflin Company, 1963.

Hartung, Maurice L., Van Engen, Henry, Knowles, Lois and Gibb, E. Glenadine. Charting the Course for Arithmetic. Chicago: Scott, Foresman and Company, 1963.

Key Topics in Mathematics for the Primary Teacher. Educational Research Council of Greater Cleveland. SRA, Inc., Chicago: 259 E. Erie St., 1962.

Mathematics in the Elementary School (Grade 1-8). State Department of Education. State of Louisiana. Elementary Pamphlet No. 9, 1963.

Morton, Robert L. What Research Says to the Teacher. Teaching Arithmetic. Department of Classroom Teachers. American Educational Research Association of the NEA. Washington, D. C., 1953.

National Council of Teachers of Mathematics Yearbooks. Twenty-fourth, The Growth of Mathematical Ideas, K-12, 1959; Twenty-fifth, Instruction in Arithmetic, 1960.

National Society for the Study of Education Yearbooks. Thirty-eighth Yearbook, Part 1, Child Development and the Curriculum; Fiftieth Yearbook, Part 2, The Teaching of Arithmetic, 1951.

The Revolution in School Mathematics. National Council of Teachers of Mathematics. Washington, D. C. 1201 16th Street, N. W., 1961.

Woodring, Paul. New Directions in Teacher Education. The Fund for the Advancement of Education, 1957.

Articles and Periodicals

A Symposium on Teacher Education. Journal of Teacher Education, 14 (March, 1963), 9-50.

Bezuszka, Stanley J. "Mathematics," National Education Association Journal, LIII (May, 1964), 48-50.

Bowie, Harold E. "Recent Developments in Mathematics Education," School and Society, XCIII (April, 1965), 252-254.

Brown, John A. and John R. Mayor. "The Academic and Professional Training of Mathematics Teachers," Review of Educational Research, XXXI (June, 1961), 302.

Brownell, William A. "Meaning and Skill: Maintaining the Balance," The Arithmetic Teacher, III (October, 1956), 129-136.

_____. "The Revolution in Arithmetic," The Arithmetic Teacher, I (February, 1954), 1-5.

Burns, Paul C. "A Brief Historical Overview of Arithmetic Methodology," School Science and Mathematics, LXI (June, 1961), 461-467.

Burns, Paul C. "Arithmetic Research That Has Made a Difference," Elementary School Journal, LXV (April, 1965), 386-392.

Clark, John R. "Issues in Teaching Arithmetic," Teachers College Record, LII (January, 1951), 205-212.

Corle, Clyde G. "Ten Questions," The Arithmetic Teacher, XIII (January, 1966), 38-42.

Dawson, Dan T. "The Case for the Meaning Theory in Teaching Arithmetic," Elementary School Journal, LV (March, 1955), 393-399.

Fehr, H. F. "Present Research in the Teaching of Arithmetic," Teachers College Record, LII (October, 1950), 11-23.

Fulkerson, Elbert. "How Well Do 138 Prospective Elementary Teachers Know Arithmetic," The Arithmetic Teacher, VII (March, 1960), 141-146.

Gibb, E. Glenadine. "A Review of a Decade of Experimental Studies Which Compared Methods of Teaching Arithmetic 1940-1950," Journal of Educational Research, XLVI (April, 1953), 603-607.

Glennon, Vincent J. "A Study in Needed Redirection in the Preparation of Arithmetic," The Mathematics Teacher, XLII (December, 1949), 389-396.

Gunderson, Agnes G. "Arithmetic for Today's Six and Seven-Year-Olds," The Arithmetic Teacher, II (November, 1955).

Habel, E. A. "Deficiencies of College Freshmen in Arithmetic," School Science and Mathematics, L (June, 1950), 480-482.

Hartford, Ellis F. "A Look at Teacher Education," Journal of Teacher Education, VIII (March, 1957), 73-80.

Henderson, K. B. "Anent the Discovery Method," The Mathematics Teacher, LII (April, 1957), 563-567.

Hickerson, J. A. "Teaching the Number System Inductively," The Arithmetic Teacher, V (October, 1958), 178-184.

Hiebert, Vern D. "Preparing Elementary Teachers in Mathematics," Educational Leadership, XIX (March, 1962), 383.

Johnson, Donovan A. "Evaluating a School Mathematics Program," School and Society, XC (December, 1962), 424-426.

