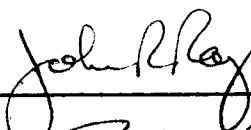
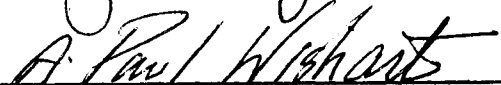


To the Graduate Council:

I am submitting herewith a dissertation written by Ronald Dewight Hagan entitled "Factors Influencing Arithmetic Performance on the Tennessee State-Mandated Eighth Grade Basic Skills Test." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Education, with a major in Curriculum and Instruction.


Aaron M. Johnston
Major Professor

We have read this dissertation
and recommend its acceptance:


Accepted for the Council:


Vice Chancellor
Graduate Studies and Research

Thesis
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FACTORS INFLUENCING ARITHMETIC PERFORMANCE ON THE TENNESSEE
STATE-MANDATED EIGHTH GRADE BASIC SKILLS TEST

A Dissertation
Presented for the
Doctor of Education
Degree
The University of Tennessee, Knoxville

Ronald Dewight Hagan

August 1979

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ABSTRACT

The problem of this study was to identify discrepancies between (1) arithmetic operations included in major mathematics textbooks; (2) operations included in local curriculum guides; (3) operations teachers say they cover in grades one through eight in selected Tennessee school systems; (4) arithmetic operations included on the Tennessee State-Mandated Eighth Grade Basic Skills Test administered in the spring of 1978; and (5) the scores on that test.

A checklist was prepared from arithmetic operations included in the major mathematics textbooks used in Tennessee, local curriculum guides, the Tennessee State List of Competencies for the area of mathematics, and the Eighth Grade Basic Skills Test administered in the spring of 1978. This checklist was presented to 1200 teachers across the state for them to check operations they felt they taught. Percentages were computed for the following:

1. Those operations included on the test that were taught and the scores on those operations.
2. Those operations included on the test that were not taught and the scores on those operations.
3. Those operations included on the test which were in the textbooks and the scores on those operations.

4. Those operations included on the test which were not in the textbooks and the scores on those operations.
5. Those operations included on the test which were in the curriculum guides and the scores on those operations.
6. Those operations included on the test that were not included in the curriculum guides and the scores on those operations.

The major findings of the research were that there seemed to be a great deal of agreement within grade levels about what operations were to be taught and that this agreement was greatest for those operations that were introduced at each grade level by the major textbooks. There were few curriculum guides available. Those that were supplied were apparently developed from textbooks. The curriculum guides seemed to follow the scope and sequence charts of the major textbooks and the teachers also seemed to follow these scope and sequences. The eighth grade basic skills test administered in the spring of 1978 was based entirely on computational skills. It was found that the textbooks were broadest in their coverage and that the coverage became increasingly narrow as one moved from the textbooks to the curriculum guides; to what teachers "taught"; to what was evaluated by the eighth grade basic skills test.

It was recommended that the Tennessee State Department of Education develop a curriculum guide for the area of mathematics. It was also recommended that the actual test be based on this curriculum guide.

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CHAPTER 1

INTRODUCTION

To the delight of some, and to the horror of others, the proficiency testing movement has spread across the nation.¹ This movement, good or bad, will have a profound effect upon the lives of students, parents, and all those concerned with the educational process.

I. THE PROBLEM

Statement of the Problem

The problem of this study was to identify discrepancies between (1) arithmetic operations included in major mathematic textbooks; (2) operations included in local curriculum guides; (3) operations teachers say they cover in grades one through eight in selected Tennessee school systems; (4) arithmetic operations included on the Tennessee State-Mandated Eighth Grade Basic Skills Test administered in the spring of 1978; and (5) the scores on that test.

Importance of the Study

On November 10, 1977, the Tennessee State Board of Education approved the recommendations of the Board's

¹H. B. Pinkney, "Public Education: Let's Not Oversimplify The Basics Through Rhetoric," Peabody Journal of Education: (July 1978): 347.

Sub-committee on High School Proficiency Testing. These recommendations required each local school system to administer a test for diagnostic purposes at the fourth, fifth, or sixth grade level and at the eighth grade level. It was recommended that skills in mathematics, reading comprehension and vocabulary, grammar, and spelling be tested.²

The Proficiency Testing Implementation Committee recommended that a skills test be designed that could relate to the objectives identified in an achievement test regularly administered to the students of Denver, Colorado.³

In the area of mathematics, objectives were drawn from Objectives-Referenced Bank of Items and Tests (ORBIT) which is published by the McGraw-Hill Publishing Company.⁴

The Proficiency Testing Implementation Committee defined the skills they considered necessary for all eighth graders. An eighth grade student was identified as being a student who was officially classified as such. There was no consideration given to where the student was located, his or her

²Sam Ingram, "State Board Mandated Eighth Grade Testing Program," letter addressed to Tennessee Public School Superintendents, Nashville, Tenn., 23 March 1978.

³Ibid.

⁴Objectives-Referenced Bank of Items and Test, (Monterey, California: McGraw Hill Inc., 1977).

proficiency level, or the course of study in which the student was enrolled.⁵

The McGraw-Hill Publishing Company stressed that the ORBIT levels were not recommended testing levels but represent the grade range in which each objective is usually introduced and mastered.⁶

Norms for the Tennessee State-Mandated Eighth Grade Basic Skills do not exist. At the time the test was prepared, neither the reliability nor the internal consistency of the ORBIT test had been measured.

Jim Mecklenburger is director of research for the National School Boards Association. He believes that competency testing may be an easy task to perform, but the difficult task will be to defend using such a test. Mecklenburger believes that it will be necessary to defend each test as an accurate measurement of whatever is tested, and that each item is important enough to be taught and tested.⁷

Merle McClung of the Cambridge, Massachusetts Center for Law and Education, points out that a number of competency

⁵Sam Ingram, "State Board Mandated Eighth Grade Testing Program", letter addressed to Tennessee Public School Superintendents, Nashville, Tenn., 23 March 1978.

⁶Objectives-Referenced Bank of Items and Test, (Monterey, California: McGraw Hill Inc., 1977).

⁷Jim Mecklenburger, "Minimum Competency Testing: The Bad Penny Again." Phi Delta Kappan 59 (June 1978): 699.

studies show racial and socio-economic prejudices involved in the test. It will be difficult to defend the use of any test that is not free of factors which discriminate against race, sex, culture, or socio-economic conditions.⁸

In another article, McClung and Deana Paullin outline what states can do for the physically and mentally handicapped children when programs require students to pass proficiency examinations.⁹

Much research needs to be done in the areas mentioned by Mecklenburger, McClung, and Paullin; however, this study will be limited to determining if there are discrepancies between what the textbooks include, what the curriculum provides for, what the teachers teach, and what is being evaluated by the Tennessee State-Mandated Basic Skills Test in mathematics.

Research on achievement testing indicates that achievement test change has not kept up with curriculum change. Decker J. Walker and James Schaffarzick, who reviewed studies comparing traditional and innovative curricula, found that new curricula had generally been introduced because educators considered them superior to older forms, but that superiority

⁸Merle McClung, "Are Competency Testing Programs Fair? Legal?" Phi Delta Kappan 59 (February 1978): 397.

⁹"Competency Testing and Handicapped Students" "cited by" Capital Publications, "Newsnotes," Phi Delta Kappan 59 (May 1978): 646.

did not always show up on achievement tests. Walker and Schaffarzick concluded that achievement tests oriented to the objectives of the new curricula showed increases in test score performance, while those oriented to the objectives of the old curricula showed declines.¹⁰

The conclusions of this study should have implications for those individuals responsible for preparing or selecting tests, textbook writers, curriculum planners, teacher education programs, state boards of education, state legislatures, and classroom teachers.

Definition of Terms

The following definitions were formulated for the purposes of this study:

Competency tests. As used in this study, competency tests were defined to be any form of assessment or evaluation that were designed to determine how well students had mastered predetermined levels of performance. This term, as used in this study, included basic skills tests, proficiency tests, and achievement tests.

Arithmetic. As used in this study, arithmetic was defined to mean those processes dealing with the four basic operations of addition, subtraction, multiplication, and

¹⁰Decker Walker and James Schaffarzick, "Comparing Curricula," Review of Educational Research 44 (Winter 1974): 87.

division of whole numbers, fractions, and decimals. Miscellaneous topics such as telling time and Roman numerals were included. To limit the scope of the study and to make it a manageable task, concepts dealing with the so called modern mathematics were not included. Elements of modern mathematics were not included on the eighth grade basic skills test administered in the spring of 1978. These concepts include, but are not limited to, such aspects as set theory, number theory, commutativity, and functions.

Mathematics. Mathematics was defined to be an art made up of five branches of study. These include arithmetic, algebra, geometry, calculus, and statistics. The term mathematics when used in this study denotes a broader coverage than the term arithmetic. For instance, when the term mathematics textbooks was used, these textbooks contained more than arithmetic as it was defined for the purpose of this study.

The Hypotheses of the Study

H_{0_1} : All arithmetic operations included in the textbooks are not evaluated by the eighth grade basic skills test.

H_{0_2} : All arithmetic operations included in the curriculum guides are not evaluated by the eighth grade basic skills test.

Ho₃: All arithmetic operations included in the textbooks are not taught by a majority of the teachers responding to the study.

Ho₄: All arithmetic operations included in the curriculum guides are not taught by a majority of the teachers responding to the study.

Ho₅: All arithmetic operations included in the curriculum guides are not included in the textbooks.

Ho₆: All arithmetic operations taught are not included in the eighth grade basic skills test.

Ho₇: Arithmetic operations that are not included in the textbooks will not receive scores less than 70 percent of the total number of correct responses for those operations.

Ho₈: Arithmetic operations that are not taught by a majority of the teachers responding to the study will not be lower than 70 percent of the total number of correct responses for those operations.

II. ASSUMPTIONS

The following assumptions were made for the purpose of this study:

1. It was not necessary to have a random sample.

A sample composed of teachers from selected stratifications and from selected systems within these stratifications was considered adequate for this study.

2. The rate of return was not of major importance.
3. Teachers responded honestly to the checklists.

III. LIMITATIONS

The following limitations must be considered when evaluating the findings of this study:

1. Only 399, or 33 percent, of the 1,220 checklists were returned. Thirty-nine (10 percent) of these were faulty and were not used in the analysis of data.

2. A follow up was conducted in which 16 (20 percent) of the principals involved in the study were contacted by telephone. These principals were from the schools from which no checklists were returned. The reason given most often for not distributing the checklists was that they arrived at the schools too late in the school year. Teachers were too busy to be bothered. The follow up also included telephone conversations with eight teachers who did not return the checklist. Four of these teachers were from West Tennessee, three were from Middle Tennessee, and one was from East Tennessee. All but one of these teachers stated that they did not receive the checklist. One stated that he was a Title I mathematics teacher and did not feel the checklist was meant for him.

3. The checklist used in the study failed to define the term "teach." This may have resulted in some confusion about

which operations teachers were to check. Teachers may have interpreted the term to mean "those operations introduced" in their grade level.

4. The tabulation of data was done by hand. This may have increased the likelihood of error.

IV. SUMMARY

This chapter discussed the statement of the problem, the importance of the study, the definitions of terms used in the study, the hypotheses, the assumptions, and the limitations of the study. Chapter 2 contains a review of related literature.

CHAPTER 2

REVIEW OF RELATED LITERATURE

In an effort to conduct a thorough search of the literature related to this study, an ERIC search was conducted in March of 1978. The following item descriptions were used for this search: (1) proficiency testing; (2) equivalency test; (3) criterion teaching; (4) criterion referenced test; (5) performance based education; (6) high school equivalency programs; (7) student accountability; (8) competency evaluation; (9) accountability; (10) teacher attitudes; (11) elementary school teachers; and, secondary school teachers.

Journals including The Elementary School Journal, Educational Leadership, The Arithmetic Teacher, Mathematics Teacher, School Science and Mathematics, Phi Delta Kappan, and The Journal of Educational Research, were reviewed back to January, 1969. A search was conducted in the Education Index for the years 1969 through 1979. The Dissertation Abstracts were reviewed back to January, 1970.

The review of the related literature did not produce any studies dealing with the Tennessee State-Mandated Eighth Grade Basic Skills Test, an indication that this study was original.

Material obtained from these searches were used to compile the chapter on the review of literature. This chapter includes state activities involving proficiency testing, support for proficiency testing, opposition to proficiency testing, and a summary.

I. STATE ACTIVITY INVOLVING PROFICIENCY TESTING

Chris Pipho, Associate Director of the Department of Research and Information for the Education Commission of the States, has compiled a list of states involved in some form of proficiency testing. In this list, Pipho gives the name of the state, what action has been taken, who is responsible for setting the standards, the grade levels assessed, the skill areas assessed, the purpose for which the standard and test will be used, and comments about each state's program. In this particular list, Pipo includes 26 states. No two states have the same program.¹

Nevada provides a test that will allow the adoption of different standards for the pupils with diagnosed learning disabilities. In Nevada a student will be granted a

¹Chris Pipho, "State Activity: Minimal Competency Testing," paper prepared for the Education Commission of the States, Denver, 1977. (Mimeographed.)

certificate of attendance at the age of 17 if he or she is unable to pass the proficiency examinations.²

Arizona requires all students to demonstrate at least a sixth grade reading competency to get a standard certificate of promotion. Those students who have physical or mental dificiencies which prevent them from being able to pass the examination are to be issued special education certificates of promotion.³

California developed a leaving examination which was designed to give 16 year olds a chance to leave school with a state certificate equivalent to a high school diploma if they are able to pass a proficiency examination applying academic skills to real life problems.⁴

The United States does not have a long history of state or nationally administered school leaving examinations. The New York Regents is probably the best known example of this practice in this country. Proficiency testing programs are a step in the direction of such external certifying

²Edward H. Howard, Assistant Director, Office of Educational Accountability, Carson City, Nev., 15 February 1978, to Ronald D. Hagan, Personal Files of Ronald D. Hagan, Russellville, Tennessee.

³Barbara I. Davis, Education Program Specialist, Phoenix, Ariz., 16 February 1978, to Ronald D. Hagan, Personal Files of Ronald D. Hagan, Russellville, Tennessee.

⁴John Marlowe, "Testing, Testing . . . Can You Hear Me?" Phi Delta Kappan 60 (January 1979): 374.

examinations. The programs in this country represent a hybrid of the European external examination system and the traditional American certification process. In the external examination system used in European countries, an agency external to the school prepares an examination related to a particular curriculum. Students must pass these in order to move into the next level of their education or qualify for civil service or other careers.⁵

The New York State basic competency tests are designed to measure the skills and capabilities that are required of adults in order to function adequately in modern society. The questions on the test deal with skills and understandings that most adults would be expected to use at some time in their lives.⁶

Some states have proposed very broad approaches to what children should be able to do by the time they graduate, but leave the decision of how well the student is to perform up to local judgment. Rhode Island, for example, has developed

⁵George F. Madaus, and Peter W. Airasian, "Issues in Evaluating Student Outcomes in Competency-Based Graduation Programs," Journal of Research and Development in Education 10 (November 1977): 82.

⁶New York State Department of Education, "The New York State Basic Competency Testing Program," Albany, 1977. (Mimeographed.)

75 performance indicators which every student should master in order to demonstrate their ability to comprehend, analyze, and evaluate.⁷

II. SUPPORT FOR THE PROFICIENCY TESTING MOVEMENT

There are very few published articles supporting proficiency testing. The review of the related literature revealed that most of the published material expressed opposition to this movement. Most of the support for proficiency testing comes from outside the education profession. The demand for such testing comes from parents and the general public.⁸ Most of this demand is caused by data on achievement test scores. Reports show that these scores have been falling for the past 14 consecutive years.⁹

Robert L. Ebel, professor of education psychology, Michigan State University, believes that the proficiency testing movement will help restore concern for cognitive development as the first mission of the schools. Abel goes

⁷Rhode Island Department of Education, Schools and Skills, (Providence: Rhode Island Department of Education, 1976), p. 3.

⁸Robert L. Ebel, "The Case for Minimum Competency Testing," Phi Delta Kappan 59 (April 1978): 546.

