1962

The Understanding and Application of the Arithmetical Vocabulary of326 Fifth and Sixth Grade Students

Mary Sharon Jakicic
Loyola University Chicago

THE UNDERSTANDING AND APPLICATION OF THE ARITHMETICAL VOCABULARY OF 326 FIFTH AND SIXTH GRADE STUDENTS

by

Sister Mary Sharon Jakicic, C.S.J.

A Thesis Submitted to the Faculty of the Graduate School of Loyola University in Partial Fulfillment of the Requirements for the Degree of Master of Arts

February

1962

LIFE

Sister Mary Sharon Jakicic, C.S.J., was born in Sharpsburg, Pennsylvania, November 9, 1930.

She was graduated from Nazareth Academy, La Grange Park, Illinois, June, 1949 and from St. Xavier College, Chicago, Illinois, June, 1954, with the degree of Bachelor of Science.

In 1954 she entered the Congregation of the Sisters of St. Joseph in La Grange Park, Illinois. She has been teaching in their schools since September, 1957. Graduate studies were begun at Loyola University in September, 1956.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF TABLES (continued)

LIST OF FIGURES

CHAPTER I

INTRODUCTION

As a child progresses in the acquisition of knowledge a broader field of learning is opened to him. As he matures he is able to arrive at an understanding of a greater number of concepts in the various subjects in which he is engaged. However the child at times is not able to progress as rapidly as he should. The technical terminology of a subject often handicaps the child in acquiring accurate and understandable concepts in a particular field. This is true of arithmetic especially in problem solving situations. Here the solution of the problem depends primarily upon the comprehension of the vocabulary used in stating the problem. An accurate understanding of arithmetical vocabulary is also important when reading directions in the arithmetic text. The child is unable to follow directions because he does not have the necessary understanding of the terminology used. Repetition of meaningless terms and symbols will not help to develop the necessary understanding of these terms. It usually creates within the child a great dislike for arithmetic.

This thesis was undertaken to determine the arithmetical vocabulary known by a group of fifth and sixth grade students and their ability to solve problems using this terminology. Interest in this particular phase of arithmetic originated while teaching children at these levels. It was observed that some pupils were very adept at solving computational exercises if the directions for these exercises contained no technical terminology not understood by the child. These same students were not as efficiently able to perform the same operations when they appeared in a problem solving situation. Here the child was required to know the meaning of the vocabulary used in order to arrive at a correct solution. The question then arose as to the effect of technical terminology on the solution of problems using arithmetical terms. Just how important are these terms and in what ways do they help or hinder a child in developing a meaningful understanding of arithmetic? This thesis is an attempt to find the answers to these questions; thus, the specific purposes of this thesis are first, to determine the students' understanding of technical terminology at their respective levels, second, to see if they are capable of applying isolated known vocabulary to a specific problem solving situation, and third, to make a comparison of those terms known by the fifth grade students in relation to those known by the sixth grade students.

Preliminary investigations of previous works concerning arithmetical vocabulary and its relation to problem solving were undertaken. To secure a general picture of the materials relative to vocabulary and arithmetic, the early authorities in the field as well as those of the present day were consulted. Topics pertinent to the place of vocabulary, reading and vocabulary, and methods of evaluation of vocabulary were examined.

Research concerning arithmetical vocabulary can be traced through the past three decades. Unlike the technical terminology used in other subjects, arithmetical vocabulary has not been made an important and functional aspect of mathematics.

The child, during his school years, has many mathematical concepts to learn. If these concepts are developed and presented in the proper manner the child will soon realize that the concepts can not only be known but also understood. Since words are necessary to express our ideas and to understand the ideas of another person, it is evident that the child, from his earliest contacts with arithmetic and its terminology, should be able to understand those terms presented by the teacher. Learning involves not only the meanings of many concepts but also the ability to arrive at an understanding of when, how and why these various functions operate. Brueckner[1] believes that understanding is a more significant concept than meaning as it indicates the satisfaction that accompanies learning. The understanding to be acquired is that of a technical and social nature. The technical phase refers to the

---

[1]Leo J. Brueckner, Improving the Arithmetic Program (New York, 1954), p. 45.

purely mathematical understandings which include understanding the technical vocabulary; understanding the number operations and their functions in social situations; understanding why numbers operate as they do in the fundamental processes and understanding the principles and relationships between numbers, their operations and their use.

Arithmetical vocabulary, like the vocabulary of other subjects, should be first presented in its arithmetical context. According to Klapper[2] the definition of a term should never be presented until after the lesson has been comprehended by the child. Even then, the definition is not to be given verbatim by the teacher. Through class discussion the teacher is to secure the important parts of the definition, which will, at the same time give proof of the pupils' comprehension. Following this, the teacher may then alter the language of the definition and put it in its correct grammatical form. Memorization of a definition is no indication of understanding and the ability to apply the definition in a problem solving situation. Noting the inaccuracy of terms often used in arithmetic and the substitution of words and phrases for specific terms, Boyer, Brumfield, and Higgins state:

> Many of the definitions of concepts which have been formulated during the last century cannot be presented formally in the classroom. Consequently, a large

---

[2]Paul Klapper, The Teaching of Arithmetic: A Manual for Teachers (New York, 1921), pp. 99-100.

> vocabulary of helping words and phrases has been developed for pedagogical purposes. We must not forget, however, that the existence of this terminology can be justified only because it enables the student to show growth in dealing with quantities. . . . Many useless words have crept into arithmetic vocabulary and some words are used incorrectly.[3]

Smith,[4] in 1935, stated that the language of arithmetic is often not the language used in everyday life. A child does not say "Subtract what I have paid and I will give you the remainder or difference." More likely he would say "Deduct what I have paid and I will give you the rest." One of the terms given as an example by Smith is the word dividend. This term has an entirely different meaning when used in school referring to the process of division, and outside of school when it refers to the profits of a stockholder. Other terms similar to this came into arithmetic at the time it was taught by memorization of rules with little emphasis on the understanding of these rules and their application. Since this method of teaching is no longer used, Smith sees little practical value in retaining this terminology.