Joyce, Bruce and Joyce, Elizabeth. "Studying Issues in Mathematics Instruction," The Arithmetic Teacher, XI (May, 1964), 303-307.

Madden, Richard. "Major Issues in Teaching Arithmetic," National Elementary Principal, XXXIX (October, 1959), 17-21.

Marks, John L. "The Uneven Progress of the Revolution in Elementary School Mathematics," The Arithmetic Teacher, X (December, 1963), 474-478.

Metter, Harry L. "Trends in the Emphasis on Various Topics of Arithmetic Since 1860," Elementary School Journal, XXXIV (June, 1934), 676-775.

Norton, Monte S. "Some Needed Breakthroughs in Mathematics Education," School Science and Mathematics, LX (October, 1960), 533-538.

Orleans, Jacob S. and Wandt, Edwin. "The Understanding of Arithmetic Possessed by Teachers," Elementary School Journal, LIII (May, 1953), 506-507.

Orleans, Jacob S. and Sperling, Julia B. "The Arithmetic Knowledge of Graduate Students," Journal of Educational Research, 48 (November, 1954), 177-186.

Phillips, Clarence. "Background and Mathematical Achievement of Elementary Education Students in Arithmetic for Teachers," School Science and Mathematics, LIII (January, 1953), 48-52.

Pincus, M. "Adventure in Discovery," The Arithmetic Teacher, XI (January, 1964), 28-29.

Rappaport, David. "Does 'Modern Math' Ignore Learning Theory?," Phi Delta Kappan, XLIV (June, 1963), 445-447.

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

Sage, Edward. "Elements of a Good Program in Arithmetic," School Science and Mathematics, LXI (March, 1961), 181-189.

Schaaf, William L. "Arithmetic for Arithmetic Teachers," School Science and Mathematics, LIII (October, 1953), 537-543.

Schult, Veryl. "A New Look at the Old Mathematics," National Education Association Journal, LIII (April, 1964), 12-15.

Shelton, Julia B. "History of Mathematics," The Mathematics Teacher, LII (November, 1959), 563-567.

Sherer, Lorraine. "Some Implications from Research in Arithmetic," Childhood Education, XXIX (March, 1953), 320-324, 346.

Stipanowich, Joseph. "The Mathematical Training of Prospective Elementary-School Teachers," The Arithmetic Teacher, IX (December, 1957), 240-241.

Sueltz, Ben A. "Arithmetic in Historical Perspective," National Elementary Principal, XXXIX (October, 1959), 12-16.

Summers, Edward G. "Bibliography of Doctoral Dissertations Completed in Elementary and Secondary Mathematics from 1918-1952," School Science and Mathematics, L (May, 1961), 323-335.

_____ and Stochl, James E. "Bibliography of Doctoral Dissertations Completed in Elementary and Secondary Mathematics from 1950-1960," School Science and Mathematics, L (June, 1961), 431-439.

Unruh, Adolph. "What's Needed in Teacher Education," Phi Delta Kappan, XXXVII (March, 1956), 258-261.

Van Engen, Henry. "Some Psychological Principles Underlying Mathematics Instruction," School Science and Mathematics, LXI (April, 1961), 242-250.

Weaver, Fred J. "A Crucial Problem in the Preparation of Elementary School Teachers," The Elementary School Journal, LVI (February, 1956), 253-257.

Weaver, J. Fred. "Research on Arithmetic Instruction," The Arithmetic Teacher, V (April, 1958); VI (April, 1959); VII (May, 1961; October, 1961).

_____. "Research on Elementary School Mathematics," The Arithmetic Teacher, VIII (May, 1961; October, 1961); IX (May, 1962); X (May, 1963); XI (April, 1964); XII (May, 1965).

Wheat, Harry G. "Changes and Trends in Arithmetic Since 1910," Elementary School Journal, XLVII (March, 1946), 134-144.

Willey, Roy D. "Functional Arithmetic, 1893-1940; A Review of Typical Theoretical Discussion and the Theory to Which It Has Led," Journal of Educational Psychology, XXXIII (April, 1942), 105-117.

Wootton, Lutian R. "Is Teacher Education in for an Awakening?," The Educational Forum, XXVII (May, 1964), 485-487.