⁹Philip L. Hosford, "The Silent Curriculum: Its Impact on Teaching the Basics," Educational Leadership, 36 (December 1978): 211.

on to point out that the movement should motivate teachers to teach with more purpose and cause students to try more.¹⁰

James Popham, Professor of Education, UCLA, believes the test will eventually improve the effectiveness of schools by requiring educators to promote student mastery of key skills.¹¹

State Senator Arlen Gregous, author of the legislation that created the test allowing California students to leave high school early, does not believe that students should be required to "fill seats" in schools when they are willing and able to show they have mastered the necessary skills.¹²

Ron Raybin, the acting director for English, social studies, and proficiency examinations in the Pasadena, California Unified School District, believes that schools should have programs for which they are accountable. In an article entitled "Minimum Essentials and Accountability," Raybin outlines what he believes to be an educationally sound approach to developing such a program. This approach would require individuals in each subject area to develop

¹⁰Ebel, "The Case for Minimum Competency Testing," Phi Delta Kappan 59 (April 1978): 546.

¹¹"Competency Tests: New Furor in Schools," U.S. News & World Report, 84 (February 1978): 48.

¹²John Marlowe, "Testing, Testing . . . Can You Hear Me?" Phi Delta Kappan 60 (January 1979): 354.

minimum essentials by semester and grade level. The essentials would represent a floor for learning, not a ceiling.¹³

Gary K. Hart introduced the bill that set up California's proficiency testing program. In the article "The California Pupil Proficiency Law as Viewed by its Author," Hart defends the use of proficiency testing by saying that without standards and accountability provided by a sanction, students become contemptuous, teachers become demoralized and schools lose more and more credibility with taxpayers. Hart goes on to stress that it is important to tell students what is expected of them and what the consequences will be if they fail to meet those expectations.¹⁴

III. OPPOSITION TO THE PROFICIENCY TESTING MOVEMENT

In the article "Changes Needed in the Current Testing in Mathematics," Robert E. Reys and Margaret B. Kasten outline what they believe to be some false premises underlying the proficiency testing movement. These false premises are:

1. A list of basic skills for mathematics exists, or can be compiled.

¹³Ron Raybin, "Minimum Essentials and Accountability," Phi Delta Kappan 60 (January 1979): 374.

¹⁴Gary K. Hart, "The California Pupil Proficiency Law as Viewed by its Author," Phi Delta Kappan 59 (May 1978): 594.

2. Proficiency test scores indicate a valid measurement of performance.
3. Measures for deciding competency levels should be determined after the data are collected.
4. Students will retain the basic skills for an indefinite period of time.

In this same article, Reys and Kasten go on to state that, "The simplistic approaches of many of the testing programs reflect amateurish solutions to very complex problems." They also believe that the proficiency testing movement has created many new problems while failing to solve the ones for which it was created.¹⁵

Some authors see a tendency to focus upon the starting and ending points of instruction with not enough concern for the process of education. Instructional activities are often taken for granted. When there is a choice between covering what is known to be on the test and other material not covered, objectives actually tested assume priority. Areas of the curriculum not directly tested may be deemphasized. There would be a tendency to teach the test.¹⁶

¹⁵Robert E. Reys and Margaret D. Kasten, "Changes Needed in the Current Direction of Minimal Competency Testing in Mathematics," Mathematics Teacher 71 (February 1978): 109.

¹⁶Madaus and Airasian, "Issues in Evaluating Student Outcomes in Competency-Based Education Programs," Journal of Research and Development in Education 10 (November 1977): 82.

There is a great deal of concern about the growth of governmental control. Arthur E. Wise, a former associate director of the National Institute of Education, believes that proficiency testing will fail to improve education and most likely will only serve to increase bureaucratization and centralization of American schools.

Wise maintains that the schools are operated as a bureaucracy, and the proficiency testing movement specifies the aims that the bureaucracy is to serve. As the state specifies aims and the schools work to attain them, the bureaucratic structures at state and local levels are strengthened.¹⁷

The National Academy of Education's Committee on Testing and Basic Skills reported that the setting of state-wide proficiency standards is unworkable, goes beyond the present measurement capacity of the teaching profession, and will create more social problems than it will solve. The Committee also expressed its belief that such testing would increase governmental power over education.¹⁸

The proficiency testing movement will increase the number of students retained each year. There is no reliable evidence

¹⁷ Arthur E. Wise, "Minimum Competency Testing: Another Case of Hyper-Rationalization," Phi Delta Kappan 59 (May 1978): 598.

¹⁸ "Viewpoints from the National Academy of Education," Today's Education 67 (September/October 1978): 32.

that grade retention is more beneficial than promotion for students with academic or adjustment problems. Educators who retain students will be doing so without valid research evidence to support their action.¹⁹

There has been a great deal of research which indicates that grade retention is harmful to students. One study equated potential repeaters on chronological age, mental age, and sex. Half of the group was promoted. The results indicated that in terms of achievement, the potential repeaters gained more from promotion.²⁰

A more recent study which matched two groups on race, sex, socio-economic status, age, type of class, mental age, and reading achievement found that the promoted group showed significantly more improvement in reading and arithmetic over a two-year period than the retained group.²¹

Research measuring the effects of pupil retention on behavior found that the failing child received less

¹⁹Gregg B. Jackson, "The Research Evidence of the Effects of Grade Retention," Review of Educational Research 45 (Fall 1975): 627.

²⁰Richard R. Abidin, Jr., Wendy M. Golladay, and Anna L. Howerton, "Elementary School Retention: An Unjustifiable, Discriminatory and Noxious Educational Policy," Journal of School Psychology 9 (Winter 1971): 411.

²¹Virginia Dobbs and Donald Neville, "The Effect of Nonpromotion on the Achievement of Groups Matched from Retained First Graders and Promoted Second Graders," Journal of Educational Research 60 (July/August 1967): 473.

satisfaction from his or her work, tended to become discouraged, and often became a discipline problem.²²

Richard Abidin, Jr., Wendy Golladay, and Anna Howerton, in an article, "Elementary School Retention: An Unjustifiable, Discriminatory and Noxious Educational Policy," state that children who are retained in the first grade continue to show a deterioration in achievement and intelligence through the sixth grade.²³

Teachers worry about the effects the proficiency testing movement will have upon teacher accountability. Many teachers fear that student test scores will be used to measure their teaching ability. They complain that scores may reflect the influence of many factors that are beyond their control.²⁴

Perhaps the greatest objection to the proficiency testing movement comes from minority groups. In Florida high schools where the student body is made up of mostly black or Hispanic students, the rate of failure on the literacy test given in

²² Eugene S. Farley, Albin J. Frey, and Gertrude Garland, "Factors Related to the Grade Progress of Pupils," Elementary School Journal 34 (November 1933): 193.

²³ Richard R. Abidin, Jr., Wendy M. Golladay, and Anna L. Howerton, "Elementary School Retention: An Unjustifiable, Discriminatory and Noxious Educational Policy," Journal of School Psychology 9 (Winter 1971): 411.

²⁴ "What do Diplomas Mean?" Newsweek, January 9, 1978, p. 65.

the fall of 1977 ran as high as 78 percent. Florida's National Association for the Advancement of Colored People plans to file suit to stop the testing, contending that proficiency tests are culturally biased.²⁵

Barry Anderson and Philip Lesser, working with funds provided by the National Institute of Education, conducted a survey in which they asked officials in states with testing programs to provide information about cost.

The cost of writing the test items, pilot testing, revising, and providing "camera ready" copy, was estimated to run between 25 and 210 dollars per item. The norm was about 100 dollars per item.

The expenses associated with the bureaucratic cost vary a great deal from state to state. The authors found that expense went from 65,000 to 945,000 dollars annually.

The state of Washington estimated that its remedial programs in reading and mathematics will cost between 43 million and 47 million dollars. New Jersey expects its bill for proficiency programs to rise from 30 million in 1976-1977 to 70 million in 1978-1979. Michigan spent about 28 million dollars, and Florida has plans to spend 10 million on remedial programs associated with proficiency testing. A

²⁵ Ibid.

1972 California report stipulated 500 million for proficiency education.²⁶

The review of related literature failed to provide an abundance of material directly related to the hypotheses of this study.

Hypotheses two and three deal with concepts included in the textbooks and/or curriculum guides that are not included on the eighth grade basic skills test in Tennessee or are not taught by a majority of the teachers responding to this study. These hypotheses are supported by statements made by William D. Smith, currently head of the Department of Secondary Education and School Administration at James Madison University in Harrisonburg, Virginia. Smith stated that the minimal competency objectives produced in several states overemphasize computational skills. Smith believes that it is a disservice to both our students and to mathematics to limit mathematical literacy to mere computation.²⁷

John F. Newport, Professor of Elementary Education, Southwest Missouri State University in Missouri, places the blame for the decline in students' mathematics achievement scores in recent years upon the teachers. Newport believes

²⁶Barry D. Anderson and Philip Lesser, "The Cost of Legislated Minimum Competency Requirements," Phi Delta Kappan 59 (May 1978): 607.

²⁷William D. Smith, "Minimal Competencies: A Position Paper," Arithmetic Teacher 26 (November 1978): 26.

that some teachers have placed less emphasis upon the teaching and learning of basic skills.²⁸

Educators are divided on the issue of how much emphasis to place on the basics and what mathematical concepts to include in the elementary school curriculum.

IV. SUMMARY

Thirty-three states now are involved in some form of proficiency testing.²⁹ The movement has slowed down a great deal since its start. States are reviewing and revising their testing programs.

Proficiency testing has few supporters within the education profession. Those who offer support do so on the grounds that they believe standards will improve the education offered our children. The review of related literature revealed few articles supporting proficiency testing. There may be many people who favor such testing programs but have not had their opinions published in professional literature dealing with education. Most of the literature presents a position opposing proficiency testing. Some of the reasons for this opposition are:

²⁸John F. Newport, "Why the Decline in Student Achievement of the Basic Skills," School Science and Mathematics 74 (February 1979): 122.

²⁹Chris Pipho, "Minimum Competency Testing in 1978: A Look at State Standards," Phi Delta Kappan 59 (May 1978): 585.

1. Basic skills that are necessary for everyone are difficult or impossible to define.
2. Proficiency testing may cause the curriculum to be narrowed.
3. Proficiency testing programs may increase governmental control over education.
4. Proficiency testing may be used to hold teachers accountable for influences beyond their control.
5. Proficiency testing programs may be more expensive than they are worth.

CHAPTER 3

PROCEDURES

This chapter includes a detailed account of the preparation of the data collecting instrument, the selection of the sample, the distribution of the data collecting instrument, and procedures for analyzing the data.

I. PREPARATION OF DATA COLLECTING INSTRUMENT

It was decided that a checklist could best be used identify discrepancies between (1) operations included in major mathematics textbooks; (2) operations included in local curriculum guides; (3) operations teachers say they cover in grades one through eight in selected Tennessee school systems; and, (4) arithmetic operations covered on the Tennessee State-Mandated Eighth Grade Basic Skills Test administered in the spring of 1978.

The 1977-1982 mathematics adoption list for the state of Tennessee showed that 15 percent of the school systems adopted mathematic books from Scott Foresman for grades three through nine, Holt Rinehart and Winston mathematic books were adopted by 47 percent of the systems for grades three through nine. Macmillan mathematic books were adopted by 46 percent of the systems for grades three through nine. Houghton Mifflin was chosen by 17 percent of the systems for

grades three through nine. A total of 125 percent occurred because some systems have adopted more than one of these four series.¹

Mathematics textbooks for grades one through eight from the Scott Foresman, Holt Rinehart and Winston, Macmillan, and the Houghton Mifflin Publishing Companies were examined. The scope and sequence charts and an examination of chapter content were used to compile a list of arithmetic operations included in these four series. (See Appendix A, page 90.)

Three school systems supplied curriculum guides. These guides were also examined. The list of arithmetic operations included in Appendix B, page 98, was compiled from these three curriculum guides.

The Tennessee state list of expected competencies in the area of arithmetic was examined. This list has been prepared for Kindergarten through the sixth grade by the Tennessee Education Association and the State Department of Education. This list was used when there was not a curriculum guide available for the school system. (See Appendix C, page 104.)

The eighth grade basic skills test which was administered in the spring of 1978 was examined to determine what arithmetic operations were included. A list of these operations was prepared. (See Appendix D, page 112.)

¹"Summary Sheet-Mathematics Adoptions 1977-82," Tennessee Department of Education, Office of Textbook Services, Nashville, Tennessee, 1977. (Mimeographed.)

Each of the four lists included items dealing with the four basic operations of addition, subtraction, multiplication, and division of whole numbers, fractions, and decimals. Several miscellaneous topics were included because they are usually included in the teaching of arithmetic. Concepts and operations dealing with the so called modern mathematics were not included in order to limit the scope of the study and make it a manageable task.

II. SELECTION OF SAMPLE

The 1977 Statistical Report of the Tennessee Department of Education gave the number of elementary teachers in the state of Tennessee as 24,406.²

A stratified sample including 5 percent of this elementary teacher population was considered an adequate sample. This sample was composed of 1,220 elementary teachers.

No attempt was made to select the sample at random. The 1977 Statistical Report of the Tennessee Department of Education was used to determine the percentage of elementary teachers in each stratification. For instance, 27 percent of the elementary teachers in Tennessee are employed by major metropolitan areas. Checklists were sent to 329

²State of Tennessee, Annual Statistical Report of the Department of Education to the Governor of Tennessee, for the Scholastic Year Ended 30 June 1977, p. 58.

(27 percent) of the teachers in a major metropolitan area. This metropolitan area was selected for convenience. This procedure was followed to select school systems for each of the stratifications identified for the study. School systems were selected in an attempt to involve systems that would produce a sample that was representative of not only the stratifications selected for this study, but would also be representative of East, Middle, and West Tennessee. Individual elementary schools were selected by alphabetical order from the listings provided in the 1977 Statistical Report of the Tennessee Department of Education.

The following stratifications were selected:

1. Major metropolitan areas (Memphis, Nashville, Knoxville, and Chattanooga). These four systems included 27 percent of the elementary teacher population. A system was selected from these major metropolitan areas to satisfy the quota of the 329 elementary teachers for this stratification.
2. Systems that are predominately rural. (For the purpose of this study, all county systems were considered predominately rural.) This group included 58 percent of the elementary teacher population. Systems were selected from the county systems to satisfy the quota of 708 elementary teachers for this stratification.
3. City systems not included among the four major metropolitan systems. This made up 12 percent of the

elementary teacher population. Systems were selected to satisfy the quota of 154 elementary teachers for this stratification.

4. Special school districts. This group made up .023 percent of the elementary teacher population. A system was selected from the special school districts to satisfy the quota of 29 elementary teachers for this stratification.

The sample obtained by the preceding process was considered to be sufficient for this study because of the number and geographical distribution of the teachers involved.

Thirty-five school systems were contacted and asked to take part in this study. Eleven systems were willing to participate. These 11 systems were enough to supply 5 percent of the elementary teachers with the state of Tennessee. The confidentiality of the study prohibited the identification of specific school systems; however, the following gives the geographical distribution of the sample:

1. One hundred percent of the 329 teachers representing major metropolitan areas was chosen from East Tennessee.

2. The county systems were represented by 55 percent of the 708 teachers necessary for this stratification chosen from East Tennessee, 25 percent chosen from Middle Tennessee and 20 percent chosen from West Tennessee.

3. Fifty-five percent of the 146 teachers representing smaller cities was chosen from East Tennessee, 45 percent

was from Middle Tennessee, and none was included from West Tennessee. The smaller city systems in West Tennessee that were contacted and asked to take part in the study were unwilling to participate.