At a later date, Brune[5] notes that the language can either

---

[3]Lee Boyer, Chas. Brumfield, and Wm. Higgins, "Definitions in Arithmetic," Instruction in Arithmetic, The Twenty-fifth Yearbook of the National Council of Teachers of Mathematics (Washington, D. C., 1960), pp. 249-250.

[4]David Eugene Smith, "Retrospect, Introspect, Prospect," The Teaching of Arithmetic, The Tenth Yearbook of the National Council of Teachers of Mathematics (New York, 1935), pp. 203-204, 206-207.

[5]Irvin H. Brune, "Language in Mathematics," The Learning of Mathematics: Its Theory and Practice, The Twenty-first Yearbook of the National Council of Teachers of Mathematics (Washington, D. C., 1953), pp. 156, 183-185.

hinder or be a help to the learning process. The manner in which language is used may produce a clear, easily understood concept or it may only confuse and frustrate the child, aiding in the development of an erroneous concept. Learning words without an accompanying experience is a hindrance to thinking. The vocabulary used by a person generally suggests his intelligence and is a reflection of his intellectual achievements. Verbalisms can be found abundantly in the vocabulary of arithmetic. One needs only to reflect on the days when he heard such often used expressions as "Invert the divisor and multiply," "Cancel," "Reduce to lowest terms," "Add the number of places in the multiplicand to the number of places in the multiplier," and then recall the absence of meaning and understanding these phrases had. The processes of arithmetic become mechanical with little or no understanding behind them.

Boyer, Brumfield, and Higgins[6] cite the following characteristics for good elementary arithmetical definitions.

1. A definition should contain words already defined or sufficiently simple so as to be accepted as undefined.

2. The definition will usually be descriptive, i.e., correct but not necessarily complete. The child should be given as much of the definition as he is capable of accurately understanding at this specific time.

3. Finally the definition must be useful. This is the most important of the criteria because definitions are the mathematicians tools used in attacking problems.

---

[6]Boyer, Brumfield, and Higgins, p. 251.

Research undertaken by Brownell[7] brought out the necessity of presenting arithmetic as a system of related ideas in which the child must perceive a need for learning these concepts and have the necessary concrete experiences in order to develop them. Often, as long as the clues are present in a problem the child will respond automatically. Take his cue away or reword the problem and frustration arises followed by inability to solve the same problem which before caused him little or no difficulty. Endless drilling on each fundamental process does not insure understanding and comprehension of the process.

Several reasons are given by Brownell[8] for teaching meanings in arithmetic. Arithmetic is no longer looked upon as a tool subject. Emphasis is placed upon the why in problem solving as well as how to solve it. Meaningful arithmetic is retained for a greater period of time and can be recalled more easily. Transfer of learning is more likely to occur when the subject matter is easily understood.

Drake[9] has divided arithmetical vocabulary into specific classifications. Technical vocabulary which is related directly to the field of mathematics and functional vocabulary which

---

[7] Wm. A. Brownell, "When Is Arithmetic Meaningful?" Journal of Educational Research, XXXVIII (March 1945), 482-484.

[8] Ibid., 494.

[9] Richard M. Drake, "Vocabulary Instruction in Mathematics," Mathematics Teacher, XXXII (April 1939), 167.

though mathematical in nature functions outside the field of mathematics. Other common divisions used are technical and semi-technical terms or technical and social terms stressing those having a purely mathematical connotation and those used outside the field of mathematics as well. There is no definite set pattern of classifying the vocabulary of arithmetic.

Some of the language difficulties believed to cause the pupil trouble are those cited by Morton.[10]

1. Technical vocabulary is often introduced before the child is mature enough to comprehend it. These terms, after being presented, are not used frequently enough to provide retention.

2. Many unnecessary terms and phrases are used without an explanation on the part of the teacher.

3. Terms may often be explained correctly but the language used in giving the explanation is above the level of the learner.

4. The explanations of terms are often vague and not adequate to allow comprehension.

5. Familiar words and expressions are often used in an unfamiliar way.

6. Explanations which lead the learner to arrive at the wrong conclusion do not give him an understanding of the term in its relation to mathematics.

A study of mathematical vocabulary appearing in current periodical literature was made in 1941 by Bertotti.[11] In this

---

[10] R. L. Morton, "Language and Meaning in Arithmetic," Educational Research Bulletin, XXXIV (November 1955), 198-203.

[11] Joseph Bertotti, "The Mathematics of Current Periodical Literature," Mathematics Teacher, XXXIV (November 1941), 317-319.

study six consecutive issues of the Readers Digest were used. The issues were thoroughly read and all mathematical terms underlined. These were then rechecked by a second reader. A total of 3,130 mathematical terms were found in 340,185 running words. This total terminology was composed of 360 different terms which were then tabulated according to frequency. Seventy-five of the terms occurred more than ten times, with per cent, the most frequent term, occurring 184 times. From this list 285 terms were found to occur less than ten times. Bertotti concluded that an intelligible reading of current literature was impossible without an adequate knowledge of mathematical terminology.

Young[12] states that one out of every ten words in our language is found to be a mathematical term. Some of these terms, as addend, quotient, minuend, and subtrahend have meaning in school during the arithmetic period only. They have no practical application to the child's life and experiences outside of school hours. Other terminology is often treated in a superficial manner and does not produce understanding of terms. The number of technical terms should be kept to the lowest minimum possible. Those concepts taught should be developed to the point of understanding and meaningful use of the term should occur in future classes.

Not all pupils will respond to the learning of these terms

---

[12] Wm. E. Young, "Teaching Quantitative Language," Education Digest, XXII (January 1957), 47, 49.

at the same rate of speed. As in all other learning situations individual differences must be considered. The slow learner will need many more repetitions of the explanation regarding the same term than the bright or even the average child. Nevertheless, he must still be taught so as to understand as much of the terminology as his level of maturity permits.