Unpublished Material

Gilbert, Virginia Terlinden. "The Relationship of Certain Educational Experiences to the Understanding of Arithmetic by Prospective Elementary Teachers." Unpublished Ph.D. dissertation, Arizona State University, 1966.

Purcell, William J. "Some Factors Affecting Attitudes of Prospective Teachers Toward Elementary Mathematics." Unpublished Ed.D. dissertation, Columbia University, 1964.

Stevens, Deon Orlo. "Analysis of Change: A Comparative Study of Mathematical Texts Published for Elementary School Children for the Eight Year Period 1956 to 1964." Unpublished Ed.D. dissertation, University of Oregon, 1965.

Strain, Lucille Brewton. "Prospective Elementary-School Teachers Knowledge of Selected Subject Matter." Unpublished Ph.D. dissertation, Ohio State University, 1965.

Williams, Ralph Curtis. "Teacher Preparation in Mathematical Arithmetic." Unpublished Ph.D. dissertation, University of Southern California, 1966.

APPENDIX A

COMPOSITE LISTS OF TEXTBOOK SERIES

AMERICAN BOOK SERIES

Meeting Mathematics. 1. Edwina Dean, Robert B. Kane, and Robert A. Oesterle.
Exploring Mathematics. 2. Dean, Kane, and Oesterle.
Developing Mathematics. 3. Dean, Kane, and Oesterle.
Understanding Mathematics. 4. Dean, Kane, McMeen, and Oesterle.
Learning Mathematics. 5. Dean, Kane, McMeen, and Oesterle.
Unifying Mathematics. 6. Dean, Kane, McMeen, and Oesterle.
American Book Company: N.Y. 1963.

SETS: SENTENCES, EQUATIONS, INEQUALITIES

Numbers to 999,999,999
Sets, Subsets, Infinite Sets
Ordinal and Cardinal Uses of Number
True and False Sentences
Open Sentences
Equations
Symbols for Inequalities
Letters as Placeholders
Use of Parentheses

NOTATION AND NUMERATION

Hindu-Arabic Numeration System
Roman Numerals
Other Bases of Numeration
Decimal Numeration
Place Value
Numerals and Number Words
Symbols for Zero
Polynomial Form

NUMBER SYSTEMS: WHOLE NUMBERS

Addition and Subtraction of Whole Numbers
Multiplication and Division of Whole Numbers
Renaming in Addition and Subtraction
Subtraction as the Inverse of Addition
Subtraction and Division as non-Commutatives
Commutative and Associative Properties of Addition
Commutative and Associative Properties of Multiplication
Property of zero and One
Concept of Integers
Prime and Composite Numbers

NUMBER SYSTEMS: RATIONAL NUMBERS

Meaning of Fractions and Fractional Parts
Naming Parts of a Whole, Parts of a Set
Adding, Subtracting, Multiplying, and Dividing Fractions
Using Ratios and Proportions
Equivalent Fractions
Rounding Numbers
Computing Interest
Commission, Mark Up
Comparison

PER CENT, RATIO, PROPORTION

Meaning of Per Cent
Proportions and Per Cent
Per Cents and Discount in Sale Prices
Using Ratios

GEOMETRY

Points and Planes
Rays and Angles
Parallel and Intersecting Lines
Closed and Open Figures
Plane and Closed Space Figures
Lines and Line Segments
Radii, Diameter, and Circumference
Finding Perimeter
Using Compasses and Rulers

MEASUREMENT

Inexact and Standard Linear Measure
Measures of Degrees and Weight
Telling Time and the Calendar
Liquid Measures
Equivalent Money Values
English and Metric Systems of Measures

TABLES, GRAPHS, SCALE DRAWINGS

Tables of Sale Results and Scores
Meaning and Uses of Tables
Floor Plans and Dimensions
Distance in Maps
Vertical and Horizontal Bar Graphs
Bar, Picture, Line, and Circle Graphs
Scale Drawings

HOLT, RINEHART, WINSTON COMPANY SERIES

Moving Ahead in Arithmetic. 1 and 2. Elda L. Merton and Leo J. Brueckner. 1964.

Moving Ahead in Arithmetic. 3, 4, 5, 6. Leo J. Brueckner, Elda L. Merton, and Foster E. Grossnickle. Holt, Rinehart, Winston: N.Y. 1963.