4. One hundred percent of the 29 teachers representing special school districts was chosen from Middle Tennessee.

III. THE SAMPLE

The superintendents of 35 school systems across the state were contacted and asked to take part in this study. The letter sent to the superintendents is in Appendix E, page 114. All the letters were identical except for the reference to the type of system, paragraph four, line one and paragraph six, line two. Eleven systems agreed to take part. The sample included teachers from grades one through eight from 80 individual schools. Table I, "Analysis of Sample by Location, Type, Size, and Return," page 31, contains a description of the resulting sample. This discription includes the type of system, its geographic location by region, the total number of teachers in the system, the number of checklists sent to each system, the number of checklists returned from each system, and the percentage of returns. This table indicates, for example, that system number five is a county system in East Tennessee with a total of 331 teachers. There were 191 checklists

Table I
Analysis of Sample by Location, Type, Size, and Returns

School Systems Studied	Type of System ¹	Location of Schools by Region ²	Number of Teachers in System ³	Questionnaires		Percent of Sample ⁶
				Sent ⁴	Returned ⁵	
1	Metropolitan	East	1513	329	109	.09
2	City	East	57	47	10	.008
3	City	East	88	51	12	.009
4	City	Middle	66	56	20	.02
5	County	East	331	191	92	.08
6	County	East	290	140	40	.03
7	County	East	156	96	23	.02
8	County	Middle	143	85	20	.02
9	County	Middle	115	69	16	.01
10	County	West	226	127	38	.03
11	Special School District	Middle	129	29	19	.02
TOTAL			3114	1220	399 ⁷	.338

¹The total number of checklists that were returned by each type of system are as follows: Metropolitan, 104; City, 40; County, 198; and Special School District, 19.

²The total number of checklists that were returned by each region are as follows: East, 261; Middle, 70; West, 30.

³The number of teachers in each system includes both secondary and elementary teachers.

⁴Number was determined for each system from the number of teachers assigned to each school as reported by the 1977 Statistical Report.

⁵Those checklists actually returned.

⁶The percent of the total sent.

⁷Thirty-nine of the checklists were discarded as faulty, this left 360 for the study.

⁸All percents were rounded to the nearest tenth.

sent. The teachers returned 92 checklists. This represented .08 percent of the total sample.

Table II, "Distribution of Responses by Grade Level," page 33, contains an analysis by grade level for those checklists that were returned. The table indicates, for example, that 69 of the 399 teachers taught first grade. This was .17 percent of the total. Nineteen, or .05 percent, were unclassified. This group included special education teachers and Title I mathematics and reading teachers who taught children from several different grade levels.

Only 33 percent of the 1,220 checklists were returned. West Tennessee was not well represented because the checklists were mailed too late in the school year. School systems in West Tennessee close down for the summer earlier than those in East Tennessee. The percentage of return for the fifth, sixth, seventh, and eighth grades was low.

The percentage of returns was not as great as a 1960 study dealing with arithmetic teaching practices for grades one through eight in Tennessee. This study was based on a sample size of 36.2 percent of 1,894 teachers.³ A major weakness of the study was the failure to conduct a follow up on the checklists to increase the rate of return. Seventeen

³A. Montgomery Johnston, "Arithmetic in Tennessee: A Survey of Teaching Practices Grades One Through Eight," The University of Tennessee Record 63 (May, 1960): 27.

Table II
Distribution of Responses by Grade Level

<u>Number of Responses by Grade Level</u>										
1	2	3	4	5	6	7	8	Unclassified	Faulty	Total
67	63	58	51	31	26	19	26	19	39	399
<u>Percent of Responses by Grade Level</u>										<u>Total</u>
.17	.16	.15	.13	.08	.06	.05	.06	.05	.10	100

principals were contacted by telephone in an attempt to determine why there were no responses from their schools. Various reasons were given for not distributing the checklists, but the most frequent response was that the checklists arrived at the schools at an inconvenient time of year. At the closing of a school year, the teachers are very busy.

IV. DISTRIBUTION OF DATA COLLECTING INSTRUMENT

The arithmetic operations from the mathematic textbooks, the curriculum guides, the list of state competencies, and the eighth grade basic skills test were combined to form a checklist of arithmetic operations for grades one through eight.

A cover letter (see Appendix F, page 116) was designed to accompany the checklist.

The checklist was designed to allow the teachers to check operations taught, fold, staple, and return it without additional postage. (See Appendix F, page 116.)

The checklists were mailed in bulk to participating schools with a letter addressed to the principal requesting his or her assistance in distributing them to those responsible for teaching mathematics. (See Appendix G, page 120.)

A major weakness in the design of the data collecting instrument was discovered as the responses were analyzed. This weakness was the failure to define the term "teach"

that was used in the instructions for the teachers completing the checklists. This term may have been interpreted as "new concepts introduced for each grade level."

V. ANALYSIS OF DATA

Comparisons were made among the checklists of operations as indicated in the hypotheses of the study.

Percentages were computed for the following:

1. Those operations included on the test that were taught by the teachers and the scores on those operations.
2. Those operations included on the test that were not taught by the teachers and the scores on those operations.
3. Those operations included on the test which were in the textbooks and the scores on those operations.
4. Those operations included on the test which were not in the textbooks and the scores on those operations.
5. Those concepts included on the test which were in the curriculum guides and the scores on those operations.
6. Those operations included on the test that were not included in the curriculum guides and the scores on those operations.

VI. SUMMARY

This chapter contained a detailed discussion of the procedures followed in this study. This discussion included factors related to (1) preparation of the data collecting instrument; (2) selection of sample; (3) the sample; (4) distribution of the data collecting instrument; and (5) analysis of the data.

CHAPTER 4

ANALYSIS OF DATA

I. INTRODUCTION

This chapter contains the analysis of the data collected for this study. The results are tabulated to show which arithmetic operations were included in the major textbooks, the curriculum guides used for this study, the Tennessee state list of competencies for mathematics, and the eighth grade basic skills test administered in the spring of 1978. The number and percent of correct responses are given for those concepts that are isolated as a specific item. The results are tabulated to show the number and percent of teachers "teaching" each concept. The number of grade levels involved in the study, the grade level distribution of the teachers that responded, the low percentage of returns, and the confusion that resulted from the failure to define the term "teach" are limitations that must be considered when interpreting the findings of this study (see Limitations, page 8). Tabulations are presented that indicate which operations are "taught" at each grade level. The findings related to each hypothesis are presented. This chapter also contains a summary.

II. ANALYSIS OF DATA DEALING WITH THE ARITHMETIC OPERATIONS

Table III, "Arithmetic Operations as They Relate to Major Textbooks, Curriculum Guides, the State Competency List, Instruction of Teachers, the Eighth Grade Basic Skills Test, and the Scores Obtained on that Test," gives a summary of the data obtained for this study. This table includes all the arithmetic operations involved in the study. It indicates whether the operation was included in the mathematics textbooks, the curriculum guides, the state competency list, and whether it was taught by a majority of the teachers responding to the study. A majority was considered to be more than half of the total number of teachers returning a usable checklist. Table III also indicates which operations were included on the 1978 Eighth Grade Basic Skills Test and gives the number and percent of correct responses for each operation. This table may be read by moving horizontally across the page. For instance, the first operation under preoperational activities (recognition of numbers one through ten) was included in the major mathematics textbooks. It was included in the curriculum guides used for this study. It was included on the state competency list for mathematics, and was "taught" by 52 percent of the teachers responding to the study. It should be kept in mind that the term "teach" was not defined on the data collecting instrument presented

Table III

Arithmetic Operations as They Relate to Major Textbooks, Curriculum Guides,
the State Competency List, Instruction of Teachers, the 1978 Eighth
Grade Basic Skills Test, and the Scores Obtained on that Test

Arithmetic Operations ^{1,2}	Textbook ³		Curriculum Guide ⁴		Competency List ⁵		Taught ⁶		Test ⁷		Score ⁸	
	yes	no	yes	no	yes	no	yes	Percent	yes	no	Number Correct ⁹	Percent ¹⁰
Preoperational activities												
1. Recognition of numbers 1-10	*		*		*		*	.52	*			
2. Recognition of numbers 11-20	*		*		*		*	.52	*			
3. Recognition of numbers 21-100	*		*		*		*	.56	*			
4. Write numerals 1-100	*		*		*		*	.58	*			
Addition of whole numbers												
1. Two one digit numbers with sum of 12 or less	*		*		*		*	.66	*			
2. Two one-digit numbers with sum greater than 12	*		*		*		*	.70	*			
3. Two one-digit numbers with no regrouping	*		*		*		*	.70	*			
4. Three one-digit numbers with no regrouping	*		*		*		*	.71	*			
5. Zero as an addend	*		*		*		*	.77	*			
6. Two two-digit numbers without regrouping	*		*		*		*	.76	*			
7. Two three-digit numbers with no regrouping	*		*		*		*	.68	*			
8. Two one-digit numbers with regrouping	*		*		*		*	.62	*			
9. Two two-digit numbers with regrouping	*		*		*		*	.70	*			
10. Three two-digit numbers with regrouping	*		*		*		*	.65	*			
11. Two three-digit numbers with regrouping	*		*		*		*	.66	*			
12. Three three-digit numbers with regrouping	*		*		*		*	.58	*			
13. Two four-digit numbers with regrouping	*		*		*		*	.55	*			
14. Three four-digit numbers with regrouping	*		*		*		*	.49	*			
15. Four four-digit numbers with regrouping	*		*		*		*	.42	*			

Table III (continued)

Arithmetic Operations ^{1,2}	Textbook ³		Curriculum Guide ⁴		Competency List ⁵		Taught ⁶		Test ⁷		Score ⁸	
	yes	no	yes	no	yes	no	yes	Percent	yes	no	Number Correct ⁹	Percent ¹⁰
16. Four five-digit numbers with regrouping	*		*		*		*	.38	*			
17. Two six-digit numbers with regrouping	*		*		*		*	.36	*			
18. Three or more one, two, or three-digit numbers in a horizontal format with no regrouping	*		*		*		*	.53	*			
19. Three or more one, two, or three-digit numbers with regrouping	*		*		*		*	.45	*		4,921	.95
Subtraction of whole numbers												
1. Two one digit numbers	*		*		*		*	.69	*			
2. Two two-digit numbers	*		*		*		*	.78	*			
3. Zero as a subtrahend	*		*		*		*	.83	*			
4. Two three-digit numbers without borrowing	*		*		*		*	.74	*			
5. Two two-digit numbers with borrowing	*		*		*		*	.75	*			
6. Two three-digit numbers with borrowing	*		*		*		*	.64	*		4,770	.92
7. Two four digit numbers with borrowing	*		*		*		*	.55	*			
8. Two five-digit numbers with borrowing	*		*		*		*	.47	*			
Multiplication of whole numbers												
1. Products through 18	*		*		*		*	.55	*			
2. Products through 36	*		*		*		*	.50	*			
3. Products through 81	*		*		*		*	.49	*			
4. One-digit number times a two-digit number	*		*		*		*	.49	*			
5. Two digit number times a two-digit number	*		*		*		*	.46	*			
6. One-digit number times a three-digit number	*		*		*		*	.54	*		6,426	.89
7. Three-digit number times a three-digit number	*		*		*		*	.37	*			
8. Four-digit number times a four-digit number	*		*		*		*	.23	*			
9. Four-digit number times a five-digit number	*		*		*		*	.19	*			

Table III (continued)

Arithmetic Operations ^{1,2}	Textbook ³		Curriculum Guide ⁴		Competency List ⁵		Taught ⁶		Test ⁷		Score ⁸	
	yes	no	yes	no	yes	no	yes	Percent	yes	no	Number Correct ⁹	Percent ¹⁰
Division of whole numbers												
1. Dividends through 36	*		*		*		*	.48	*			
2. Dividends through 81	*		*		*		*	.47	*			
3. One-digit divisor and one-digit dividend with no remainder	*		*		*		*	.50	*			
4. One-digit divisor and two-digit dividend with no remainder	*		*		*		*	.53	*			
5. Two-digit divisor and two-digit dividend with no remainder	*		*		*		*	.39	*			
6. Two-digit divisor and three-digit dividend with no remainder	*		*		*		*	.41	*			
7. One-digit divisor and one-digit dividend with a remainder	*		*		*		*	.49	*			
8. One-digit divisor and two-digit dividend with a remainder	*		*		*		*	.51	*			
9. One-digit divisor and three-digit dividend with a remainder	*		*		*		*	.45	*			
10. One-digit divisor and four-digit dividend with a remainder	*		*		*		*	.38	*			
11. One-digit divisor and five-digit dividend with a remainder	*		*		*		*	.33	*			
12. Two-digit divisor and two-digit dividend with a remainder	*		*		*		*	.39	*			
13. Two-digit divisor and three-digit dividend with a remainder	*		*		*		*	.40	*			
14. Two-digit divisor and four-digit dividend with a remainder	*		*		*		*	.35	*		2,830	.55
15. Two-digit divisor and five-digit dividend with a remainder	*		*		*		*	.29	*			
16. Three-digit divisor and five-digit dividend with a remainder	*		*		*		*	.21	*			

Table III (continued)

Arithmetic Operations ^{1,2}	Textbook ³		Curriculum Guide ⁴		Competency List ⁵		Taught ⁶		Test ⁷		Score ⁸	
	yes	no	yes	no	yes	no	yes	Percent	yes	no	Number Correct ⁹	Percent ¹⁰
17. Three-digit divisor and six-digit dividend with a remainder	*		*		*		*	.19	*			
Fractions												
1. Expressing fractions in simplest terms	*		*		*		*	.70	*			
2. Changing improper fractions into mixed numbers	*		*				*	.40	*			
3. Changing mixed numbers into improper fractions	*		*		*		*	.39	*			
4. Finding least common denominator	*		*		*		*	.35	*			
Addition of fractions												
1. Two fractions with like denominators	*		*		*		*	.48	*			
2. Three fractions with like denominators	*		*		*		*	.39	*			
3. Four fractions with like denominators	*		*		*		*	.28	*			
4. Two fractions with unlike denominators	*		*		*		*	.40	*			
5. Three fractions with unlike denominators	*		*		*		*	.30	*			
6. Four fractions with unlike denominators	*		*		*		*	.18	*			
7. Two mixed numbers with common denominators and no regrouping	*		*		*		*	.38	*			
8. Two mixed numbers with unlike denominators and no regrouping	*		*		*		*	.35	*			
9. Two mixed numbers with like denominators and regrouping	*		*		*		*	.31	*			
10. Two mixed numbers with unlike denominators and regrouping	*		*		*		*	.30	*			
11. Three mixed numbers with like denominators and regrouping	*		*		*		*	.21	*			
12. Three mixed numbers with unlike denominators	*		*		*		*	.22	*		4,106	.79

Table III (continued)

Arithmetic Operations ^{1,2}	Textbook ³		Curriculum Guide ⁴		Competency List ⁵		Taught ⁶		Test ⁷		Score ⁸	
	yes	no	yes	no	yes	no	yes	Percent	yes	no	Number Correct ⁹	Percent ¹⁰
Subtraction of fractions												
1. Fractions with like denominators and no regrouping	*		*		*		*	.47	*			
2. Fractions with unlike denominators and no regrouping	*		*		*		*	.40	*			
3. Fractions with like denominators and regrouping	*		*		*		*	.29	*			
4. Fractions with unlike denominators and regrouping	*		*		*		*	.33	*			
5. Fractions from mixed number with no regrouping	*		*		*		*	.33	*		2,408	.47
6. Mixed numbers with like denominators and no regrouping	*		*		*		*	.35	*			
7. Mixed numbers with like denominators and regrouping	*		*		*		*	.31	*			
Multiplication of fractions												
1. Two fractions	*		*		*		*	.33	*			
2. A fraction and a mixed number	*		*		*		*	.26	*		2,408	.47
3. Two mixed numbers	*		*		*		*	.25	*			
4. A whole number and a fraction	*		*		*		*	.28	*			
Division of fractions												
1. A fraction by a fraction	*		*		*		*	.31	*		2,314	.49
2. A fraction by a whole number	*		*		*		*	.28	*			
3. A whole number by a fraction	*		*		*		*	.28	*			
4. A mixed number by a fraction	*		*		*		*	.24	*			
5. A fraction by a mixed number	*		*		*		*	.24	*			
6. A mixed number by a mixed number	*		*		*		*	.22	*			

Table III (continued)