When examining recently published texts in arithmetic, it will be noted that one of the objectives of present day arithmetic is to develop a meaningful vocabulary of useful technical terminology which specifies ideas and the relationship between them. Thus Alexander, seeing the need for such a vocabulary holds that "the responsibility of developing and improving the general and technical vocabularies that are associated with elementary mathematics lies in the hands of the teacher."[13]

As the teacher is responsible for developing the meaningful technical terminology of arithmetic, it must first be assumed that the teacher has a conscientious awareness of this terminology. The clear concise meaning of each term and its application to the arithmetical processes should be a part of every teacher's background before he attempts to develop its understanding in others. In a report of a study by Gorman in 1938, it was found that twenty-five per cent of the teachers or prospective teachers failed to

---

[13]Burton F. Alexander, "Language Development in Mathematics through Vocabularies," Mathematics Teacher, XL (December 1947), 389.

pass an arithmetic vocabulary test. There was a significant difference between the vocabulary known by teachers and the vocabulary known by the prospective teachers. Gorman advocated the teaching of technical vocabulary to prospective teachers, especially those terms concerned with the fundamental operations of whole numbers, the vocabulary of common and decimal fractions, terms related to units of measurement and large numbers, both Arabic and Roman.[14] He also found a definite lack of knowledge in signs and in the abbreviations of terms.

Another aspect of vocabulary which the teacher must consider is the method of presenting terminology. In trying to explain a term, the teacher must be aware of using superfluous words which might lead the learner to the wrong conclusion and develop misunderstanding rather than meaningful comprehension of the term. McSwain and Cooke[15] caution the teacher in substituting what he believes to be simpler terminology for the abstract term which should be taught. Neither should the teacher alter the term in any way because of difficulty in accurate spelling. Spelling of a term should be demanded in relationship to the ability of the

---

[14]Frank H. Gorman, "The Arithmetic Vocabulary of the Elementary School Teacher," Elementary School Journal, XXXVIII (January 1938), 378-379.

[15]E. T. McSwain and Ralph J. Cooke, Understanding and Teaching Arithmetic in the Elementary School (New York, 1958), p. 314.

child. Clark and Eads[16] believe that mathematical terminology should be used only after other more comprehensible terms have been used and understood by the pupil. Even then these terms should not be dropped in favor of the mathematical terms but should still be used along with the technical terms.

Methods of teaching arithmetical vocabulary have changed during the last three decades. Pupils are no longer mere passive listeners and the teacher the imparter of each minute detail of arithmetic. The trend is in the direction of guiding and motivating the child to think and discover the meanings of the terminology and its practical application to a given problem solving situation. By giving the child less verbal help the teacher is, in reality, helping the pupil to use and develop his powers of reasoning.

Koenker[17] applies the fundamental principles of learning to the acquisition of mathematical skills. These principles he states as follows:

1. Learning should be organized and meaningful. Our number system logically organized is based on some value of the power of ten.

2. Learning should be logical. The structure of our number system is such that it will develop understandings that cannot be attained by drill alone.

---

[16] John R. Clark and Laura K. Eads, Guiding Arithmetic Learning (New York, 1954), p. 81.

[17] Robert H. Koenker, "Psychology Applied to the Teaching of Arithmetic," Arithmetic Teacher, V (November 1958), 261-264.

3. Learning should develop gradually from the concrete to the abstract. The child first needs concrete familiar experiences before he can be expected to comprehend the abstract.

4. Learning is intensified and becomes more permanent when the pupil is guided to discover meanings for himself.

5. Learnings should be connected with one another. The processes of adding and subtracting should be carried through to division and decimals as well.

6. Learning should proceed from the whole to the individual parts. This follows the Gestalt theory of learning.

7. Drill will best serve its purpose when it follows meaningful learning rather than preceding it.

8. Learning must be systematically presented in an organized program.

9. The goals of learning should be made known to and understood by the pupils.

10. Motivation is necessary in order to have the child form a favorable attitude toward the learning situation.

Teaching arithmetic vocabulary to insure comprehension and understanding is the problem of the individual teacher. The methods, techniques, and devices used will differ with the teacher according to the ability and maturity level of the members of his class. Alexander[18] believes that the teacher has certain obligations concerning instruction in arithmetical terminology. He must realize the important role reading plays in solving arithmetic problems. The growth of an arithmetical vocabulary is something real although it is a slow gradual process. Here the teacher must be aware that children tend to use terms with some

---

[18]Alexander, p. 389.

degree of accurateness but often without a real knowledge of their correct meanings. The growth of an arithmetical vocabulary is a reflection of the teacher's skill. It is his responsibility to set up the aims and functions for teaching vocabulary and to use the suitable methods and techniques to accomplish the desired objectives.

At the very beginning of his elementary school days a child encounters many different technical vocabularies. One of these which he is expected to develop and retain through the years is the vocabulary of arithmetic. Yet until recent years little emphasis has been placed upon helping the child acquire this specific knowledge. Growth in mathematical vocabulary, like any other learning process, should of necessity be a slow, gradual but meaningful growth.

Hollister and Gunderson[19] in discussing the vocabulary of children in the primary grades state that an accurate arithmetical vocabulary should be built from the very beginning of grammar school days. At this level terms should be used in context so as to develop the correct understanding of the term as it applies to arithmetic. Kerfoot[20] reminds the primary teacher that the

---

[19] George E. Hollister and Agnes C. Gunderson, Teaching Arithmetic in Grades 1 and 2 (Boston, 1954), pp. 99-100.

[20] James F. Kerfoot, "Vocabulary in Primary Arithmetic Texts," The Reading Teacher, XIV (January 1961), 177-178.

vocabulary used in arithmetic has not been introduced in the reading class. Therefore it is the duty of the teacher to provide the necessary instruction for the arithmetical vocabulary. This instruction should lead to the development of the reading vocabulary as well as the building of arithmetical concepts. New terminology should be introduced as the child progresses and is ready to undertake the meanings of new terms. A child is not ready to continue on to a new learning experience simply because the teacher has presented a term the previous day. Concrete learning experiences and continued repetition until the child grasps the meaning of the term in its abstract form are essential. The amount of time spent on vocabulary development varies according to the experiential background of the members of the class.

A study was undertaken by Chase[21] concerning the words used in arithmetic textbooks. It was concluded that the words often used in these books are not found in other fields of learning. Problems often presented conditions not true to life. They use vocabulary not suited to the pupil's experiences and often not even known by the pupil. Fifteen years later Pressey and Moore,[22]

---

[21]Sara E. Chase, "Waste in Arithmetic," Teachers College Record, XVIII (September 1917), 370.