SETS, NUMBER AND NUMERALS

One-to-one Correspondence
Idea of Ordinal and Cardinal Numbers
Naming Sets
Sequence of Numbers
Concept of Place Value
Decimal Numeration System
Terms of Comparison
Equivalent and Non-equivalent Sets
Number Concepts
Egyptian, Greek, and Roman Numerals
Hindu-Arabic System

ADDITION AND SUBTRACTION

Commutative and Associative Laws of Addition
Zero as the Identity Element of Addition
Subtraction as the Inverse of Addition
Addend-Sum Relationship
Place Value
Addition and Subtraction in Other Bases

MULTIPLICATION AND DIVISION

Commutative and Distributive Laws of Multiplication
Property of One and Zero in Multiplication and Division
Multiplication and Division of Whole Numbers
Exact and Approximate Numbers
Prime Numbers and Prime Factorization
Reciprocals

GEOMETRY

Concept of Geometric Region
Points and Line Segments
Rays and Angles
Introducing Three-Dimensional Shapes
Naming Figures
Constructing Figures

MEASUREMENT

Meaning of Terms of Measurement
Measures--liquid, linear, time, weight, distance, temperature
Precision of Measurement
Comparing Amounts of Money
Making a Calendar

FRACTIONS

Renaming Fractions
Meaning of Decimal Fractions
Fractional Parts
Different Fractional Names
Addition and Subtraction of Like and Unlike Fractions
Addition and Subtraction of Decimal Fractions
Multiplication and Division of Decimal Fractions
Greatest Common Factor

PER CENT, RATIO, RATES

Ratios and Rates
Finding Per Cents
Renaming Ratios as Per Cents
Per Cent of Change and Reduction

PROBLEM SOLVING

Writing Number Sentences
Choosing Equations
Determining Known and Unknown Facts
Solving Verbal Problems
Problems Involving Addition, Subtraction, Multiplication, and Division
Scientific Applications

GRAPHS, CHARTS, TABLES

Reading Graphs
Understanding Scale as Ratio
Using Mean, Median, Mode
Inequalities and Order
Rounding Numbers and Intervals

LAIDLAW BROTHERS SERIES

Sets. Numbers. Numerals. 1 and 2. Bernard H. Gundlach, Ronald C. Welch, and Edward G. Buffie. Laidlaw: River Forest, Illinois. 1965.

Arithmetic. 3, 4, 5, 6. E. T. McSwain, Kenneth E. Brown, Bernard H. Gundlach, and Ralph J. Cooke. Laidlaw: River Forest, Illinois. 1965.

SETS, NUMBERS, NUMERALS

Meaning of Numbers and Numerals
Number Sequences and Patterns
Natural Order of Numbers
Cardinal Concept of Number
Understanding Place Value
Understanding Zero
Addition, Subtraction, Multiplication, and Division of Whole Numbers
Hindu-Arabic Numeration System
Roman Numerals
One-to-one Matching
Recognition of Sets
Nonequivalent Sets

FRACTIONS AND FRACTIONAL NUMBERS

Kinds of Fractions
Finding Fractional Parts
Addition and Subtraction of Fractional Numbers
Reducing Fractions to Lowest Terms
Changing Fractions to Higher Terms
Changing to a Common Denominator
Multiplying and Dividing Fractions

ADDITION AND SUBTRACTION COMBINATIONS

Addition and Subtraction of Whole Numbers
Language of Addition and Subtraction
Zero in Addition and Subtraction

MULTIPLICATION AND DIVISION COMBINATIONS

Multiplication and Division of Whole Numbers
Properties of Division
Regrouping Factors
Finding Averages

GEOMETRY

Lines and Line Segments
Points, Rays, Angles, and Planes
Geometric Figures
Area of Closed Figures
Meaning of Volume and Area
Finding a Perimeter and a Dimension

MEASUREMENT

Measures of Length, Liquids, Weights, Time, Temperature, Produce, and Money
Estimation in Measurement
Approximate Nature of Measurement
Adding, Subtracting, Multiplying, and Dividing Measures

PROBLEM SOLVING

Solving and Writing Equations
Solving Story Problems
Placeholders for Numerals
Problems Using Addition, Subtraction, Multiplication, and Division
Arithmetic Sentences
Selecting Relevant Information
Supplying Missing Information
Planning Solutions
Estimating Answers