Arithmetic Operations ^{1,2}	Textbook ³		Curriculum Guide ⁴		Competency Guide ⁵		Taught ⁶		Test ⁷		Score ⁸	
	yes	no	yes	no	yes	no	yes	Percent	yes	no	Number Correct ⁹	Percent ¹⁰
Decimals												
1. Addition of decimals	*		*		*		*	.44	*		4,860	.94
2. Subtraction of decimals	*		*		*		*	.44	*		3,833	.75
3. Multiplication of decimals	*		*		*		*	.31	*			
4. Division of decimals	*		*		*		*	.28	*			
5. Changing decimals to percents	*		*		*		*	.24	*			
6. Changing percents to decimals	*		*		*		*	.23	*			
7. Changing decimals to fractions	*		*		*		*	.26	*			
8. Changing fractions to decimals	*		*		*		*	.26	*			
Miscellaneous topics												
1. Telling time	*		*		*		*	.67		*		
2. Money	*		*		*		*	.77		*		
3. Standard measurements	*		*		*		*	.81	*			
4. Roman numerals	*		*		*		*	.46		*		
5. Counting by 2's, 5's, and 10's	*		*		*		*	.71		*		
6. Square root	*		*				*	.10		*		
7. Recognition of number words	*		*		*		*	.80	*			
8. Spelling of number words	*		*		*		*	.67		*		
9. Metric measurements	*		*		*		*	.59	*			
10. Read and interpret tables, maps, graphs, and charts	*		*		*		*	.58		*		
11. Compute compound interest	*		*				*	.08		*		
12. Solve simple interest, percent, and ratio problems	*		*		*		*	.18		*		
13. Solve word problems involving any of the operations (addition, subtraction, multiplica- tion, and division)	*		*		*		*	.72	*			
14. Multiply decimal fraction by a decimal number	*		*		*		*	.19	*		2,544	.68
15. Divide decimal number by a whole number	*		*		*		*	.23	*		3,059	.59
16. Customary units of measurement equivalency	*		*		*		*	.31	*			
17. Place value	*		*		*		*	.64	*		2,488	.48
18. Decimal fraction to percent	*		*		*		*	.20	*		1,716	.42
19. Percent of a number	*		*		*		*	.21	*		2,186	.42
20. Decimal equivalency	*		*		*		*	.23	*			
21. Equivalent fractions	*		*		*		*	.36	*			
22. Rounding off numbers	*		*		*		*	.49	*			

Table III (continued)

Arithmetic Operations ^{1,2}	Textbook ³		Curriculum Guide ⁴		Competency List ⁵		Taught ⁶		Test ⁷		Score ⁸	
	yes	no	yes	no	yes	no	yes	Percent	yes	no	Number Correct ⁹	Percent ¹⁰
23. Metric equivalency	*		*		*		*	.21	*			
24. Measure of temperature	*		*		*		*	.43		*		
25. Recognition of mathematical symbols	*		*		*		*	.61	*			
26. Ordinal numbers	*		*		*		*	.47		*		
27. Simple two-step word problems including whole numbers, fractions, or decimals	*		*		*		*	.38	*			

¹Although metric and standard measurements were included on the checklists, these two operations were not broken down enough to allow teachers to respond to the addition, subtraction, multiplication, and division of measures.

²The order of decimal fractions failed to be included on the checklists that were presented to the teachers.

³L. C. Bolster et al., Mathematics Around Us (Glenview: Scott Foresman, 1975). Eugene D. Nichols et al., Holt School Mathematics (New York: Holt, Rinehard and Winston, 1974). Tina Thoburn et al., Macmillan Mathematics (New York: Macmillan, 1976). Richard A. Denholm et al., Mathematics for Individual Achievement (New York: Houghton Mifflin, 1975).

⁴DeKalb County Schools, "Pupil Expectations for Mathematics Grades K-12," Smithville, Tennessee, 1977. Manchester City Schools, "Curriculum Guide for Mathematics Grades K-9," Manchester, Tennessee, 1978. Sweetwater City Schools, "Mathematics Curriculum Guide Grades K-9," Sweetwater, Tennessee, 1978.

⁵"Student Expectations in the Basic Skills K-6, Mathematics," Tennessee Teacher 46 (January 1979): 20.

⁶These operations were reported taught by the teachers responding to the study.

⁷Tennessee State-Mandated Eighth Grade Basic Skills Test administered in the spring of 1978.

⁸The score is reported as the total number of correct responses to each operation.

⁹Only those operations that were directly included on the test have scores reported.

¹⁰Percent of the 5,176 students involved in the study.

to the teachers (see the Limitations section, page 8). Low percentages may have resulted from misinterpretation of the term. It is unrealistic, for example, to assume that teachers can introduce other arithmetic operations without including recognition of numbers. This operation was evaluated indirectly by the eighth grade basic skills test. There was not a score recorded for this operation because it was not isolated as a specific item, and no specific score was available. It should be obvious that knowledge of this was necessary to complete other test items. There were operations included in the major textbooks that were not evaluated by the eighth grade basic skills test. This table identifies these operations. For instance, Roman numerals were not evaluated. (See operation four under miscellaneous topics, page 44.)

The percentage for the number of teachers "teaching" each operation ranged from a high of 75 percent for the concept of using zero as a subtrahend to a low of 11 percent for the teaching of square root. These findings represent a lack of uniformity in what teachers "teach" for grades one through eight across the state of Tennessee. The differences in what teachers "teach" should be expected to vary a great deal from the first grade to the eighth grade. These differences are necessary because basic arithmetic operations are presented in the first grade and are built upon year

after year. Table IV, "Number and Percent of Teachers Teaching Each Arithmetic Operation for Grade Levels One Through Eight," gives the number and percent of teachers "teaching" each operation for each grade level. An analysis of responses by grade level produced a clearer view of what the teachers "teach" in each grade level. These findings indicate that there is agreement among grade levels about what should be taught on each level. There was a high percentage of agreement on those operations that are introduced in each grade level by the major textbooks. For instance, the operation multiplication of decimals, page 53, was introduced in the fifth grade textbooks by Scott Foresman.¹ This operation was "taught" by 81 percent of the fifth grade teachers, by 85 percent of the sixth grade teachers, by 100 percent of the seventh grade teachers, and by 96 percent of the eighth grade teachers responding to this study.

Comparison of Operations in Textbooks and Test

The first hypothesis of this study was that there would be operations included in the mathematics textbooks that were not evaluated by the eighth grade basic skills test. Table V, "Arithmetic Operations Included in the Textbooks

¹L. C. Bolster et al., Mathematics Around Us, (Glenview: Scott Foresman, 1975).

Table IV
Number and Percent of Teachers Teaching Each Arithmetic
Operation for Grade Levels One Through Eight

Operations	Responses by Grade Level ¹															
	1		2		3		4		5		6		7		8	
	Number ²	Percent ³	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Preoperational activities																
1. Recognition of numbers 1-10	67	100	47	.75	26	.45	13	.25	6	.19	5	.19	2	.11	5	.19
2. Recognition of numbers 11-20	67	100	50	.79	24	.41	12	.24	6	.19	6	.23	2	.11	5	.19
3. Recognition of numbers 21-100	67	100	55	.87	28	.48	13	.25	6	.19	6	.23	5	.26	6	.23
4. Write numerals 1-100	67	100	59	.94	28	.48	14	.27	7	.23	6	.23	5	.26	5	.19
Addition of whole numbers																
1. Two one-digit numbers with sum of 12 or less	67	100	59	.94	43	.74	22	.43	10	.32	8	.31	5	.26	6	.23
2. Two one-digit numbers with sum greater than 12	62	.93	61	.97	48	.83	26	.51	14	.45	10	.38	6	.32	10	.38
3. Two one-digit numbers with no regrouping	64	.96	60	.95	47	.81	25	.49	14	.45	9	.35	7	.37	9	.35
4. Three one-digit numbers with no regrouping	56	.84	60	.95	51	.88	25	.49	16	.52	11	.42	8	.42	11	.42
5. Zero as an addend	66	.99	59	.94	51	.88	26	.51	19	.61	13	.50	12	.63	14	.54
6. Two two-digit numbers without regrouping	65	.97	61	.97	53	.91	28	.55	15	.48	11	.42	9	.47	15	.58
7. Two three-digit numbers with no regrouping	29	.45	61	.97	54	.93	30	.59	18	.58	12	.46	9	.47	15	.58
8. Two one-digit numbers with regrouping	9	.16	59	.94	52	.90	34	.67	17	.55	13	.50	9	.47	14	.54
9. Two two-digit numbers with regrouping	7	.13	61	.97	56	.97	41	.80	24	.74	16	.62	14	.74	18	.69
10. Three two-digit numbers with regrouping	2	.03	33	.52	55	.95	49	.96	24	.81	17	.65	17	.89	20	.77
11. Two three digit numbers with regrouping	1	.01	33	.52	57	.98	49	.96	26	.84	18	.69	18	.95	21	.81
12. Three three-digit numbers with regrouping	0	0	13	.21	49	.84	49	.96	27	.87	19	.73	18	.95	21	.81
13. Two four-digit numbers with regrouping	0	0	8	.13	45	.78	49	.96	27	.87	19	.73	17	.89	20	.77
14. Three four-digit numbers with regrouping	0	0	4	.06	29	.50	47	.92	26	.84	20	.77	19	100	22	.85
15. Four four-digit numbers with regrouping	0	0	2	.03	18	.31	40	.78	23	.74	20	.77	17	.89	20	.78

Table IV (continued)

Operations	Responses by Grade Level ¹															
	1		2		3		4		5		6		7		8	
	Number ²	Percent ³	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
16. Four five-digit numbers with regrouping	0	0	2	.03	15	.26	36	.71	18	.58	20	.77	15	.78	19	.73
17. Two six-digit numbers with regrouping	0	0	3	.05	12	.21	30	.59	21	.68	21	.81	14	.74	18	.69
18. Three or more one, two, or three-digit numbers in a horizontal format with no regrouping	18	.27	23	.37	29	.51	36	.71	19	.61	18	.69	17	.89	22	.85
19. Three or more one, two, or three digit numbers with regrouping	2	.03	8	.13	23	.40	38	.75	25	.81	19	.73	16	.84	21	.81
Subtraction of whole numbers																
1. Two one-digit numbers	65	.97	60	.95	47	.81	29	.57	11	.35	9	.35	4	.21	7	.27
2. Two two-digit numbers	62	.93	61	.97	53	.91	33	.65	18	.58	12	.46	9	.47	14	.54
3. Zero as a subtrahend	63	.94	61	.97	52	.90	38	.75	24	.74	16	.62	12	.63	17	.65
4. Two three-digit numbers without borrowing	31	.48	59	.94	55	.95	41	.80	20	.65	17	.65	10	.53	17	.65
5. Two two-digit numbers with borrowing	9	.13	60	.95	58	100	47	.92	25	.81	17	.65	17	.89	21	.81
6. Two three-digit numbers with borrowing	0	0	23	.37	56	.97	48	.94	25	.81	21	.81	19	100	22	.85
7. Two four-digit numbers with borrowing	0	0	6	.09	43	.74	47	.92	25	.81	21	.81	19	100	22	.85
8. Two five-digit numbers with borrowing	0	0	5	.08	20	.34	43	.84	25	.81	22	.85	19	100	21	.81
Multiplication of whole numbers																
1. Products through 18	0	0	29	.46	56	.97	41	.80	17	.55	13	.50	11	.50	14	.54
2. Products through 36	0	0	14	.22	54	.93	42	.82	17	.55	13	.50	11	.58	14	.54
3. Products through 81	0	0	5	.08	53	.91	43	.84	20	.65	16	.62	11	.58	14	.54
4. One-digit number times a two-digit number	0	0	3	.05	48	.83	48	.94	26	.84	20	.77	13	.68	19	.73
5. Two-digit number times a two-digit number	0	0	0	0	12	.21	49	.96	28	.90	20	.77	18	.95	22	.85
6. One-digit number times a three-digit number	0	0	1	.02	39	.67	51	100	28	.90	21	.81	16	.84	21	.81
7. Three-digit number times a three-digit number	0	0	0	0	1	.02	26	.51	28	.90	22	.85	19	100	24	.92
8. Four-digit number times a four-digit number	0	0	0	0	1	.02	5	.10	10	.32	20	.77	17	.89	21	.81
9. Four-digit number times a five-digit number	0	0	0	0	1	.02	4	.08	8	.26	16	.62	16	.84	18	.69

Table IV (continued)

Operations	Responses by Grade Level ¹															
	1		2		3		4		5		6		7		8	
	Number ²	Percent ³	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Division of whole numbers																
1. Dividends through 36	0	0	5	.08	49	.84	43	.84	22	.71	14	.54	11	.58	14	.54
2. Dividends through 81	0	0	1	.02	47	.81	42	.82	23	.74	16	.62	11	.58	14	.54
3. One-digit divisor and one-digit dividend with no remainder	0	0	3	.05	51	.88	48	.94	23	.74	16	.62	9	.49	13	.50
4. One-digit divisor and two-digit dividend with no remainder	0	0	2	.03	49	.84	48	.94	27	.87	20	.77	11	.58	16	.62
5. Two-digit divisor and two-digit dividend with no remainder	0	0	0	0	7	.12	43	.84	26	.84	20	.77	14	.74	16	.62
6. Two-digit divisor and three-digit dividend with no remainder	0	0	0	0	5	.09	42	.82	28	.90	22	.85	16	.84	20	.77
7. One-digit divisor and one-digit dividend with a remainder	0	0	1	.02	45	.78	45	.88	22	.71	20	.77	13	.68	15	.58
8. One-digit divisor and two-digit dividend with a remainder	0	0	1	.02	42	.72	47	.92	26	.84	20	.77	15	.78	19	.73
9. One-digit divisor and three-digit dividend with a remainder	0	0	0	0	19	.33	44	.86	27	.87	21	.81	17	.89	21	.81
10. One-digit divisor and four-digit dividend with a remainder	0	0	0	0	7	.12	31	.61	28	.90	22	.85	17	.89	20	.77
11. One-digit divisor and five-digit dividend with a remainder	0	0	0	0	3	.05	21	.41	25	.81	21	.81	16	.84	19	.73
12. Two-digit divisor and two-digit dividend with a remainder	0	0	0	0	1	.02	38	.75	27	.87	22	.85	19	100	23	.88
13. Two-digit divisor and three-digit dividend with a remainder	0	0	0	0	1	.02	35	.69	27	.87	24	.92	19	100	25	.96
14. Two-digit divisor and four-digit dividend with a remainder	0	0	0	0	1	.02	25	.49	27	.87	22	.85	19	100	23	.88
15. Two-digit divisor and five-digit dividend with a remainder	0	0	0	0	0	0	10	.20	22	.71	22	.85	19	100	22	.85
16. Three-digit divisor and five-digit dividend with a remainder	0	0	0	0	0	0	4	.08	7	.23	20	.77	19	100	22	.85

Table IV (continued)

Operations	Responses by Grade Level ¹															
	1		2		3		4		5		6		7		8	
	Number ²	Percent ³	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
17. Three-digit divisor and six-digit dividend with a remainder	0	0	0	0	0	0	3	.06	4	.13	19	.73	19	100	20	.77
Fractions																
1. Expressing fractions in simplest terms	24	.36	23	.37	48	.83	44	.86	29	.94	24	.92	19	100	24	.92
2. Changing improper fractions into mixed numbers	0	0	0	0	1	.02	32	.63	28	.90	25	.96	19	100	24	.92
3. Changing mixed numbers into improper fractions	0	0	0	0	0	0	29	.57	28	.90	25	.96	19	100	24	.92
4. Finding least common denominators	0	0	0	0	3	.05	35	.69	28	.90	25	.96	19	100	24	.92
Addition of fractions																
1. Two fractions with like denominators	2	.03	2	.03	16	.26	44	.86	29	.94	24	.92	19	100	24	.92
2. Three fractions with like denominators	0	0	1	.02	8	.14	27	.53	26	.84	23	.88	19	100	24	.92
3. Four fractions with like denominators	0	0	0	0	3	.05	19	.37	15	.48	20	.77	14	.74	22	.85
4. Two fractions with unlike denominators	0	0	0	0	0	0	35	.69	29	.94	24	.92	19	100	25	.96
5. Three fractions with unlike denominators	0	0	0	0	0	0	13	.25	23	.74	21	.81	19	100	25	.96
6. Four fractions with unlike denominators	0	0	0	0	0	0	5	.10	6	.19	17	.65	14	.74	20	.77
7. Two mixed numbers with common denominators and no regrouping	0	0	0	0	1	.02	30	.59	28	.90	24	.92	19	100	25	.96
8. Two mixed numbers with unlike denominators and no regrouping	0	0	0	0	0	0	20	.39	29	.94	23	.80	19	100	25	.96
9. Two mixed numbers with like denominators and regrouping	0	0	0	0	1	.02	14	.27	24	.74	23	.80	17	.89	23	.88
10. Two mixed numbers with unlike denominators and regrouping	0	0	0	0	0	0	13	.29	24	.74	23	.80	18	.95	24	.92
11. Three mixed numbers with like denominators and regrouping	0	0	0	0	0	0	6	.12	11	.35	17	.65	17	.89	22	.85
12. Three mixed numbers with unlike denominators	0	0	0	0	0	0	5	.10	10	.32	18	.69	19	100	24	.92