[22]L. C. Pressey and W. S. Moore, "The Growth of Mathematical Vocabulary from the Third Grade through High School," School Review, XL (June 1932), 452.

as a result of their investigation found that some terms were learned at an early age and were retained. Others were learned in the grade where they were taught and were then forgotten. Still others were acquired gradually at various levels while some terms were never mastered. The test used consisted of 106 technical terms. Of these terms eighty-nine were never mastered by more than fifty per cent of the pupils and only thirty-six were mastered by ninety-five per cent of those tested.

Buswell and John[23] from their research found that pupils in the same grade level differ in the size of their arithmetical vocabulary. Growth in the terminology is not at a standard rate for all children in grades four to six. It was also noted that the ability to respond correctly on one type of test does not indicate complete comprehension of the term.

An increase in the knowledge of technical vocabulary can be brought about only by training and concentration on the terms when presenting them to the class. Dresher[24] says that training helps to understand concrete problems. Failure to understand the terminology indicates failure to comprehend the ideas represented by the terms which must necessarily lead to failure in applying the correct solution to the problem.

23Guy T. Buswell and Lenore John, The Vocabulary of Arithmetic (Chicago, 1931), p. 41.

24Richard Dresher, "Training in Mathematics Vocabulary," Educational Research Bulletin, XIII (November 1934), 203.

The teacher often assumes the child understands more of the vocabulary than he actually does. In solving reasoning problems, unfamiliar terminology and irrelevant data lead to confusion and lack of comprehension by the learner. Pressey and Elam referring to the relationship of problem solving and vocabulary "are convinced that one outstanding source of error in arithmetic problems and of antagonisms toward arithmetic lies in the fact that children do not know what the words mean. Most investigations of the matter seem to show that knowledge of subject matter and mastery of technical vocabulary go hand in hand."[25]

Many sources of difficulty arise in arithmetic which are based on the child's inability to read and understand the concepts used in the problem. A slow learner in fifth or sixth grade, with poor reading ability and limited intellectual powers, will by the very nature of this disability be unable to solve a problem at that level. Therefore he should not be expected to solve the same problems as normal fifth and sixth graders but should be given those suited to his ability. In order to attain some feeling of success, easier problems should first be given to the slow learner and then gradually he should be led to attempt the more difficult problems. An immature child, according to Clark and Eads,[26] attempting to solve a problem beyond his capabilities will

---

[25] L. C. Pressey and M. K. Elam, "The Fundamental Vocabulary of Elementary School Arithmetic," Elementary School Journal, XXXIII (September 1932), p. 50.

[26] Clark and Eads, p. 261.

invent his own method in order to have the feeling of success. Since he cannot comprehend the necessary relationships he will tend to ignore the words either because he cannot read them or they make no sense to him. He will then be concerned with the numbers only. His decision to add, subtract, multiply or divide will be determined by the way the numbers look to him.

Reading involves the understanding of words used in expressing another's ideas. It is of major importance in problem solving situations. If the learner finds the words unfamiliar he is already handicapped in arriving at the correct solution. Should these terms be of vital importance to the accurate solving of the problem there is little hope for a correct solution.

Brueckner[27] lists the following reading abilities as essential for the development of an effective arithmetic program.

1. The ability to read numbers and comprehend their meaning.
2. Reading involved in learning numbers and their operations.
3. Knowledge of arithmetic vocabulary.
    a. technical terms
    b. units of measure and their abbreviations
    c. quantitative vocabulary used in social applications
4. Reading skills necessary for reading and solving textbook problems.
5. Ability to interpret charts, graphs, maps, and tables.
6. Skills needed to acquire information in studying the social aspects of arithmetic.

---

[27]Brueckner, pp. 52-57.

Emphasis has been placed primarily on computational skills. Instruction in specific reading skills so necessary to the study of arithmetic has been neglected. There is a need for greater integration between reading and arithmetic.

According to Grossnickle and Brueckner[28] the various ideas conveyed by the arithmetical vocabulary are a contributing factor to the reading difficulties of the problems. Words normal to a fourth grade child's vocabulary appearing in the first twenty-five hundred words of the Thorndike Word List can often cause difficulty in reading and comprehension. "The square of the sum of two numbers is equal to the square of the first number added to twice the product of the first and second number, added to the square of the second number."[29] While a fourth grade child would probably know all of these words in isolation or in his reader, when used in this mathematical context, they have no meaning and he is incapable of comprehending the ideas these words are trying to convey.

Brink[30] notes that almost every page of an arithmetic textbook contains some technical terminology. If a teacher is to

---

[28]Foster E. Grossnickle and Leo J. Brueckner, Discovering Meanings in Arithmetic (Philadelphia, 1959), p. 325.

[29]William E. Young, "The Language Aspects of Arithmetic," School Science and Mathematics, LVII (March 1957), 172.

[30]William G. Brink, Directing Study Activities in Secondary Schools (New York, 1937), pp. 525-526.

direct study skills he must be sure that the pupils can read intelligently the printed matter of the text. In arithmetic the learner needs skill in reading for details. Besides the understanding of the technical vocabulary so necessary to problem solving, common words are often used that have a mathematical connotation. Here the learner must be sure to know the exact meaning of the word used in its arithmetical context.

Johnson[31] made a study to determine the amount of improvement made in problem solving after specific instruction in arithmetic vocabulary. A comparatively homogeneous junior high school population was used. The testing was done as part of the regular arithmetic period. The actual experiment lasted for fourteen weeks and covered five chapters in the text agreed upon by the teachers. The experimental period was divided into three sections Each period was preceded and followed by vocabulary and problem solving tests. Emphasis was placed on the acquisition of vocabulary rather than computational skill. At the expiration of the fourteen weeks the experimental group was found to have made greater progress than the control group in vocabulary and problem solving. A test administered three months later still found the experimental group superior to the control group in the retention of knowledge. Johnson concluded from his study that training in

---

[31]Harry C. Johnson, "The Effect of Instruction in Mathematical Vocabulary upon Problem Solving in Arithmetic," Journal of Educational Research, XXXVIII (October 1944), 97-110.

arithmetical vocabulary should begin as soon as the formal study of arithmetic begins. Regular use of the terminology would insure retention of the knowledge gained.