DECIMALS

Adding and Subtracting Decimals
Reading and Writing Decimals
Multiplying and Dividing Decimals
Multiplying and Dividing a Decimal by a Whole Number
Multiplying and Dividing a Whole Number by a Decimal
Using Division to Find Decimal Equivalents

RATIO, PROPORTION, PER CENT

Making Comparisons
Determining Equivalent Ratios
Using Per Cent in Comparison
Making Estimates with Per Cent Forms
Using Decimals in Ratios
Using Per Cent in Solving Problems
Using Ratios to Find Per Cent
Proportion (Equality Between Two Ratios)

GRAPHS AND SCALE DRAWING

Meaning of a Graph
Kinds of Graphs

SCOTT FORESMAN COMPANY SERIES

Numbers We See. 1. Maurice L. Hartung, Henry Van Engen, Anita Riess, and Catherine Mahoney. 1961.

Numbers in Action. 2. Maurice L. Hartung, Henry Van Engen, and Catherine Mahoney. 1961.

Seeing Through Arithmetic. 3, 4, 5, 6. Maurice L. Hartung, Henry Van Engen, Lois K. Knowles, and Catherine Mahoney. Scott Foresman: Chicago. 1961.

NUMBERS, OPERATIONS, MATHEMATICAL SYSTEMS

Natural Numbers (0-999,999,999)
Symbolization of Additive, Subtractive, Multiplicative, and Divisive Situations
Relationship Between Addition and Subtraction
Idea of Commutative and Associative Properties of Addition
Commutative Property of Multiplication
Identity Property of Addition
Distributive Property of Multiplication
Meaning of Numbers Within the Decades
Recognition of Number Symbols and Number Words
Ordinal Use of Number
Rounding Numbers
Fractions: unit fractions, nonunit fractions

SETS, CONDITIONS, VARIABLES

One-to-one Correspondence; one-to-two; two-to-one
Use of Statements of Equality
Concept of Solution Set
Grouping and Regrouping
Use of Variety of Symbols as Placeholders

RATE PAIRS (Ratios)

Idea of Equivalent Rate Pairs
Introduction to Rate Pairs
Ratios as Expressions of Rates and Comparisons
Distinguishing Among Fractions and Rates
Introduction to Per Cent
Per Cents Expressed as Ratios
Fraction Numerals as Terms of Ratios
Meaning of Equivalent Fractions
Common Divisors and Common Multipliers
Reduction of Ordered Pairs of Numbers

PROBLEM SOLVING

Introduction to n as a Placeholder
Multiple-Step Problems
Mathematical Sentences
Comparison by Subtraction and Division
Averages
Generalizing the Use of Symbolism

NUMERATION

Base-Ten System Through 999,999,999
Place Value
Grouping by Ones, Tens, Hundreds, Thousands
Regrouping for Carrying and Borrowing
Decimal Fraction Numerals
Roman Numerals

COMPUTATION

Basic Facts; sums, minuends, products, dividends
Addition, Subtraction, Multiplication, and Division

MEASUREMENT

Concept of a Unit of Measure
Concept of Standard Units
Use of Standardized Measuring Instruments
Ideas of Linear and Capacity Measure
Finding Areas
Measures of Volume
Metric Measures
Use of Money

GEOMETRY

Geometric Solids
Closed and Open Curves
Concept of Perimeter
Points, Angles, Lines and Line Segments
Polygons and Trapezoids
Scale Drawings

PROBABILITY AND STATISTICS

Introduction to Graphs
Introduction to Statistical Tables

SILVER BURDETT COMPANY SERIES

Modern Arithmetic Through Discovery. 1, 2, 3, 4, 5, 6. Robert Lee Morton, Myron F. Resskepf, H. Stewart Moredock, Merle Gray, Edward E. Sage, and Wagner G. Collins. Silver Burdett: Morristown, N. J. 1964.