Table IV (continued)

	Responses by Grade Level ¹															
	1		2		3		4		5		6		7		8	
	Number ²	Percent ³	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Operations																
Subtraction of fractions																
1. Fractions with like denominators and no regrouping	1	.01	0	0	16	.28	43	.84	29	.94	24	.92	19	100	24	.92
2. Fractions with unlike denominators and no regrouping	0	0	0	0	0	0	35	.69	29	.94	24	.92	19	100	24	.92
3. Fractions with like denominators and regrouping	0	0	0	0	1	.02	24	.47	27	.87	24	.92	17	.89	23	.88
4. Fractions with unlike denominators and regrouping	0	0	0	0	0	0	18	.35	26	.84	23	.88	18	.95	24	.92
5. Fractions from mixed number with no regrouping	0	0	0	0	0	0	20	.39	26	.84	23	.88	19	100	25	.96
6. Mixed numbers with like denominators	0	0	0	0	0	0	23	.45	27	.87	23	.88	19	100	25	.96
7. Mixed numbers with like denominators and regrouping	0	0	0	0	0	0	12	.24	27	.87	23	.88	18	.95	24	.92
Multiplication of fractions																
1. Two fractions	0	0	0	0	2	.03	13	.25	26	.84	23	.88	19	100	25	.96
2. A fraction and a mixed number	0	0	0	0	0	0	7	.14	15	.48	23	.88	19	100	25	.96
3. Two mixed numbers	0	0	0	0	0	0	6	.12	13	.42	22	.85	18	.95	25	.96
4. A whole number and a fraction	0	0	0	0	1	.02	8	.17	21	.68	23	.88	19	100	25	.96
Division of fractions																
1. A fraction by a fraction	0	0	0	0	1	.02	9	.18	22	.71	23	.88	19	100	25	.96
2. A fraction by a whole number	0	0	0	0	0	0	7	.14	19	.61	23	.88	19	100	25	.96
3. A whole number by a fraction	0	0	0	0	0	0	6	.12	18	.58	23	.88	19	100	25	.96
4. A mixed number by a fraction	0	0	0	0	0	0	4	.08	11	.35	23	.88	19	100	25	.96
5. A fraction by a mixed number	0	0	0	0	0	0	4	.08	11	.35	23	.88	19	100	25	.96
6. A mixed number by a mixed number	0	0	0	0	0	0	2	.04	9	.29	22	.85	19	100	25	.96

Table IV (continued)

Operations	Responses by Grade Level ¹															
	1		2		3		4		5		6		7		8	
	Number ²	Percent ³	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Decimals																
1. Addition of decimals	0	0	6	.09	22	.38	26	.51	29	.94	24	.92	19	100	25	.96
2. Subtraction of decimals	0	0	6	.09	22	.38	25	.49	29	.94	24	.92	19	100	25	.96
3. Multiplication of decimals	0	0	0	0	2	.03	13	.25	25	.81	22	.85	19	100	25	.96
4. Division of decimals	0	0	0	0	0	0	8	.17	21	.68	22	.85	19	100	25	.96
5. Changing decimals to percents	0	0	0	0	0	0	6	.12	12	.39	22	.85	18	.95	25	.96
6. Changing percents to decimals	0	0	0	0	0	0	6	.12	9	.29	22	.85	18	.95	25	.96
7. Changing decimals to fractions	0	0	0	0	0	0	7	.14	17	.55	22	.85	19	100	25	.96
8. Changing fractions to decimals	0	0	0	0	0	0	7	.14	17	.55	22	.85	19	100	25	.96
Miscellaneous topics																
1. Telling time	61	.91	56	.89	54	.93	33	.65	10	.32	7	.27	1	.05	3	.12
2. Money	61	.91	56	.89	54	.93	40	.78	18	.58	13	.50	5	.26	12	.46
3. Standard measurements	52	.80	51	.81	53	.91	43	.84	24	.74	19	.73	14	.74	21	.81
4. Roman numerals	1	.01	14	.22	38	.66	43	.84	26	.84	19	.73	5	.26	8	.31
5. Counting by 2's, 5's, and 10's	61	.91	52	.83	54	.93	37	.73	16	.52	11	.42	4	.21	6	.23
6. Square root	0	0	0	0	1	.02	1	.02	1	.03	6	.23	11	.58	16	.62
7. Recognition of number words	58	.87	55	.87	51	.88	40	.78	18	.58	16	.62	15	.79	20	.77
8. Spelling of number words	40	.60	52	.83	50	.86	37	.73	16	.52	12	.46	10	.53	11	.42
9. Metric measurements	26	.39	31	.49	34	.59	35	.69	22	.71	21	.81	16	.84	23	.88
10. Read and interpret tables, maps, graphs, and charts	15	.22	31	.49	40	.69	36	.71	24	.74	20	.77	13	.69	20	.78
11. Compute compound interest	0	0	0	0	0	0	1	.02	1	.03	5	.19	8	.42	13	.50
12. Solve simple interest, percent, and ratio problems	0	0	0	0	0	0	2	.04	7	.23	18	.26	15	.79	23	.88
13. Solve word problems involving any of the operations (addition, subtraction, multiplication, and division)	33	.49	34	.64	46	.79	38	.75	28	.90	23	.88	19	100	23	.88
14. Multiply decimal fraction by a decimal number	0	0	0	0	0	0	2	.04	9	.29	15	.58	16	.84	21	.81

Table IV (continued)

Operations	Responses by Grade Level ¹															
	1		2		3		4		5		6		7		8	
	Number ²	Percent ³	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
15. Divide decimal number by a whole number	0	0	0	0	0	0	5	.10	12	.39	17	.65	18	.95	24	.92
16. Customary units of measurements-equivalency	11	.16	6	.10	14	.24	22	.43	12	.39	17	.65	10	.53	17	.65
17. Place value	30	.46	34	.64	38	.66	35	.69	27	.87	17	.65	17	.89	23	.88
18. Decimal fraction to percent	0	0	0	0	0	0	5	.10	6	.19	18	.69	18	.95	23	.88
19. Percent of a number	0	0	0	0	0	0	5	.10	6	.19	21	.81	18	.95	25	.96
20. Decimal equivalency	0	0	0	0	0	0	6	.12	14	.45	19	.73	17	.89	23	.88
21. Equivalent fractions	0	0	0	0	5	.09	27	.53	26	.84	23	.88	18	.95	23	.88
22. Rounding off numbers	0	0	1	.02	36	.62	37	.73	28	.94	23	.88	18	.95	23	.88
23. Metric equivalency	0	0	2	.03	5	.09	13	.25	4	.13	16	.62	13	.69	20	.78
24. Measure of temperature	12	.18	29	.46	29	.50	29	.57	10	.32	10	.38	11	.58	15	.58
25. Recognition of mathematical symbols	32	.48	36	.57	34	.59	33	.65	21	.68	18	.69	15	.79	19	.73
26. Ordinal numbers	26	.39	34	.64	36	.62	27	.53	15	.48	12	.46	5	.26	8	.31
27. Simple two-step word problems including whole numbers, fractions, or decimals	4	.06	12	.19	10	.17	28	.55	19	.61	17	.65	17	.89	20	.78

¹The grade level distribution of the returns were as follows: first grade, 67; second grade, 63; third grade, 58; fourth grade, 51; fifth grade, 31; sixth grade, 26; seventh grade, 19; and eighth grade, 26.

²The number of teachers responding to each operation for this grade level.

³The percent of the total number of checklists returned for this grade level.

Table V

Arithmetic Operations Included in the Textbooks that were not Evaluated by the Eighth Grade Basic Skills Test^{1,2}

Operations		
Miscellaneous topics		
1. Telling time		
2. Money		
3. Common shapes		
4. Roman numerals		
5. Counting by 2's, 5's, and 10's		
6. Square root		
7. Spelling of number words		
8. Read and interpret tables, maps, graphs, and charts		
9. Compute compound interest		
10. Solve simple interest, percent, and ratio problems		
11. Measure of temperature		
12. Ordinal numbers		
TOTAL	Number	Percent ³
	12	.10

¹L. C. Bolster et al., Mathematics Around Us, (Glenview: Scott Foresman, 1975). Eugene D. Nichols et al., Holt School Mathematics (New York: Holt, Rinehard and Winston, 1974). Tina Thoburn et al., Macmillan Mathematics (New York: Macmillan, 1976). Richard A. Denholm et al., Mathematics for Individual Achievement (New York: Houghton Mifflin, 1975).

²Tennessee State-Mandated Eighth Grade Basic Skills Test administered in the spring of 1978.

³Percent of total number of arithmetic operations included in the textbooks.

that were not Evaluated by the Eighth Grade Basic Skills Test," page 55, includes these operations. It was found that 12 of the operations (10 percent) included in the textbooks were not evaluated by the eighth grade basic skills test. Many operations were not directly included on the test but were evaluated because they were included in the skills necessary to complete test items. For instance, addition, subtraction, and multiplication are needed to complete a division problem. Those operations not evaluated by the eighth grade basic skills test came from the miscellaneous section of the checklists.

No studies were found that relate to this hypothesis. The eighth grade basic skills test covered all the basic operations of addition, subtraction, multiplication, and division of whole numbers, fractions and decimals. Emphasis was placed on computation, and as a result, operations such as telling time and spelling of number words were not included. Those operations that required an interpretation of what process or procedure to follow were not well represented in the test. Those operations include computing simple interest and word problems.

The basic skills test did not contain any items that were not included in the major textbooks used for this study.

Comparison of Operations in Curriculum Guides and Test

The second hypothesis of this study was that there would be arithmetic operations included in the curriculum guides that were not evaluated by the eighth grade basic skills test. Table VI, "Arithmetic Operations Included in the Curriculum Guides that were not Evaluated by the Eighth Grade Basic Skills Test," page 58, presents these concepts. Eight operations (6 percent) included in the curriculum guides were not directly evaluated by the eighth grade basic skills test.

Only three of the eleven systems that agreed to participate indicated that they had written curriculum guides for the area of mathematics. A. Montgomery Johnston found in 1960 that few school systems had written guides.² The curriculum guides used for this study were prepared by the teachers in the individual systems, and reflect a very wide range of operations to be taught. Those operations not directly included in the eighth grade basic skills test were almost identical to those included in Table V, "Arithmetic Operations Included in the Textbooks that were not Evaluated by the Eighth Grade Basic Skills Test," page 55. This finding also pointed out that the eighth grade basic skills

²A. Montgomery Johnston, "Arithmetic in Tennessee: A Survey of Teaching Practices Grades One Through Eight," The University of Tennessee Record 63 (May, 1960): 51.

Table VI

Arithmetic Operations Included in the Curriculum Guides that were not Evaluated by the Eighth Grade Basic Skills Test^{1,2}

Operations		
Miscellaneous topics		
1. Telling time		
2. Roman numerals		
3. Counting by 2's, 5's, and 10's		
4. Square root		
5. Read and interpret tables, maps, graphs, and charts		
6. Solve simple interest, percent, and ratio problems		
7. Compute compound interest		
8. Solve word problems involving any of the four operations (addition, subtraction, multiplication, and division)		
TOTAL	Number	Percent ³
	8	.06

¹DeKalb County Schools, "Pupil Expectations for Mathematics Grades K-12," Smithville, Tennessee, 1977. Manchester City Schools, "Curriculum Guide for Mathematics Grades K-9," Manchester, Tennessee, 1978. Sweetwater City Schools, "Mathematics Curriculum Guide Grades K-9," Sweetwater, Tennessee, 1978.

²Tennessee State-Mandated Eighth Grade Basic Skills Test administered in the spring of 1978.

³Percent of total arithmetic operations included in the curriculum guides.

test was for the most part an evaluation of computation skills dealing with the basic operations and placed less emphasis on those items that did not deal directly with the basic operations or that required a decision about what operation to use. The student would have been required to make decisions about what operations to use in order to compute simple interest.

Comparison of Operations in the Textbooks and Instruction

The third hypothesis of this study was that there would be operations included in the textbooks that were not taught by a majority of the teachers that responded to the study. This information was gathered by means of a checklist. (See Appendix F, page 116.) All of the operations included in this study were included in the textbooks.

The findings indicated that the teachers of Tennessee attempt to cover a wide range of arithmetic operations. There was little, if any, agreement about what operations were to be taught in all grade levels; however, an analysis of responses by grade levels indicated that there was a great deal of agreement within each grade level about what operations are to be "taught." Table IV, "Number and Percent of Teachers Teaching each Arithmetic Operation for Grade Levels One Through Eight," summarizes the findings related to the operations taught in each grade level (see Table IV,

page 48). Each operation in the table seems to receive higher percentages of responses for the grade level at which the operation was presented by the major textbooks used for this study. For example, the first operation in this table, recognition of numbers 1-10, was introduced in the major textbooks in the first grade. Table IV, page 48, indicates that 100 percent of the first grade teachers and 75 percent of the second grade teachers "taught" this operation. The percentages of responses for this operation go down as one goes higher in the grade levels. It would appear that the respondent's idea of "teach" may have meant "introduce new operations," for surely the simpler operations were a base for the more complex operations. There is some question of whether or not any of the more advanced operations can be taught without mastery of the simpler operations. The teachers responded based on what they felt they taught in their grade. More accurate findings would have resulted if the teachers had been asked to check those operations they presented or attempted to teach during the school year. Operation six, under multiplication of whole numbers, page 49, is introduced in the third grade by the major textbooks. Table IV indicates that 67 percent of the third grade, 100 percent of the fourth grade, and 90 percent of the fifth grade teachers responding to the study "taught" this operation. Sixth, seventh, and eighth grade teachers continued

to emphasize this operation, although the percentage of responses was less than those of the fourth and fifth grades. This operation was not "taught" by any of the first grade teachers and by only 2 percent of the second grade teachers. This indicates that the operation of a one-digit number times a two-digit number was not "taught" in grades one and two except perhaps to some accelerated second grade students. These findings indicate that the teachers are following the scope and sequence presented for their grade level by the textbook companies.

Comparison of the Operations in the Curriculum Guides and Instruction

The fourth hypothesis of this study was that there would be operations included in the curriculum guides that were not taught by a majority of the teachers responding to the study.

As previously stated, only three of the eleven participating systems had curriculum guides for the area of mathematics. These guides covered a wide range of arithmetic operations. Each guide was different and introduced operations at slightly different grade levels. The findings indicate that there was little agreement among teachers about which operations were to be taught for grades one through eight. The low percentages for several operations may have resulted from disagreement about when a operation

should or should not be taught. Montgomery Johnston found some disagreement about what topics teachers felt should be taught in each grade.³ Some teachers may have felt that the operation had already been covered or would be covered in a later grade and as a result did not believe it was necessary to cover it in his or her classroom. The term "teach" may have been interpreted to mean only "new operations introduced." Table IV, "Number and Percent of Teachers Teaching each Operation for Grade Levels One Through Eight," indicates that there is agreement within each grade level concerning what is taught (see Table IV, page 48).