Schorling[32] lists four steps in problem solving.

1. Sensing the problem. The child should be able to understand the circumstances under which the problem arises. He is more likely to understand the problem if it is reworded in his own vocabulary since technical vocabulary is not a part of his life.

2. Appraising the data. A problem solving situation should contain irrelevant data as well as necessary data. The learner should be able to select only necessary information involved in the solution of the problem.

3. Analyzing relations. A reasoning problem depends upon the ability to visualize the conditions of a problem, a knowledge of how to plan its solution, and the ability to judge the reasonableness of the answer.

4. Computation. The learner must have the ability to perform the actual computation once he has decided how to solve the problem.

Some practical principles given by Schorling for problem solving are to give special attention to the teaching of reading. Most difficulties in problem solving arise from inability to read or are due to a low intelligence. Often it is due to a combination of the two. Schorling advises the teacher not to rush the child into problem solving situations. The maturity and experiences of the learner will be great assets to the teacher. His third principle is to train the learner in the analysis of a problem. This series of steps is one type that can be used.

---

[32] Raleigh Schorling, The Teaching of Mathematics (Ann Arbor, 1936), pp. 109-115.

1. Read the problem carefully and know the meanings of all the words.
2. Decide what you are asked to find.
3. Note the given facts as well as those which are implied.
4. Make a decision as to the operation that should be used.
5. Estimate the answer.
6. Work the problem.

The pupil should be allowed to solve reasoning problems according to his own method not according to a fixed standard set up by the teacher. The slow learner will use a simpler method than the average or bright student.

Clark and Eads[33] identify a child as being ready for problem solving if he can find the solution readily and in more than one way. He should have an explanation as to why he used a particular method. Irrelevant data should not confuse him. Ability to talk about the problem and the circumstances under which it might occur as well as the ability to formulate problems of his own with similar situations are all indications of readiness for attacking problem solving situations with accuracy.

Brueckner[34] states that difficulties arising in problem solving stem from one or more reasons. These he believes to be low mental ability, limited environmental experiences, lack of reading ability, and poor methods of instruction.

---

[33]Clark and Eads, p. 262.

[34]Brueckner, p. 78.

A teacher interested in improving the arithmetical vocabulary of his students will use to the best possible advantage any concrete materials that are available. Grossnickle, Junge, and Metzner[35] state that these materials can include anything that will be a help to the learning process. The success of a meaningful arithmetic program depends upon the materials used as well as the methods of instruction. These materials should be objects that can be handled such as charts, pictures, diagrams, and other manipulative objects. Schubert[36] suggests games involving the use of terms such as building a list of words that are related to a basic term. Another idea that could be of valuable assistance is to let the brighter students help those who are having difficulties. Grossnickle and Brueckner[37] cite the use of community resources and field trips in helping the children see arithmetic in action as an important part of daily life. Measuring instruments and devices can be studied in relation to their use in industry. The background and history of arithmetic can be explored through the use of the library. To arouse the interests of students a special mathematics club can be formed to enrich their arithmetical experiences.

---

[35] Foster E. Grossnickle, Charlotte Junge, and William Metzner, "Instructional Materials for Teaching Arithmetic," The Teaching of Arithmetic, The Fiftieth Yearbook of the National Society for the Study of Education (Chicago, 1951), pp. 164-165.

[36] Delwyn G. Schubert, "Formulas for Better Reading in Mathematics," School Science and Mathematics, LV (november 1955), 651.

[37] Grossnickle and Brueckner, p. 367.

Various means of evaluating the learnings of arithmetic have been given by educators. Brownell[38] rates the paper and pencil test as the most common test used by teachers. He notes however, that this type of test measures isolated knowledge rather than knowledge under practical circumstances. Scores of such tests have a tendency to be misinterpreted. Morton[39] holds that tests often neglect to measure the more important aspects of arithmetic. The true and false type test when used in arithmetic usually measures the child's knowledge of facts. The multiple choice test while also testing factual knowledge gives the learner a choice from three or more possible answers which seem reasonable. The matching and completion tests are not widely used in arithmetic.

Paper and pencil tests are usually concerned with measuring computational skills and problem solving abilities. Other phases, such as an understanding of the number system, estimating answers and rounding numbers are ignored.

The standardized tests are considered superior to any type of teacher-made test used in arithmetic. The advantages and limitations of these tests are given by Morton.[40] Factors in

---

[38] William A. Brownell, "The Evaluation of Learning in Arithmetic," Arithmetic in General Education, The Sixteenth Yearbook of the National Council of Teachers of Mathematics (New York, 1941), pp. 265.

[39] Robert Lee Morton, Teaching Children Arithmetic (New York, 1953), pp. 519-520.

[40] Ibid., pp. 520-525.

favor of the standardized tests are the preparation of these tests by experts in the field of arithmetic; two or more equivalent forms of the test comparable in difficulty; class and individual ratings are given according to set norms and standards. While these tests have definite advantages they also have their limitations. They tend to test only computational and reasoning skills. With this fact in mind, teachers often drill only on these skills in order to prepare the pupils for the test. Other limitations are the emphasis placed on speed in these tests and items not yet taught are encountered by the learner.

The importance of diagnostic testing is stressed by Grossnickle and Brueckner[41] in order to find the individual pupil's weaknesses in arithmetic. These tests should be given at the end of each unit before beginning new material. This enables the teacher to correct any errors in the learner's comprehension of the subject matter before he attempts to acquire new knowledge. The use of the case study method can also be of valuable assistance to the teacher. Indicating where the child is making his errors and having him solve the problem orally gives the teacher some knowledge of the reasoning used by the child.

Sueltz[42] suggests a written test followed by an interview

---

[41]Grossnickle and Brueckner, pp. 384, 388.

[42]Ben A. Sueltz, "Measuring the Newer Aspects of Functional Arithmetic," Elementary School Journal, XLVII (February 1947), 326.

and discussion with the teacher as one valuable measure of learning in arithmetic.

Spitzer[43] recommends a variety of tests to be used in evaluating arithmetical learnings. Since many uses of arithmetic in daily life involve mental skills, the use of oral tests is suggested. Everyday arithmetic problems seldom require an exact answer, therefore problems should be given that ask for approximate answers only. The language of the textbook should not be used in testing. This is likely to test the child's memory of textbook language rather than comprehension of the actual concepts.