NUMBERS, NUMERALS, SETS AND SET NOTATION

Matching one-to-one, two-to-one
Cardinal Numbers and Ordinal Numbers
Place Value to Twelve Places
Other Bases of Numeration
Number Sequences and Patterns
Recognizing and Describing Sets, and Sets within Sets
Comparing and Rounding Numbers
Roman Numerals
Decimals

EQUALITIES AND INEQUALITIES

Informal Number Comparisons
Number Sentences to Illustrate Operations and Relationships
Number Sentences in Problem Solving
Open Sentences and Inequalities
Using Parentheses

ADDITION AND SUBTRACTION

Commutative and Associative Principles of Addition
Identity Element for Addition
Addition and Subtraction as Inverse Operations
Addition and Subtraction with Fractions and Decimals
Addition and Subtaction: through six-place sums and minuends

MULTIPLICATION AND DIVISION

Commutative and Associative Principles of Multiplication
Identity Element for Multiplication
Distributive Principle
Multiplication as Successive Addition
Division as Successive Subtraction
Division as the Inverse of Multiplication
Role of Zero in Multiplication

MEASUREMENT

Concepts of Liquid, Linear, and Dry Measures
Measures in Money
Telling Time
Using a Calendar
Units of Area
Introduction to Metric System

FRACTIONAL NUMBERS

Fractional Parts
Equivalent Fractions
Writing Fractions
Regrouping of Fractional Numbers
Improper and Mixed Fractions
Adding and Subtracting Like and Unlike Fractions
Multiplying and Dividing Fractions

RATIO AND PER CENT

Ratios in Problem Solving
Per Cent as a Ratio
Finding Per Cent
Discounts, Interest, and Rates

PROBLEM SOLVING

Recognizing Essential Data
Estimating the Answers to Problems
Checking as the Final Step
Supplying Additional Information
Interpreting Number Stories
Averages in Problem Situations
Finding Areas in Problem Situations

GEOMETRY

Patterns with Geometric Figures
Solid and Closed Figures
Angles and Planes
Points, Lines and Line Segments
Areas and Perimeters
Concept of a Hemisphere
Understanding a Diameter

GRAPHS AND STATISTICS

Types of Graphs
Ideas of Probability
Rounding to Interpret Tables of Data
Understanding the Purpose of a Graph

APPENDIX B

DESCRIPTION OF COLLEGES AND UNIVERSITIES

GRAMBLING COLLEGE
Grambling, Louisiana

In 1928, Grambling, a former industrial quasi-public school became a state junior college and in 1940 a four year program was inaugurated. Today it offers work in the divisions of Applied Sciences and Technology, Education, Liberal Arts, and General Studies. It is fully accredited by the Southern Association of Colleges and Schools and the National Council for Accreditation of Teacher Education. The Campus site comprises approximately 340 acres. (From College Bulletin, 1967-1968, pp. 37-38.)

NORTHWESTERN STATE COLLEGE
Natchitoches, Louisiana

Northwestern was established by the legislature in 1884 as a normal school, and in 1918 it became Louisiana State Normal College offering four years of academic work. In 1944 the name of the college was changed to the present one. The college now consists of four undergraduate schools--Applied Arts and Sciences, Arts and Sciences, Education, and Nursing, and the Graduate School. The college is a member of the Southern Association of Colleges and Secondary Schools. All programs for teachers are accredited by the National Council for Accreditation of Teacher Education. The Campus site comprises 766 acres. (From College Bulletin Volume LIV Number 6, 1966-67, pp. 25-27.)

LOUISIANA POLYTECHNIC INSTITUTE
Ruston, Louisiana

Founded in 1894, Louisiana Polytechnic was formerly called Industrial Institute and the College of Louisiana. In 1921, its name was changed to the one by which it is presently known. The university is accredited by the Southern Association of Colleges and Secondary Schools and the department of education is approved by the National Council for Accreditation of Teacher Education. Louisiana Tech is organized into six schools: the Schools of Agriculture and Forestry, Arts and Sciences, Business Administration, Education, Engineering, and Home Economics, and the Graduate School. The Campus site consists of 209 acres. (From College Bulletin Volume LXIV No. 1, 1965-1966, 1966-1967, pp. 8-9.)

NORTHEAST LOUISIANA STATE COLLEGE
Monroe, Louisiana

Northeast opened for its first session in September 1931, as Ouchatta Parish Junior College and was operated as a part of the Ouchita Parish school system. In 1950 the state legislature authorized the transfer of Northeast from the LSU system to the State Board of Education and the expansion of the program to a four year institution. The name was then changed to the present one. Curricula are offered in the Schools of Business Administration,

Education, Liberal Arts, Pharmacy, and Pure and Applied Sciences, and the Graduate School. The college is a member in good standing of the Southern Association of Colleges and Schools. The teacher preparatory programs at the bachelor's and master's degree levels are accredited by the National Council for Accreditation of Teacher Education. The Campus site consists of 130 acres. (From College Bulletin Volume XXXII Number 2, 1966-67, pp. 8-9.)