The percentage of responses for each grade level is higher for the grade level in which the operation was covered by the major textbooks. For instance, operation 17 under division of whole numbers, page 51. (A three-digit divisor and a six-digit dividend with a remainder) was not reported "taught" in grades one through three. Only 6 percent of the fourth grade teachers and 13 percent of the fifth grade teachers felt they "taught" this particular operation. This operation is introduced in the major textbooks at the sixth grade level. A dramatic increase in the percentage of responses for this operation can be seen beginning with the sixth grade and moving through the eighth grade. This

³Ibid.

finding indicates that the curriculum guides appear to be based on the scope and sequence of the mathematics textbooks and that the teachers are following this scope and sequence.

Comparison of Operations Included in Curriculum Guides and Textbooks

The fifth hypothesis of this study was that there would be arithmetic operations included in the curriculum guides that were not included in the textbooks. All of the operations included in the curriculum guides were covered by the major textbooks. Teachers across the state, for the most part, appear to depend only on the use of textbooks when teaching arithmetic. The curriculum guides that are available were written by teachers who appeared to pattern their product around the material covered in their textbooks. Differences among the curriculum guides appeared to develop as a result of the individual preferences of the teachers who designed them. Some variety may have resulted from the differences in the textbooks used as models.

Comparisons of Operations that were Taught by a Majority of the Teachers and the Eighth Grade Basic Skills Test

Hypothesis six deals with operations that were taught by a majority of the teachers responding to the study but which were not evaluated by the eighth grade basic skills test. A summary of data pertaining to this hypothesis is contained in Table VII, "Arithmetic Operations which were

Table VII

Arithmetic Operations which were Taught by a Majority of
the Teachers but were not Included on the Eighth
Grade Basic Skills Test^{1,2}

Number of Responses by Grade Level									
1	2	3	4	5	6	7	8	Unclassified	Total
67	63	58	51	31	26	19	26	19	360
Percent of Response by Grade Level									
.19	.18	.16	.14	.09	.07	.05	.07	.05	100
Operations								Taught by Teachers	
								Number	Percent
Miscellaneous topics									
1. Telling time								240	.67
2. Money								276	.77
3. Common shapes								276	.77
4. Counting by 2's, 5's, and 10's								256	.71
5. Spelling of number words								240	.67
6. Read and interpret tables, maps, graphs, and charts								210	.58
TOTAL								Number 6	Percent ³ .05

¹A majority in this case was considered to be greater than one-half of those teachers responding to the study.

²Tennessee State-Mandated Eighth Grade Basic Skills Test administered in the spring of 1978.

³Percent of total number of operations involved in the study.

Taught by a Majority of the Teachers but were not Included on the Eighth Grade Basic Skills Test," page 64. This table indicates that only six (5 percent) of the total number of operations included in the study which were taught by a majority of the teachers were not evaluated by the eighth grade basic skills test. This finding indicates that the eighth grade basic skills test evaluated most of the operations that a majority of the teachers felt they "taught."

Comparison of Test Scores for those Operations
not Included in the Textbooks

Hypothesis seven of this study stated that the test scores would be lower for arithmetic operations which were not included in the major textbooks. The data compiled for this study indicated that there were no arithmetic operations evaluated by the eighth grade basic skills test that were not included in the major textbooks used in Tennessee.

Test Scores on those Operations not Taught
by a Majority of the Teachers Responding
to the Study

The eighth and last hypothesis of this study was that the test scores would not be lower than 70 percent on those arithmetic operations that were not taught by a majority of the teachers responding to the study. Table VIII, "Test Scores of Students as they Relate to the Instruction of the Teachers Responding to the Study," page 66, summarizes the data related to this hypothesis. This table indicates that

Table VIII

Test Scores of Students as they Relate to the Instruction
of the Teachers Responding to the Study^{1,2}

Number of Responses by Grade Level									
	1	2	3	4	5	6	7	8	Total
	67	63	58	51	31	26	19	26	399
Percent of Response by Grade Level									
	.17	.16	.15	.13	.08	.06	.05	.06	.10
									100
Operations				Taught			Not Taught		
	Number	Percent ³	Number	Percent ³	Number	Percent ³	Number	Percent ³	Correct Response ⁴
1. Divide four-digit multiple of 100 by multiple of 10, no remainder	147	.41	213	.59			2,830	.55	
2. Subtract fraction from mixed number	120	.33	240	.67			2,408	.47	
3. Multiply mixed number by a fraction	95	.26	265	.74			2,370	.46	
4. Divide rational numbers	110	.31	250	.69			2,314	.48	
5. Multiply decimal fraction by decimal number, hundredths	67	.19	293	.81			3,544	.68	
6. Divide decimal fraction by a whole number	83	.23	277	.77			3,059	.59	
7. Decimal fraction to percent	73	.20	287	.80			1,716	.42	
8. Percent of a number	77	.21	283	.79			2,182	.42	
TOTAL	Number			Percent ⁵			Percent ⁵		
	8						.06		

¹Tennessee State-Mandated Eighth Grade Basic Skills Test administered in the spring of 1978.

²Responses obtained from checklist (see Appendix F).

³Percent of total responses for each operation.

⁴Percent of total number of students responding correctly to this operation.

⁵Percent of total number of operations involved in this study.

there were eight operations which were not taught by a majority of the teachers and the scores on these operations were below 70 percent of the total number of students responding to the study. The low percentage of responses for each of these operations was effected by the number and distribution of the grade levels used in the study. Another limitation of the study that had adverse effects on the percentages was the failure to define the term "teach" that was used in the directions to teachers completing the check-lists. Many of these teachers may have interpreted this term to mean "new operations introduced." A tabulation of responses by grade level, indicated that there was a high degree of agreement about what is to be "taught" in each grade level. High percentages were reported for each operation for the grade levels at which that operation was included in the major textbooks used for this study (see Table IV, page 48).

III. SUMMARY

As stated in the first hypothesis of this study, there were more operations included in the textbooks than were evaluated by the eighth grade basic skills test. Twelve (10 percent) of the operations included in the textbooks were not evaluated by the test. The textbooks used for this study included other areas of arithmetic than "operations" and other areas of mathematics than arithmetic.

Data collected for the second hypothesis, which states that there would be arithmetic operations included in the curriculum guides that were not evaluated by the eighth grade basic skills test, revealed that eight (6 percent) of the arithmetic operations included in the curriculum guides were not evaluated by the eighth grade basic skills test.

There were operations included in the textbooks that were not "taught" by a majority of the teachers responding to this study. This finding supports hypothesis three, which states that there would be arithmetic operations included in the textbooks that were not taught by a majority of the teachers responding to the study. When analyzed by grade level, it appeared that teachers were responding to those operations they felt they introduced as new operations. The percentage of responses was greater for the operation in the grade levels where that operation was introduced by the major textbooks.

The curriculum guides contained operations that were not "taught" by a majority of the teachers responding to the study. This supports hypothesis four, which states that there would be operations included in the curriculum guides that were not taught by a majority of the teachers responding to the study. The percentage of responses was greater for the operations in the grade levels where that operation was introduced by the major textbooks.

The fifth hypothesis, which states that there would be arithmetic operations included in the curriculum guides that were not included in the textbooks, proved to be not supported. All of the operations that were included in the curriculum guides were also included in the textbooks.

The sixth hypothesis states that there would be operations taught by the teachers that were not evaluated by the eighth grade basic skills test. Six of the operations (5 percent) that were taught by a majority of the teachers were not evaluated by the eighth grade basic skills test.

The seventh hypothesis states that the test scores would not be lower for those arithmetic operations that were not included in the textbooks. This hypothesis proved to be moot, since all the operations that were evaluated on the test were included in the textbooks.

The eighth hypothesis of this study was that test scores would not be lower than 70 percent on those arithmetic operations not taught by a majority of the teachers responding to the study. The findings related to this hypothesis indicated that there were eight operations on the test that were not "taught" by a majority of the teachers responding to this study and which received scores of less than 70 percent. The term "teach" was not defined on the checklists that were completed by the teachers. This limitation should be considered when evaluating these findings.

CHAPTER 5

LIMITATIONS, FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

I. INTRODUCTION

The purpose of this study was to identify discrepancies between (1) arithmetic operations included in major mathematics textbooks; (2) operations included in local curriculum guides; (3) operations teachers say they cover in grades one through eight in selected Tennessee school systems; (4) arithmetic operations covered on the Tennessee State-Mandated Eighth Grade Basic Skills Test administered in the spring of 1978; and (5) the scores on that test.

A checklist was prepared which contained the arithmetic operations included in the major arithmetic textbooks, the curriculum guides from the systems that were willing to participate, the state competency list for mathematics, and the arithmetic portion of the Tennessee State-Mandated Eighth Grade Basic Skills Test administered in the spring of 1978.

Thirty-five systems across the state of Tennessee were contacted and asked to take part. Checklists were mailed to 1,220 elementary teachers chosen from 80 schools. These teachers were asked to check the operations they taught.

A total of 399 (33 percent) of the checklists were returned. The analysis of data was based on 360, or 30 percent of the checklists. Thirty-nine (10 percent) of those checklists that were returned were faulty. Comparisons are made for the following:

1. Those operations included on the test that were taught by the majority of the teachers were compared with the test scores on those operations.
2. Those operations included on the test that were not taught by the majority of the teachers were compared with the test scores on those operations.
3. Those operations included on the test which were in the textbooks were compared with the test scores on those operations.
4. Those operations included on the test which were not in the textbooks were compared with the test scores on those operations.
5. Those operations included on the test which were in the curriculum guides were compared with the scores on those operations.
6. Those operations included on the test that were not included in the curriculum guides were compared with the test scores on those operations.

This chapter presents the limitations of the study as well as the conclusions and recommendations formulated from the analysis of data obtained for this study.

II. LIMITATIONS

The following limitations must be considered when evaluating the findings of this study:

1. Only 399, or 33 percent, of the 1,220 checklists were returned. Thirty-nine (10 percent) of these were faculty and were not used in the analysis of data.

2. A follow up was conducted in which 16 (20 percent) of the principals involved in the study were contacted by telephone. These principals were from the schools for which no checklists were returned. The reason given most often for not distributing the checklists was that they arrived at the schools too late in the school year. Teachers were too busy to be bothered. The follow up also included telephone conversations with eight teachers who did not return the checklist. Four of these teachers were from West Tennessee, three were from Middle Tennessee, and one was from East Tennessee. All but one of these teachers stated that they did not receive the checklist. One stated that he was a Title I mathematics teacher and did not feel the checklist was meant for him.

3. The checklist used in the study failed to define the term "teach." This may have resulted in some confusion

about which operations teachers were to check. Teachers may have interpreted the term to mean "those operations introduced" in their grade level.

4. The tabulation of data was done by hand. This may have increased the likelihood of error.

III. FINDINGS

An analysis of data obtained from 360 checklists produced the following findings:

1. It was hypothesized that arithmetic operations included in the textbooks are not all evaluated by the eighth grade basic skills test. It was found that the textbooks chosen for this study included 12 operations that were not evaluated by the test. The eighth grade basic skills test contained operations dealing almost entirely with computational skills. Those operations covered the four basic operations of addition, subtraction, multiplication, and division of whole numbers, fractions, and decimals. The test was weak in the items that required a decision on the part of the student about what process or procedure to follow. Operations that did not deal directly with the four basic operations, for example, Roman numerals and telling time, were not evaluated by the test. The so called "modern mathematics" concepts dealing with such things as sets and subsets were not evaluated by the test.

2. It was hypothesized that there would be more operations included in the textbooks than were taught by a majority of the teachers responding to the study. It was found that the textbooks contained more operations than were "taught" by a majority of the teachers responding to this study. This finding revealed a high degree of differences in the operations being taught in grades one through eight. An analysis by grade level proved that this apparent wide range of disagreement did not hold true within each grade. There was agreement about what should be taught in each grade level and the percentages of responses were high for those operations that are recommended for introduction in each grade level by the major mathematics textbooks. The teachers seemed to follow their scope and sequence charts of the mathematics textbooks for their grade level.

3. It was hypothesized that there would be more operations included in the curriculum guides than were evaluated by the eighth grade basic skills test. There were eight (6 percent) of the operations involved in the guides that were not evaluated by the eighth grade basic skills test.

Eleven systems were willing to participate in the study. Only three of these systems supplied a written guide for the area of mathematics. The operations included in these

curriculum guides that required a decision about process or those not directly involved with the basic operations were not well represented on the eighth grade basic skills test. These operations included such things as computing simple interest.

4. It was hypothesized that there would be more operations included in the curriculum guides than were taught by a majority of the teachers responding to the study. There were operations involved in the curriculum guides, that were not "taught" by a majority of the teachers responding to this study. The teachers did not agree on what operations should be taught in grades one through eight. However, when the responses were analyzed by grade level there was agreement about what should be taught in each grade. The teachers seemed to follow the scope and sequence charts developed for each grade level by the major textbook companies.

5. It was hypothesized that there would be arithmetic operations included in the curriculum guides that were not included in the textbooks used for this study. It was found that all the arithmetic operations included in the curriculum guides were included in the major textbooks. This indicates that the textbooks present the broadest coverage of the lists compiled from the textbooks, the curriculum guides, the competency list, and the eighth grade basic skills test.

6. It was hypothesized that there would be operations taught by a majority of the teachers responding to this study which were not evaluated by the eighth grade basic skills test. It was found that not all the operations taught by a majority of the teachers were evaluated by the eighth grade basic skills test. Only 42 (34 percent) of the 125 operations involved in the study were reported taught by a majority of the teachers. Seven (5 percent) of those operations were not included on the eighth grade basic skills test. These operations were those that did not directly involve the basic operations of addition, subtraction, multiplication, or division of whole numbers, fractions, and decimals. These findings indicate that the textbooks are broadest in their coverage of arithmetic operations; the curriculum guides are next; what the teachers say they "teach" is next; and the eighth grade basic skills test is the most narrow in its coverage of arithmetic operations.

7. It was hypothesized that test scores would not be lower than 70 percent on those operations included on the eighth grade basic skills test that were not included in the textbooks used for this study. It was found that all the operations that were evaluated by the eighth grade basic skills test were included in the major textbooks.

8. It was hypothesized that the test scores would not be lower than 70 percent for those operations not taught by

a majority of the teachers responding to the study. It was found that there were eight operations that were not taught by a majority of the teachers responding to the study and that received a score of less than 70 percent. Each of these operations received higher percentages of responses from the teachers of the grade level where the operation was introduced and stressed by the major textbook companies.

IV. CONCLUSIONS

Based on the data obtained from 360 checklists, the following conclusions seem reasonable:

1. An analysis of the data obtained from the checklists indicated that the elementary teachers across the state of Tennessee have attempted to "teach" those arithmetic operations which were included in the major mathematics textbooks for their particular grade level. The eighth grade basic skills test did not contain any operations that were not included in the major textbooks. It was concluded that the unsatisfactory scores obtained by some students on some items were not a result of teachers not "teaching" those operations. The low scores may have resulted from instructional methodology, the depth to which each operation was covered, or poor ability of the learners.

2. The findings indicated that the textbooks used for this study were broad in their coverage of arithmetic

operations. This coverage became more narrow as one moved from the textbooks; to the curriculum guides; to what was taught; to the eighth grade basic skills test. The test evaluated only the four basic operations of addition, subtraction, multiplication, and division of whole numbers, fractions and decimals. A great deal of time was spent in the classroom presenting topics that were not evaluated.

V. RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made involving textbook development, curriculum development, test development, and the need for more research.

Textbook Development

The current emphasis on accountability and proficiency testing will most likely cause textbook writers to include fewer concepts dealing with modern mathematics in their preparation of textbooks. The findings of this study indicate that the mathematics textbooks present the broadest coverage of mathematical concepts. This coverage became more narrow as one moved from the textbooks to the curriculum guides, to what the teachers teach, and to what is evaluated by the eighth grade basic skills test. It is recommended that textbooks maintain the broadest possible coverage of mathematical operations. This broad coverage can be

justified on the ideas that (1) the program is designed for more than the minimum level of operation competence; (2) most students go on to higher mathematics in high school and need broader coverage; and (3) students need far more mathematics in their daily living than just arithmetic operations, they need to understand applications of mathematics, they also need geometry, and simple statistics.