Alexander lists the following criteria to be taken into consideration when teaching the vocabulary of arithmetic to children.

1. "The language should be within the maturity, range, and understanding of all the pupils.

2. The language should be based upon the actual needs and life experiences.

3. The teacher must have complete knowledge of the language of mathematics and its varied applications.

4. The vocabulary should be selected in terms of the aims and content of the course of study in mathematics."[44]

---

[43]Herbert F. Spitzer, "Procedures and Techniques for Evaluating the Outcomes of Instruction in Arithmetic," Arithmetic 1948 (Chicago, 1948), pp. 18-20.

[44]Alexander, p. 390.

CHAPTER II

DETAILS OF THE RESEARCH

The testing program for this research was carried on in a large parochial school on the south side of Chicago. The school contains four classrooms of fifth grade students taught by lay teachers and four classrooms of sixth grade students taught by the Sisters. Each room, at the beginning of the school year, had been grouped homogeneously according to reading ability. There was a further grouping within each room into the basic group or those reading at grade level or above and the corrective group or those reading below grade level. Group A contained those children with the highest reading scores according to the Stanford Achievement Tests. These comprised the basic group. The corrective group was composed of the students having the highest scores among the children below grade level. Group B included the children with the next highest scores at both levels with Group C containing those children with the scores just below Group B. The lowest basic or grade level group and the lowest of the corrective or below grade level were placed in Group D. This same situation existed in both fifth and sixth grades. No rearrangement of this grouping was found to be necessary for the testing program. Tests were to be administered to all the children in each room regardless of ability or lack of ability to perform on the tests. Exception was made in the case of three fifth grade pupils who were absent at the time of the testing and were not able to return to school for several weeks. The 4 groups at the fifth grade level contained 163 children as did the 4 groups at the sixth grade level, making a combined population of 326 children used for testing purposes.

Several fifth and sixth grade arithmetic texts were examined. A study made of the terminology of these books was found to be similar to the vocabulary used in the series Growth in Arithmetic. This was the text used by the fifth and sixth grade children who participated in this research project.

A list of the arithmetical terminology used in the fifth and sixth grade books of this series was compiled. From this list seventy-eight terms were selected which appeared to occur frequently throughout the text. Terms and symbols pertaining to the fundamental processes, fractions, decimals, and units of measure were chosen. Terminology used in daily life was also included in the list of arithmetical vocabulary. Some of the terms were common to both fifth and sixth grade arithmetic, others were indicative of sixth grade arithmetic only. Seventy-five of these terms were to be used in construction Test I, a test of arithmetical vocabulary concerned with the definitions of the given terms. Twenty-two of these seventy-five terms and three additional terms were to be incorporated in Test II, a problem solving test involving the use of arithmetical terminology.

Table I, below, indicates the terms selected from the fifth and sixth grade test. These terms have been classified under terminology related to the fundamental processes, fractions, decimals, units of measure, counting measures, terminology used in daily life, terms relative to the measurement of figures, and five miscellaneous terms. The terms listed in the table include those used in both Test I and Test II.

TABLE I

ARITHMETICAL TERMINOLOGY

Fundamental processes	Fractions	Decimals
addend	mixed number	two places to the left
borrow	lowest terms	decimal point
minuend	common denominators	hundredths
product	improper fraction	decimal fraction
remainder	equal fraction	Daily life
subtrahend	cancellation	estimating
difference	denominator	reduced
multiplier	common fraction	selling price
partial products	invert	as much as
multiplicand	of	P. M.
dividend	terms	purchased
quotient	unlike fractions	earned
divisor	Units of measure	deposit
total	century	income
sum	leap year	capacity
divided by	square inch	reasonable
	gross	twice
	5280 ft.	Measuring terms
	cubic foot	square
	2000 lbs.	rectangle
Miscellaneous	dozen	perimeter
Roman numerals	foot	length
graph	"	volume
weight	Counting measures	dimensions
average	place value	depth
	annexed	
	millions	
	tens place	

The vocabulary test was to be constructed in two parts. A preliminary multiple choice test was devised using seventy-five terms in isolation and giving those tested a choice of four possible answers. The test was then administered to 287 pupils as a trial test. After checking the results of this test, changes were made in those items where the wording was not clearly understood. In some instances the pupils inserted what they thought was the correct definition of a term rather than using one of the possible choices. The answers that appeared logical to the child's manner of reasoning were inserted in place of one of the original possible answers. The test was then rewritten in its final form. To facilitate correction of the papers an answer sheet was also drawn up for this test. A copy of the test and the answer sheet appear in Appendix I.

Part two of the vocabulary test was composed of twenty-five terms concerning arithmetical terminology used in context. Twenty-two of these terms appeared in the first part of the vocabulary test while the remaining three were introduced as new terms in the second part of the test. The purpose of the second test was to determine whether pupils responding correctly to a term used in isolation could respond in the same manner when the term occurs in a problem solving situation. Preliminary testing was conducted and revisions were made in the test. No answer sheet was needed for this part of the test. Computations were kept simple and sufficient room was allotted for working the problems on the test paper. See Appendix II for a copy of this test.

Final copies of both parts of the test were duplicated as well as the answer sheets for part one.

Copies of several standardized arithmetic computation tests were examined. It was decided that the Stanford Intermediate Arithmetic Computation Test, Form K would be used. This test comprised of forty-five exercises requiring only the use of computational skills appeared to be the best standardized test suited for this research. The primary purpose of administering this test was to determine the ability of the fifth and sixth grade students tested to solve exercises not dependent upon a knowledge of arithmetical vocabulary. In this test the child is given a choice of four possible answers. Three of the four choices are possible correct answers while the fourth choice represents an answer that is not given. The test requires the student to know the meanings of such basic terminology as add, subtract, and multiply. It is also necessary for the pupil to know the meanings of the symbols $+$, $-$, x, and $\div$. The test includes problems involving the computation of whole numbers, fractions, decimals, and denominate numbers, as well as one problem in finding the average, one in percentage, and two problems requiring ability to read graphs. Space is provided on the test paper for marking the answers. The actual computation of the problems had to be performed on separate paper since space was not allowed for solving the problems on the test paper. These papers were then checked against the choice of answers on the test papers. It was found that in some cases the computation was performed correctly on the one paper but the wrong answer was marked on the test paper. In such instances the problems were considered as correct.