UNIVERSITY OF SOUTHWESTERN LOUISIANA
Lafayette, Louisiana

USL was established in 1898 as the Southwestern Louisiana Industrial Institute. In 1960 the legislature changed the name to the present one. It is accredited by the Southern Association of Colleges and Secondary Schools as a four-year college and the College of Education is accredited by the National Council for the Accreditation of Teacher Education. The University included undergraduate colleges of Liberal Arts, Education, Agriculture, Engineering, Nursing, and Commerce, and the Graduate School. The Campus site consists of 735.58 acres. (From College Bulletin Volume 59 Number 1, 1964-66, pp. 34-37.)

SOUTHERN UNIVERSITY
Baton Rouge, La.

Southern was chartered in January 1880 by the General Assembly of the State of Louisiana. Southern was moved from New Orleans to Baton Rouge and the New Southern opened on the present site in 1914. Southern offers undergraduate degrees in Agriculture, Arts and Sciences, Business, Engineering, Education, and Home Economics, and graduate degrees in Education and Law. It is a member of the Southern Association of Colleges and Secondary Schools, and its College of Education is a member of the American Association of Colleges for Teacher Education. The Campus site consists of 512 acres. (From College Bulletin Volume 51 No. 1, 1965-1967, pp. 35-37.)

LOUISIANA STATE UNIVERSITY
Baton Rouge, La.

Louisiana State was opened in 1860 in Alexandria, Louisiana, was later moved to New Orleans and then to Baton Rouge in 1869. The university program consists of the Colleges of Agriculture, Arts and Sciences, Business Administration, Chemistry and Physics, Education, Engineering, Schools of Law, Library Science, Music, Social Welfare, Graduate School, University College and Junior Division; and a School of Medicine located in New Orleans. The College of Education is fully accredited for undergraduate

and graduate work by the National Council for Accreditation of Teacher Education. The Campus site comprises 4,725 acres, 300 acres of which are devoted particularly to purposes of Administration and instruction. (From College Bulletin Volume 56 Number 1, 1965-1967, pp. 47-48.)

APPENDIX C

GENERAL INFORMATION SHEET AND INTERVIEW INSTRUMENT

PREPARATORY PROGRAM

General Information

College:

Teacher Education Students

Total Number of Students Working Toward Degrees and/or Certification to teach in the Elementary School: _____

Total Number of Students Enrolled in Differentiated Programs

Elementary (all grades) Education: _____

Early Childhood Education: _____

Later Childhood Education: _____

Mathematics Education (k-12): _____

Others: _____

Mathematics and Mathematics Methods Courses Required for Degree(s) and/or Certification

Program	Course	Credit	Instructor(s)

INTERVIEW INSTRUMENT

INSTRUCTOR:
POSITION:
COLLEGE:

COURSE:

MATHEMATICS COURSE

1. What textbook(s) is/are used in this course?

2. What role does the textbook play in the course organization?

3. Do you introduce any mathematical content other than the content in the textbook? To what extent?

4. What proportion of the course time is devoted to mathematics content and what proportion to methods?

5. What are the purposes and major emphases of the course?

6. What are the most common work-study requirements of this course?

Requirements	Most Frequently	Moderately	Seldom
Individual Projects			
Group Projects			
Demonstration Lessons			
Participation in Work-Shops or Conferences			
Discussions and/or Question periods			
Reports (Oral or Written)			

7. What are the most common instructional procedures emphasized in this course?

Procedures	Most Frequently	Moderately	Seldom
Discovery Method			
Questioning			
Reviewing or Check Up Time			
Meanings and Understandings			
Ideas of Place Value Through Experiences in Other Bases			
Learning Stages			
A Four-Step Method: "See, Think, Try, and Do"			
Whole Class Procedure			
Individual Pupil Assignment			
Ability Grouping			
Self Instruction			
Others			

8. To what extent does the class review evaluation instruments which can be used with pupils?

Evaluation Instruments	Most Frequently	Moderately	Seldom
Standardized Achievement Tests			
Diagnostic Tests			
Teacher-made Paper & Pencil Tests			
Others			