Today's society requires that schools help children prepare for a life of continuous learning. Textbook writers must design material that will help teachers prepare students to cope with unknown changes. Leonard Kennedy in his book, Guiding Children to Mathematical Discovery, states that during their elementary years, children should learn mathematics in a manner that will:

1. Provide them with opportunities to manipulate concrete objects and models to develop their understanding of the characteristics of numbers and number systems.
2. Lead them through varied experiences and dialogue to discover mathematical operations.
3. Let them work according to their individual learning styles and at their individual rates.
4. Inspire them to enjoy the study of mathematics.

5. Lead them to recognize the importance of mathematics in an increasingly technological society.¹

It may not be impossible to have a mathematics program like that described by Kennedy without adequate textbooks and other resources, but it would be difficult. Any attempt to narrow the coverage of the textbooks would result in a mathematics program that would meet the needs of fewer and fewer students and would most likely result in a testing program that would be so narrow in its coverage of mathematical operations that it would be meaningless.

Curriculum Development

Because of the lack of written curriculum guides in the area of mathematics, and because of the differences in the ones that did exist, it is recommended that the Tennessee State Department of Education develop a curriculum guide for the area of mathematics for grades one through eight. The discrepancies between what teachers say they have "taught" and scores of pupils on the tests suggests that teachers need the help of a curriculum guide to suggest better methods, how to individualize, and how to evaluate learning. This guide should include operations dealing with material

¹Leonard Kennedy, Guiding Children to Mathematical Discovery (Belmont, California: Wadsworth Publishing Company Inc., 1975), pp. 3-4.

that is appropriate for most of the children in each grade level. There should be remedial work, work for the so called average student, and work for the more advanced student. The so called modern mathematics approach which includes an emphasis on reasoning, understanding, and application as well as computation, should not be abandoned in favor of a narrow approach involving only computational skills.

The curriculum guide should contain a section that lists sources of reference material, films, film strips, and other teaching aids available for teacher use. This curriculum guide should be used as a "guide" that would enable the teacher to take a child where he or she is and follow a sequence of concepts to a desired goal. Suggestions should be made that would enable the teacher to involve the student in intergraded, functional, and practical learning situations. Greater effort should be made by state and local administrators to see that teachers are aware of and are using the curriculum guides once they are made available. The state and local administrators should be constantly evaluating their curriculum guides.

Test Development

Guidelines for proficiency tests should be designed by the State Department of Education. Guidelines should be developed because they would enable test makers to design

tests that are consistant in their level of difficulty and consistant in the material that they evaluate. Guidelines would also help teachers become familiar with procedures and instructions for administering the tests. These guidelines should indicate what operations are to be tested and should be based on the curriculum guide developed by the State Department of Education. These two factors would increase the degree of uniformity about what arithmetic operations are to be taught in grades one through eight and would ensure some degree of uniformity about what skills are tested. The test should be broadened to include operations dealing with the so called modern mathematics, simple geometry, and other areas emphasized in the elementary mathematics program. The experiences encountered by children in their daily lives will require more than a knowledge of mathematical operations. Students going from elementary school into high school and on to college will find an ever increasing need for a broader understanding of mathematics. Even those who choose to drop out of school will be faced with experiences that require more than an understanding of arithmetic operations.

Needed Research

There is a need for additional research dealing with the proficiency testing program. The relationships between instructional methodology and test performance should be

studied. The amount of emphasis placed on the teaching of each operation and test performance should be examined. There are many questions that remain unanswered. For instance, the effects of proficiency testing on the attitudes, academic performance, and self-esteem of students has not been determined. These studies should be conducted for several years so that test scores could be compared over a period of time. Changes in curricula, textbook design, teaching strategies, and test design could be noted as they develop. Pupil, teacher, and public attitudes toward the testing program could be more closely monitored and these attitudes used to develop a more acceptable testing program. Proficiency testing programs of other states should be examined and the strong points, if any, used in Tennessee's testing program. Research appears to be needed on teacher's methods, since the present study suggests that the teachers "cover" the topics, and yet many learners have not learned (or retained) the material covered.

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APPENDIXES

APPENDIX A

ARITHMETIC OPERATIONS INCLUDED IN THE MAJOR MATHEMATICS TEXTBOOKS USED IN THIS STUDY*

Preoperational activities

1. Recognition of numbers 1-10
2. Recognition of numbers 11-20
3. Recognition of numbers 21-100
4. Write numerals 1-100

Addition of whole numbers

1. Two one-digit numbers with sum of 12 or less
2. Two one-digit numbers with sums greater than 12
3. Two one-digit numbers with no regrouping
4. Three one-digit numbers with no regrouping
5. Zero as an addend
6. Two two-digit numbers with regrouping
7. Two three-digit numbers with no regrouping

* L. C. Bolster et al., Mathematics Around Us (Glenview: Scott Foresman, 1975).

* Eugene D. Nichols et al., Holt School Mathematics (New York: Holt, Rinehard and Winston, 1974).

* Tina Thoburn et al., Macmillan Mathematics (New York: Macmillan, 1976).

* Richard A. Denholm et al., Mathematics for Individual Achievement (New York: Houghton Mifflin, 1975).

8. Two one-digit numbers with regrouping
9. Two two-digit numbers with regrouping
10. Three two-digit numbers with regrouping
11. Two three-digit numbers with regrouping
12. Three three-digit numbers with regrouping
13. Two four-digit numbers with regrouping
14. Three four-digit numbers with regrouping
15. Four four-digit numbers with regrouping
16. Four five-digit numbers with regrouping
17. Two six-digit numbers with regrouping
18. Three or more one, two, or three-digit numbers in
a horizontal format with no regrouping
19. Three or more one, two, or three digit numbers
with regrouping

Subtraction of whole numbers

1. Two one-digit numbers
2. Two two-digit numbers
3. Zero as a subtrahend
4. Two three-digit numbers without borrowing
5. Two two-digit numbers with borrowing
6. Two three-digit numbers with borrowing
7. Two four-digit numbers with borrowing
8. Two five-digit numbers with borrowing

Multiplication of whole numbers

1. Products through 18
2. Products through 36
3. Products through 81
4. One-digit number times a two-digit number
5. Two-digit number times a two-digit number
6. One-digit number times a three-digit number
7. Three-digit number times a three-digit number
8. Four-digit number times a four-digit number
9. Four-digit number times a five-digit number

Division of whole numbers

1. Dividends through 36
2. Dividends through 81
3. One-digit divisor and one-digit dividend with no remainder
4. One-digit divisor and two-digit dividend with no remainder
5. Two-digit divisor and two-digit dividend with no remainder
6. Two-digit divisor and three-digit dividend with no remainder
7. One-digit divisor and one-digit dividend with a remainder
8. One-digit divisor and two-digit dividend with a remainder

9. One-digit divisor and three-digit dividend with a remainder
10. One-digit divisor and four-digit dividend with a remainder
11. One digit divisor and five-digit dividend with a remainder
12. Two-digit divisor and two-digit dividend with a remainder
13. Two-digit divisor and three-digit dividend with a remainder
14. Two-digit divisor and four-digit dividend with a remainder
15. Two-digit divisor and five-digit dividend with a remainder
16. Three-digit divisor and five-digit dividend with a remainder
17. Three-digit divisor and six-digit dividend with a remainder

Fractions

1. Expressing fractions in simplest terms
2. Changing improper fractions into mixed numbers
3. Changing mixed numbers into improper fractions
4. Finding least common denominators

5. Arranging fractions in ascending or descending order

Addition of fractions

1. Two fractions with like denominators
2. Three fractions with like denominators
3. Four fractions with like denominators
4. Two fractions with unlike denominators
5. Three fractions with unlike denominators
6. Four fractions with unlike denominators
7. Two mixed numbers with common denominators and no regrouping
8. Two mixed numbers with unlike denominators and no regrouping
9. Two mixed numbers with like denominators and regrouping
10. Two mixed numbers with unlike denominators and regrouping
11. Three mixed numbers with like denominators and regrouping
12. Three mixed numbers with unlike denominators

Subtraction of fractions

1. Fractions with like denominators with no regrouping

2. Fractions with unlike denominators and no regrouping
3. Fractions with like denominators and regrouping
4. Fractions with unlike denominators and regrouping
5. Fractions from mixed number with no regrouping
6. Mixed numbers with like denominators and no regrouping
7. Mixed numbers with like denominators and regrouping

Multiplication of fractions

1. Two fractions
2. A fraction and a mixed number
3. Two mixed numbers
4. A whole number and a fraction

Division of fractions

1. A fraction by a fraction
2. A fraction by a whole number
3. A whole number by a fraction
4. A mixed number by a mixed number

Decimals

1. Addition of decimals
2. Subtraction of decimals

3. Multiplication of decimals
4. Division of decimals
5. Changing decimals to percents
6. Changing percents to decimals
7. Changing decimals to fractions
8. Changing fractions to decimals

Miscellaneous topics

1. Telling time
2. Money
3. Standard measurements
4. Roman numerals
5. Counting by 2's, 5's, and 10's
6. Square root
7. Recognition of number words
8. Spelling of number words
9. Metric measurements
10. Read and interpret tables, maps, graphs, and charts
11. Compute compound interest
12. Solve simple interest, percent, and ratio problems
13. Solve word problems involving any of the four operations (addition, subtraction, multiplication, and division)

14. Multiply decimal fraction by decimal number
15. Divide decimal number by whole number
16. Customary units of measurement--equivalency
17. Place value
18. Decimal fraction to percent
19. Percent of a number
20. Decimal equivalency
21. Equivalent fractions
22. Rounding off numbers
23. Metric equivalency
24. Measure of temperature
25. Recognition of mathematical symbols: (-)
minus, (+) plus, (=) equal, greater than (>),
less than (<), division ($\div$), and multiplication
($\times$)
26. Ordinal numbers
27. Simple two step word problems including those
with whole numbers, fractions, or decimals

APPENDIX B

ARITHMETIC OPERATIONS CONTAINED IN THE CURRICULUM GUIDES USED FOR THIS STUDY*

Preoperational activities

1. Count objects 1-10
2. Count by rote 1-10
3. Identify numerals 0-10
4. Identify coins: penny, nickel, dime, quarter
5. Count, say, and write the numbers to 100
6. Identify number words zero through ten

Addition of whole numbers

1. Add one-digit numbers with sums of less than 10
2. Add two-digit numbers with sums of less than 100 (with and without regrouping)
3. Add numbers up to three digits (with or without regrouping)

*Manchester City Schools, "Curriculum Guide for Mathematics Grades K-9," Manchester, Tennessee, 1978.

*Sweetwater City Schools, "Mathematics Curriculum Guide Grades K-9," Sweetwater, Tennessee, 1978.

*DeKalb County Schools, "Pupil Expectations for Mathematics Grades K-12," Smithville, Tennessee, 1977.

4. Add four-digit numbers (with or without regrouping)
5. Solve simple one-step word problems using addition
6. Add up to six-digit numbers (with regrouping)
7. Add using any whole numbers

Subtraction of whole numbers

1. Subtract one-digit numbers (with no regrouping)
2. Subtract two-digit numbers (with no regrouping)
3. Subtract multiples of 10, up to 100
4. Subtract three-digit numbers (with or without regrouping)
5. Subtract four-digit numbers (with or without regrouping)
6. Solve simple one-step word problems using subtraction
7. Subtract six-digit numbers (with regrouping)
8. Subtract using any whole numbers

Multiplication of whole numbers

1. Know one-digit multiplication facts
2. Know multiplication facts through 6's
3. Multiply one-digit number by a two-digit number (with or without regrouping)

4. Multiply one-digit number by a three-digit number (with or without regrouping)
5. Know multiplication facts through 9's
6. Multiply any whole number by a one-digit number
7. Multiply any whole number by a two-digit number
8. multiply a three-digit number by a three-digit number
9. Multiply any whole number by a three-digit number

Division of whole numbers

1. Know division facts through 6's
2. Divide one-digit number into one-digit number (with or without remainder)
3. Divide one-digit number into two-digit number (with or without remainder)
4. Divide any whole number by a one-digit number
5. Divide any whole number by a two-digit number
6. Divide three-digit dividend by two-digit divisor
7. Divide four-digit dividend by two-digit divisor

8. Divide any whole number by a three-digit number

Fractions

1. Say and write the fraction associated with marked parts of a region
2. Know fraction terms: numerator, denominator, proper, improper, mixed
3. Arrange fractions of like denominators in ascending or descending order
4. Reduce fractions
5. Change improper fractions to mixed numbers
6. Change mixed numbers to improper fractions

Addition of fractions

1. Add two fractions with like denominators
2. Add two or more fractions with unlike denominators
3. Add two or more fractions and mixed numbers with like or unlike denominators
4. Add two or more mixed numbers with like or unlike denominators

Subtraction of fractions

1. Subtract two fractions with like denominators
2. Subtract two fractions with unlike denominators

3. Subtract using fractions and mixed numbers with like or unlike denominators

Multiplication of fractions

1. Two fractions
2. A fraction and a mixed number
3. Two mixed numbers
4. A whole number and a fraction

Division of fractions

1. A fraction by a fraction
2. A fraction by a whole number
3. A whole number by a fraction
4. A mixed number by a mixed number
5. A mixed number by a whole number

Decimals

1. Addition of decimals
2. Subtraction of decimals
3. Multiplication of decimals
4. Division of decimals
5. Arranging decimals in ascending or descending order
6. Changing decimals to percents
7. Changing percents to decimals
8. Changing decimals to fractions
9. Changing fractions to decimals

Miscellaneous topics

1. Using zero in addition, subtraction, multiplication, and division
2. Telling time
3. Standard measurements
4. Metric measurements
5. Roman numerals
6. Counting by 2's, 5's, and 10's
7. Square root
8. Read and interpret tables, maps, graphs, and charts
9. Solve simple interest, percent, and ratio problems
10. Compute compound interest
11. Solve word problems involving any of the four operations (addition, subtraction, multiplication, and division)

APPENDIX C

ARITHMETIC OPERATIONS INCLUDED IN THE LIST OF STUDENT EXPECTATIONS IN THE BASIC SKILLS FOR KINDERGARTEN THROUGH THE SIXTH GRADE*

Grade one

1. Count and write by 1's, 5's, and 10's to 100
2. Recognize numerals 0-100
3. Show which of two numbers, 0-50, is less or greater
4. Identify the following coins: penny, nickel, dime, quarter, half-dollar
5. Tell time to the hour, using a standard clock
6. Recognize a thermometer as an instrument for measuring temperature
7. Recognize and use symbols -, +, = (minus, plus, equal)
8. Show which of ten objects is first, second, . . . tenth
9. Recognize place value for 1's, 10's, and 100's

*"Student Expectations in the Basic Skills K-6, Mathematics," Tennessee Teacher 46 (January 1979): 20.