Mental maturity is at times a controlling factor in the pupil's ability or lack of ability to perform at grade level. Intelligence quotients were determined for each pupil tested according to the Otis Quick-Scoring Mental Ability Tests: Beta Test, Form Em. To facilitate correcting the separate answer sheet edition was used.

The teachers were consulted and the proposed research was explained to them. Each was asked if he would be willing to allow his class to participate in this project. Assurance was given that the work of administering and correcting the tests would not be allocated to the teachers. Every effort was made to insure each teacher that the results of the tests would not be used for purposes of comparing one teacher's work with that of other teachers. The only thing asked of the teacher was that he be willing to permit the testing to take place during class time. In all cases the teachers were found to be very cooperative.

The actual testing program at the fifth grade level was conducted by the principal of the school. Two of the sixth grade teachers volunteered to do the testing at that level. Before administering any of the tests, each test was thoroughly explained to the principal and the teachers. Explicit instructions for each test were given. Manuals for the arithmetic computation test and the intelligence test were examined and explained. A time limit of forty minutes was given for the first part of the vocabulary test and twenty minutes was allotted to the second section. This period of time was found to be sufficient for all students to finish the entire test without difficulty. The test was to determine the understanding of certain concepts and was not based on the speed with which the questions could be answered. Time limits for the computation test and the intelligence test were obtained from the manual of directions.

The testing covered a period of one week. One test was administered to each group every day. The last day was used for testing those students who had been absent on any previous day and were missing any of the tests.

All tests were carefully checked and scored. Each paper was rechecked and in the event of errors found in the rechecking, the papers were then given to a third person for correction.

The limitations of this study should be taken into consideration. The vocabulary tests used in this research presuppose some knowledge of reading skills on the part of the population tested. It is possible that some of the pupils tested would have been able to define the terms orally if asked to do so. No oral interviews with any of the pupils were conducted. Knowledge of the arithmetical vocabulary is based upon the written test alone. The vocabulary test includes a selected part of the terminology of one arithmetic text at the fifth and sixth grade levels. A broader sampling of such materials might give additional information.

CHAPTER III

ANALYSIS OF RESEARCH

Each grade used for testing purposes was divided into four rooms. In the discussion of the test results the groups in Grade 5 will be classified as A, B, C, and D. The groups in Grade 6 will be referred to as A1, B1, C1, and D1.

An analysis of the terminology appearing in both vocabulary tests will be made to show the dependence of problem solving upon a comprehensive knowledge of the vocabulary contained in the problem. These terms will be discussed according to the order of classification previously given in Table I. Statistical results for each group and for each grade will attempt to show the differences existing between the groups and each grade. By means of partial correlation, the relationship between arithmetic computation and arithmetical vocabulary will be discussed.

Terminology related to the fundamental processes that appeared in both tests were addends, minuend, product, and quotient. The results of Test I showed that seventy per cent of the fifth grade were able to define the term addends correctly. The term minuend, appearing twice in Test I was defined by twenty-four per cent of the entire group while forty-two per cent were capable of identifying a minuend in a given subtraction example. Product, a term which often causes many children difficulty was defined correctly by fifty-five per cent of Grade 5 with seventy-three per cent able to identify the product in a given multiplication exercise. Quotient, a term related to the process of division was correctly defined by sixty-seven per cent of the fifth grade population. Table II gives the per cent of correct responses for each term related to the fundamental processes in both vocabulary tests. The results for each group and for the combined fifth grade are shown.

TABLE II

PER CENT OF CORRECT RESPONSE FOR TERMINOLOGY RELATED TO THE FUNDAMENTAL PROCESSES FOR GRADE 5

Term	GROUP				
	A	B	C	D	TOTAL
Addend					
Test I	76	57	68	77	70
II	76	62	76	80	74
Minuend					
Test I					
9	26	22	24	25	24
26	45	45	41	37	42
Test II	33	17	17	17	21
Product					
Test I					
15	83	37	34	65	55
31	95	70	54	72	73
Test II	64	30	22	52	42
Quotient					
Test I	88	75	54	57	69
II	86	45	56	60	62

An analysis of the results of Test II as indicated in Table II shows a slight increase in the per cent of correct response in the application of the term addends to a specific problem. An additional eight per cent connected the term with the process of addition but failed to perform the correct computation. Eleven per cent subtracted the given numbers. Group A maintained the same score on both tests. All other groups showed a slight increase in the per cent of correct response for Test II.

The term minuend though introduced in the lower grades still appears not to be understood by many of the students. In item nine of Test I, the pupils were asked for the definition of minuend. Twenty-seven per cent of the fifth grade pupils defined the term as the number you subtract, twelve per cent as the answer to a subtraction exercise, and thirty-five per cent said the answer was not given. An increase of correct response was shown for item twenty-six which asked for the identification of the minuend. The most common error made by thirty-seven per cent of the class was to identify the subtrahend as the minuend. Comparing the results of Test I with those of Test II, all scores showed a decline in the rate of correct response. Given the subtrahend and the difference, only twenty-one per cent of the fifth grade performed the correct solution. The most notable error was to subtract the difference from the subtrahend, calling the answer 209 the minuend. This error was made by fifty-two per cent of Grade 5.

Chaos is often caused in the mind of a child when he encounters the term product unless he understands its meaning as used in arithmetic. As shown in Table II the best response to the term was in item thirty-one of Test I where identification of the product for a given multiplication example was necessary. When faced with the actuality of solving for a product in Test II, the per cent of correct response decreased. Forty-two per cent correctly applied the term with an additional ten per cent selecting the correct process but failing in the computation. Thirty-four per cent of Grade 5 applied the term to addition, six per cent to subtraction, and eight per cent did not work the problem.