9. What are the most common mathematical concepts covered in this course?

Mathematical Content	Most Frequently	Moderately	Seldom
Sets, Numbers, Numerals			
One-to-one Correspondence; One-to-two; Two-to-one			
Sets, Subsets, Infinite and Solution Sets; Equivalent and nonequivalents			
Variety of Symbols as Placeholders; Zero; Parentheses			
True-False and Open Sentences; Patterns, Equations, and Polynomial Form			
Hindu-Arabic Number System; Numbers to 999,999,999,999			
Egyptian, Greek, and Roman Numerals			
Other Bases of Numeration			
Decimal Numeration System			
Addition, Subtraction, Multiplication, and Division of Whole Numbers			
Concept of Place Value			
Idea of Ordinal and Cardinal Numbers			
Terms of Comparison			
Addition, Subtraction, Multiplication, Division			
Associative and Commutative Laws of Addition and Multiplication			

Mathematical Content	Most Frequently	Moderately	Seldom
Property of One and Zero in Addition, Multiplication and Division			
Subtraction as Inverse of Addition			
Subtraction and Division not Commutative			
Addition and Subtraction in Other Bases			
Addition and Subtraction with Fractions and Decimals			
Commutative and Distributive Laws of Multiplication			
Multiplication as Successive Addition			
Division as Successive Subtraction			
Division as the Inverse of Multiplication			
Concept of Integers			
Composite, Prime Numbers, and Prime Factorization			
Exact and Approximate Numbers			
Geometry			
Lines, Line Segments; Parallel and Intersecting Lines			
Points, Rays, Angles, Planes			
Solid and Closed Planes and Figures			

Mathematical Content	Most Frequently	Moderately	Seldom
Meaning of Volume and Area; Geometric Region			
Radii, Diameter, Circumference			
Perimeter, Dimension, Hemisphere			
Measurement			
Meaning of Terms of Measurement; Standard Units			
Measures: liquid, dry, linear, time, weight, distance, produce, temperature, volume, degrees			
Precision of Measurement; Estimation in measures			
Use of Standardized Measuring Instruments			
Equivalent Money Values			
Time Zone and the Calendar			
The Metric System			
Fractions			
Meaning of Fractions and Fractional Parts			
Kinds of Fractions: decimal, equivalent, improper, mixed			
Addition and Subtraction of Like and Unlike Fractions			
Addition, Subtraction, Multiplication, and Division of Decimal Fractions			

Mathematical Content	Most Frequently	Moderately	Seldom
Greatest Common Factor			
Reducing Fractions to Lowest Terms			
Changing Fractions to Higher Terms			
Changing to a Common Denominator			
Computing Interest			
Commission, Mark Up			
Problem Solving			
Problems Using Addition, Subtraction, Multiplication, and Division			
Introduction to n as a Placeholder; Placeholders for Numerals			
Multiple-Step Problems			
Averages and Finding Areas in Problem Situations			
Scientific Applications			
Solving, Choosing, and Writing Equations; Mathematical Sentences			
Planning Solutions			
Determining Known and Unknown Facts			
Selecting and Recognizing Relevant and Essential Data			
Supplying Missing and Additional Information			

Mathematical Content	Most Frequently	Moderately	Seldom
Estimating Answers, and Solving Story and Verbal Problems			
Interpreting Number Stories			
Checking as the Final Step			
Generalizing the Use of Symbolism			
Per Cent, Proportion, Ratio, Rates			
Introduction to Per Cent and Proportion			
Introduction to Rate Pairs (Ratios)			
Idea of Equivalent Rate Pairs			
Per Cent of Change and Reduction			
Ratio as Expression of Rates and Comparison			
Graphs, Charts, Tables, Scale Drawing			
Introduction to Graphs; Meaning, Purpose, and Kinds of Graphs			
Introduction to Statistical Tables; Meaning and Uses of Tables			
Idea of Probability			
Understanding Scale as Ratio			
Scale Drawing; Distance in Maps; Floor Plans and Dimensions			
Tables of Sale Results and Scores			

PREPARATORY PROGRAM

1. What do you consider to be the major problems in preparing teachers to teach mathematics?

2. What major changes in the preparatory program would you suggest?