10. Recognize the following mathematical terms:
add, subtract, longer, shorter, more than,
less than, equal, largest, smallest, before,
between, after
11. Identify $\frac{1}{2}$, $\frac{1}{4}$, of a region, if whole is
shown
12. The use of zero in addition and subtraction
13. Recall basic addition and subtraction facts
with sums and differences 10 or less
14. Add and subtract multiples of 10, up to 100
15. Use a ruler to measure a line segment to
the nearest whole unit (standard or metric)

Grade two

1. Count, recognize, and write to 100, by 2's
5's, or 10's
2. Count and write to 200 by 1's
3. Show which of two whole numbers is less than
or greater than through the hundred's place
4. Identify the following coins: penny, nickel,
dime, quarter, half-dollar, and dollar
5. Tell time to the half-hour on a standard
clock
6. Count money to the dollar using coins of
equal value
7. Match number words to numerals up to 20

8. Demonstrate an understanding of mathematical terms and symbols: equal ($=$), add ($+$), subtract ($-$), greater than ($>$), less than ($<$)
9. Identify fractional parts if the whole is shown ($\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{2}{3}$, $\frac{3}{4}$)
10. Demonstrate recall of basic addition and subtraction facts up to the sum of 18
11. Add three one-digit numbers with or without regrouping
12. Subtract two-digit numbers without regrouping
13. Read and write ordinals first to tenth
14. Solve simple one-step oral and written subtraction word problems without regrouping
15. Solve simple one-step oral and written addition word problems with or without regrouping
16. Identify odd or even numbers from numbers randomly selected from 1 through 20

Grade three

1. Count by 2's, 3's, 5's, 10's up to 100
2. Tell time by the hour, half-hour, quarter-hour, and minute
3. Read and write money amounts using dollar symbol, decimal notation, and cent symbol

4. Read and write word names for two-digit numerals to 100
5. Identify and use the symbols $+$, $-$, $=$, $\div$, $\times$, $>$, and $<$
6. Identify place value in a three-digit numeral
7. Identify and write common fractions: halves, thirds, and fourths
8. Recall all basic addition and subtraction facts
9. Add three-digit numbers with or without regrouping
10. Subtract three-digit numbers with or without regrouping
11. Recall multiplication tables through fives
12. Multiply a two-digit number by a one-digit number with or without regrouping
13. Use division facts through 45
14. Count by ordinals to twenty-fifth
15. Solve simple one-step word problems using addition, subtraction, multiplication, or division
16. Read and write Roman numerals through XII
17. Read simple graphs
18. Round numbers to nearest ten and hundred
19. Identify any even and odd numbers to 50

Grade four

1. Tell and record time
2. Count, read, and write numerals through 100,000 in standard form and word names through 1,000
3. Identify place value of each digit in a three and four-digit numeral
4. Add four-digit numbers with regrouping
5. Subtract three-digit numbers with regrouping
6. Recall from memory multiplication and division facts through nine
7. Multiply a three-digit multiplicand by one and two-digit multiplier with and without regrouping
8. Divide two and three-digit dividends by one-digit divisor with a remainder
9. Write ordinals to twenty-fifth
10. Solve word problems using addition, subtraction, multiplication, or division
11. Recognize the Roman numeral symbols: I, V, X, L, C
12. Add and subtract fractions with like denominators
13. Interpret simple charts, graphs, and tables
14. Round to the nearest tens and hundreds

Grade five

1. Read and write numerals through 100,000
2. Solve addition, subtraction, multiplication, and division problems involving monetary units
3. Identify place value up to seven-digit numerals
4. Add a column of five-digit whole numbers with regrouping
5. Subtract four-digit whole numbers with regrouping
6. Apply the basic facts of multiplication and division when dividing or multiplying
7. Multiply two and three-digit multiplicand by two and three-digit multiplier
8. Divide three and four-digit dividends by two-digit divisor
9. Recall the multiplication facts through 12
10. Solve two-step word problems using addition, subtraction, multiplication, or division
11. Read simple word problems including those with whole numbers, fractions, or decimals; decide which operation to utilize; and calculate the answer
12. Recognize, read, and write Roman numerals to 500

13. Arrange fractions of like denominators in ascending or descending order
14. Add, subtract, multiply, and divide fractions with like denominators, simplifying answers
15. Change fractions, with terms divisible by 2, 3, or 4, to simplest form
16. Add and subtract mixed numbers
17. Change improper fractions to mixed numbers and the reverse, reducing fractions to lowest terms
18. Add and subtract using decimals, dollar and cent symbols correctly
19. Find common denominators
20. Interpret simple charts, graphs, and tables
21. Find equivalent fractions
22. Identify even and odd numbers
23. Round off three and four-digit numerals to the nearest tens, hundreds and thousands, and use to estimate sums and differences

Grade six

1. Read and write numerals through 1,000,000
2. Add and subtract using any whole numbers
3. Multiply any whole number by a four-digit multiplier

4. Divide any whole number by a three-digit divisor
5. Read simple word problems, including whole numbers, fractions, or decimals, decide which operations to perform, estimate the answer, and calculate the answer
6. Recognize the Roman numeral symbols and be able to write them up to 2,000
7. Add, subtract, multiply, and divide using fractions or mixed numbers
8. Add, subtract, multiply, and divide decimal numbers
9. Multiply and divide using dollar and cent symbols correctly
10. Change proper fractions to decimals then to percent
11. Compute a given percent of a whole number
12. Multiply and divide mixed numbers
13. Add and subtract units of measurement using renaming (standard or metric)

APPENDIX D

ARITHMETIC OPERATIONS INCLUDED ON THE TENNESSEE EIGHTH GRADE BASIC SKILLS TEST FOR 1978*

1. Add four three-digit numbers with regrouping
2. Subtract two three-digit numbers in a horizontal format with regrouping
3. Multiply three-digit by a two-digit number with regrouping
4. Add three mixed numbers, unlike denominators with regrouping
5. Divide four-digit multiple of 100 by multiple of 10, no remainder
6. Subtract fraction from mixed number
7. Multiply mixed number by a fraction
8. Divide rational numbers
9. Add two or more decimal numbers, thousandths, with regrouping
10. Subtract two decimal numbers, with regrouping
11. Multiply decimal fraction by decimal number, hundredths
12. Divide decimal fraction by whole number

*Objectives-Referenced Bank of Items and Test (Monterey, California: McGraw Hill Inc., 1977).

13. Add measures
14. Subtract measures
15. Multiply measures
16. Divide measures
17. Place value, decimal
18. Order of decimal fraction
19. Decimal fraction to percent
20. Percent of a number

APPENDIX E

LETTER ADDRESSING SUPERINTENDENTS

April 9, 1979

John B. Jones
Superintendent of Ranger City Schools
233 East Main Street
Ranger, Tennessee 38765

Dear Mr. Jones:

I am conducting research for a doctoral dissertation concerning the arithmetic portion of the 1978 Tennessee State-Mandated Eighth Grade Basic Skills Test.

The purpose of this study is to identify discrepancies between (1) concepts included in major arithmetic books; (2) concepts included in local curriculum guides; (3) concepts teachers say they cover in grades one through eight in selected Tennessee school systems; and, (4) arithmetic concepts covered on the Tennessee State-Mandated Eighth Grade Basic Skills Test administered in the spring of 1978.

A testing program which will inevitably have a profound effect on the lives of so many people should be examined from every possible angle. The implications of this and similar studies could be useful to all those interested in providing the best education possible for our children.

Your system has been selected to represent smaller urban areas. The study will be of little value without your system's input.

If you allow me to include your system in this study, I will need the following: (1) the computer printout relative to your school system's overall performance for the area of mathematics on the basic skills test; and, (2) your system's curriculum guide for the area of mathematics for grades one through eight, if any.

All information will be kept confidential. Your system will be identified in the study only as a smaller urban area. No

attempt will be made to compare systems or test scores except as outlined by the enclosed proposal.

A summary of findings will be made available to participating systems upon request.

A stamped self-addressed envelope has been enclosed for your convenience in responding to my request for permission to include your system in this study.

Your cooperation will be greatly appreciated.

Thank you,

Ronald D. Hagan
Route One
Russellville, Tennessee 37860
586-4518

Enclosure

APPENDIX F

THE QUESTIONNAIRE

April 16, 1979

Dear Colleague:

I am conducting research for a doctoral dissertation concerning the arithmetic portion of the 1978 Tennessee State-Mandated Eighth Grade Basic Skills Test. The purpose of this study is to identify discrepancies between (1) concepts included in major arithmetic books; (2) concepts included in local curriculum guides; (3) concepts teachers say they cover in grades one through eight in selected Tennessee school systems; and (4) arithmetic concepts covered on the Tennessee State-Mandated Eighth Grade Basic Skills Test administered in the spring of 1978. I realize, that as a teacher, you are a very busy person; however, a testing program which will inevitably have a profound effect on the lives of so many people should be examined from every possible angle. The implications of this and similar studies could be useful to all those interested in providing the best education possible for our children. This questionnaire has been designed so that it may be folded, stapled together, and returned with no additional postage. Will you please take a few minutes to complete the questionnaire and drop it in the mail? Information from your questionnaire will be treated confidentially and combined with others so that no individual school will be identifiable in the reports. Your cooperation will be greatly appreciated.

Thank you,

Ronald D. Hagan

Fold here

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Attention:
Ronald D. Hagan

Fold here

A SURVEY OF ARITHMETIC CONCEPTS INCLUDED ON THE 1978 TENNESSEE STATE-MANDATED EIGHTH GRADE BASIC SKILLS TEST

1. Name of School _____
2. School _____ City _____
System _____
3. I teach _____ grade. I am certified to teach _____

Please place a check in the area for those concepts you feel you teach in the area of arithmetic.

	MARK HERE ↓		MARK HERE ↓
A. Pre operational activities		17. two six-digit numbers with regrouping	
1. recognition of numbers 1-10		18. three or more one, two, or three-digit numbers in a horizontal format with no regrouping	
2. recognition of numbers 11-20		19. three or more one, two, or three-digit numbers with regrouping	
3. recognition of numbers 21-100		C. Subtraction of whole numbers	
4. write numerals 1-100		1. two one-digit numbers	
5. recognition of common shapes		2. two two-digit numbers	
B. Addition of whole numbers		3. zero as a subtrahend	
1. two one-digit numbers with sum of 12 or less		4. two three-digit numbers without borrowing	
2. two one-digit numbers with sum greater than 12		5. two two-digit numbers with borrowing	
3. two one-digit numbers with no regrouping		6. two three-digit numbers with borrowing	
4. three one-digit numbers with no regrouping		7. two four-digit numbers with borrowing	
5. zero as an addend		8. two five-digit numbers with borrowing	
6. two two-digit numbers without regrouping		D. Multiplication of whole numbers	
7. two three-digit numbers with no regrouping		1. products through 18	
8. two one-digit numbers with regrouping		2. products through 36	
9. two two-digit numbers with regrouping		3. products through 81	
10. three two-digit numbers with regrouping		4. one-digit number times a two-digit number	
11. two three-digit numbers with regrouping		5. two-digit number times a two-digit number	
12. three three-digit numbers with regrouping		6. one-digit number times a three-digit number	
13. two four-digit numbers with regrouping		7. three-digit number times a three-digit number	
14. three four-digit numbers with regrouping		8. four-digit number times a four-digit number	
15. four four-digit numbers with regrouping		9. four-digit number times a five-digit number	
16. four five-digit numbers with regrouping		E. Division of whole numbers	
		1. dividends through 36	
		2. dividends through 81	

	MARK HERE ↓		MARK HERE ↓
3. one-digit divisor and one-digit dividend with no remainder		2. changing improper fractions into mixed numbers	
4. one-digit divisor and two-digit dividend with no remainder		3. changing mixed numbers into improper fractions	
5. two-digit divisor and two-digit dividend with no remainder		4. finding least common denominator	
6. two-digit divisor and three-digit dividend with no remainder		G. Addition of fractions	
7. one-digit divisor and one-digit dividend with a remainder		1. two fractions with like denominators	
8. one-digit divisor and two-digit dividend with a remainder		2. three fractions with like denominators	
9. one-digit divisor and three-digit dividend with a remainder		3. four fractions with like denominators	
10. one-digit divisor and four-digit dividend with a remainder		4. two fractions with unlike denominators	
11. one-digit divisor and five-digit dividend with a remainder		5. three fractions with unlike denominators	
12. two-digit divisor and two-digit dividend with a remainder		6. four fractions with unlike denominators	
13. two-digit divisor and three-digit dividend with a remainder		7. two mixed numbers with common denominators and no regrouping	
14. two-digit divisor and four-digit dividend with a remainder		8. two mixed numbers with unlike denominators and no regrouping	
15. two-digit divisor and five-digit dividend with a remainder		9. two mixed numbers with like denominators and regrouping	
16. three-digit divisor and five-digit dividend with a remainder		10. two mixed numbers with unlike denominators and regrouping	
17. three-digit divisor and six-digit dividend with a remainder		11. three mixed numbers with like denominators and regrouping	
F. Fractions		12. three mixed numbers with unlike denominators	
1. expressing fractions in simplest terms		H. Subtraction of fractions	
		1. fractions with like denominators and no regrouping	
		2. fractions with unlike denominators and no regrouping	
		3. fractions with like denominators and regrouping	

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	MARK HERE ↓		MARK HERE ↓
4. fractions with unlike denominators and regrouping		L. Miscellaneous topics	
5. fractions from mixed number with no regrouping		1. telling time	
6. mixed numbers with like denominators and no regrouping		2. money	
7. mixed numbers with like denominators and regrouping		3. standard measurements	
I. Multiplication of fractions		4. common shapes	
1. two fractions		5. Roman numerals	
2. a fraction and a mixed number		6. counting by 2's, 5's, and 10's	
3. two mixed numbers		7. square root	
4. a whole number and a fraction		8. recognition of number words	
J. Division of fractions		9. spelling of number words	
1. a fraction by a fraction		10. metric measurements	
2. a fraction by a whole number		11. finding area	
3. a whole number by a fraction		12. finding perimeter	
4. a mixed number by a fraction		13. finding circumference	
5. a fraction by a mixed number		14. finding volume	
6. a mixed number by a mixed number		15. read and interpret tables, maps, graphs, and charts	
K. Decimals		16. compute compound interest	
1. addition of decimals		17. solve simple interest, percent, and ratio problems	
2. subtraction of decimals		18. solve word problems involving any of the operations (addition, subtraction, multiplication, and division)	
3. multiplication of decimals		19. multiply decimal fraction by a decimal number	
4. division of decimals		20. divide decimal number by a whole number	
5. changing decimals to percents		21. customary units of measurement - equivalency	
6. changing percents to decimals		22. place value	
7. changing decimals to fractions		23. decimal fraction to percent	
8. changing fractions to decimals		24. percent of a number	
		25. decimal equivalency	
		26. equivalent fractions	
		27. rounding off numbers	
		28. metric equivalency	
		29. determining average	
		30. measure of temperature	
		31. recognition of mathematical symbols	
		32. ordinal numbers	
		33. simple two-step word problems including whole numbers, fractions, or decimals	

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APPENDIX G

LETTER ADDRESSING PRINCIPALS

April 9, 1979

Mr. Dave Sam
Principal of Davis Middle School
666 West View Street
Ranger, Tennessee 38765

Dear Mr. Sams:

I have contacted the superintendent of your system and have received permission to use your system in a research project for my doctoral dissertation.

This study will deal with the arithmetic portion of the Tennessee State-Mandated Eighth Grade Basic Skills Test.

The purpose of this study is to identify discrepancies between (1) concepts included in major arithmetic books; (2) concepts included in local curriculum guides; (3) concepts teachers say they cover in grades one through eight in selected Tennessee school systems; and, (4) arithmetic concepts covered on the Tennessee State-Mandated Eighth Grade Basic Skills Test administered in the spring of 1978.

I realize that you and your teachers are very busy at this time of year; however, will you please take a few minutes and distribute the enclosed checklists and cover letter to those teachers on your staff who are responsible for teaching mathematics.

Your cooperation will be greatly appreciated.

Thank you,

Ronald D. Hagan
Route One
Russellville, Tennessee 37860
586-4518

Enclosures

VITA

Ronald Dewight Hagan was born in New Orleans, Louisiana on April 6, 1945. He attended elementary schools in various parts of East Tennessee and was graduated from Sevier County High School in May 1963. The following September he entered Lee College in Cleveland, Tennessee. He left Lee College to enroll in the Southern Institute of Graphic Arts at Nashville, Tennessee in June 1964. In September 1964, he was employed by Victor Business Forms of Atlanta, Georgia as a linotype operator and proofreader.

He was drafted into the army in September 1965. After a two year tour of duty with one year in Vietnam, he entered Lincoln Memorial University, Harrogate, Tennessee, in September 1968 and received a Bachelor of Science degree in Elementary Education in December 1969. The following January, he entered East Tennessee State University, Johnson City, Tennessee and began study toward a Master of Arts degree with a major in Elementary Education. This degree was awarded in June 1971. While enrolled at East Tennessee State University, he was employed by the Morristown City School System.

In the summer of 1977, he entered the Graduate School of The University of Tennessee, Knoxville. He received the

Doctor of Education degree with a major in Curriculum and Instruction in August 1979.

The author is a member of the Morristown Education Association, East Tennessee Education Association, Tennessee Education Association, and National Education Association. He will continue his employment with the Morristown City School System, Morristown, Tennessee.

He is married to the former Linda McDaniel of Tazewell, Tennessee and has two sons, Ronald Dewayne and James Dewight.