The term quotient, correctly defined by sixty-nine per cent of Grade 5 showed a slight decrease in correct response on Test II. Groups A and B scored lower on Test II with Groups C and D scoring slightly higher. Table II shows sixty-two per cent responding correctly on Test II. The correct operation performed by twenty-three per cent of the class showed failure in the computation of the problem. A common error was the omission of the zero in the quotient, giving 19 rather than 109 for the answer. Lack of a clear understanding of the term was indicated by ten per cent of the fifth grade members who listed the dividend or divisor as the quotient and by eight pupils who did not attempt the problem.

Among the sixth grade population there was a larger rate of correct response for each term in comparison to the fifth grade responses. The term addends gave little difficulty to any of the groups in either Test I or Test II. The poorest response was made by Group C1 in the application of the term in Test II. Four per cent of the class subtracted the given addends while seven per cent using the process of addition failed to secure the correct answer.

A study of Table III andthe results of the term minuend shows the best response made was in the identification of the term with a given number from a subtraction exercise. All groups in the sixth grade show a marked decrease in the rate of correct response for the same term in Test II. Forty-seven per cent of the population tested solved the problem correctly while forty-five per cent subtracted the difference from the subtrahend as was done by Grade 5. The definition of the term minuend was known to sixty-four per cent of the entire sixth grade.

The poorest response to the term product occurred in Test II with sixty-nine per cent of the class answering correctly. Eighteen pupils in response to item fifteen of Test I said they would add the numbers if asked to find a product. In Test II however, thirty-two students believed they had correctly solved the problem by adding. Three pupils subtracted the given numbers and one divided. The best response as shown in Table III was to item thirty-one of Test I calling for the identification of the term with a given multiplication exercise to which ninety per cent or more of each group gave the correct response.

TABLE III

PER CENT OF CORRECT RESPONSE FOR TERMINOLOGY RELATED TO THE FUNDAMENTAL PROCESSES FOR GRADE 6

Term	Group				
	A1	B1	C1	D1	Total
Addend					
Test I	95	98	93	85	93
Test II	85	90	76	88	85
Minuend					
Test I					
9	77	76	51	51	64
26	85	83	90	68	82
Test II	62	44	41	39	47
Product					
Test I					
15	82	85	71	68	77
31	92	93	93	90	92
Test II	70	76	71	59	69
Quotient					
Test I	97	95	88	78	90
Test II	86	45	56	60	62

The rate of correct response for the term quotient shows a decrease of twenty-eight per cent between Tests I and II. All groups in Grade 6 showed a poorer response in applying the term than in identifying it with Group B1 dropping from ninety-five per cent to forty-five per cent on Test II. Nine per cent of the class errors were made in division with the common error the omission of the zero in the quotient. Only one child [illegible] the dividend, one the divisor, and three failed to work the problem. One child changed the problem to a fraction problem and then proceeded to solve it correctly.

The vocabulary tests showed little understanding of most of the terms related to fractions and their operations. This was found to be especially true of those terms pertaining to the multiplication and division of fractions. The study of fractions, begun simply at the fifth grade level, is primarily knowledge to be attained from sixth grade arithmetic. The per cent of correct response for Grade 5 for terminology concerning fractions is given in Table IV.

The term mixed numbers was correctly defined by ninety-three per cent of Grade 5 with eighty-seven per cent able to recognize a mixed number in Test II.

Equal fractions, though introduced in fifth grade when the study of fractions is first begun, is not clearly understood by a majority of these students. The poorest response was made by Group C with fifty-nine per cent defining the term correctly but only thirty-seven per cent able to identify a set of equal fractions. Group B showed the greatest decrease in the rate of correct response dropping from eighty-five per cent on Test I to a twenty-five per cent correct response on Test II.

TABLE IV

PER CENT OF CORRECT RESPONSE FOR TERMINOLOGY RELATED TO FRACTIONS FOR GRADE 5

Term	Group				
	A	B	C	D	Total
Mixed numbers					
Test I	98	95	90	87	93
II	90	80	93	85	87
Equal Fractions					
Test I	64	85	59	62	68
II	48	25	37	50	40
Cancellation					
Test I	38	45	20	30	33
II	2	7	39	0	12
Lowest terms					
Test I	83	52	66	65	67
II	52	50	63	67	58
Invert					
Test I	52	52	66	37	52
II	12	15	63	2	23
Common denominator					
Test I	19	27	24	22	23
II	33	62	2	70	42
Improper fraction					
Test I	57	60	68	45	58
II	26	5	15	12	15
Of					
Test I	10	47	39	12	27
II	48	42	39	35	41

Table IV shows a very poor response to the term cancellation by the fifth grade. This terminology introduced at the sixth grade level is therefore unknown to most fifth grade students.

Thirty-three per cent of the combined fifth grade were able to define the term but only twelve per cent understood the process of cancellation sufficiently to work the problem on Test II correctly. The application of the term was known by thirty-nine per cent of Group C but only two per cent of Group A, containing the brighter children had the correct response. No child in Group D was capable of applying the term. Forty-four per cent of Grade 5 made no attempt to solve the problem.

Another arithmetical term related to fractions is that of lowest terms which is formally introduced at the fifth grade level. According to Table IV, the definition of the term had a greater per cent of correct response than did the application of the term in Test II. Group D was an exception to this with a score two per cent higher on Test II.

Invert, another term introduced in the sixth grade was known by few fifth grade students. The meaning of the term invert was known to fifty-two per cent of Grade 5 but only twenty-three per cent of the class knew how to invert in Test II. Scores on Test II for all groups were lower than the scores on Test I. Group A showed the greatest decrease in scores while Group C had the least difference between the two tests as is shown in Table IV. Thirty-five per cent of Grade 5 did not attempt to invert the fraction given in Test II.

The results of Test I show little understanding of the term common denominator used in both fifth and sixth grade arithmetic.

Twenty-three per cent of Grade 5 correctly defined the term with Group B having the highest correct response of twenty-seven per cent. The responses to this same term in Test II were greater for all groups except Group C dropping from twenty-four per cent on Test I to two per cent on Test II. The greatest increase was shown by Group D with a twenty-two per cent correct response on Test I and a seventy per cent correct response on Test II.

Improper fractions, a term common to both grades was correctly defined by fifty-eight per cent of Grade 5 on Test I. Table IV shows considerable differences in the rate of correct response for Test I and Test II. This is due primarily to the inability of any group to distinguish between the two types of improper fractions. Only fifteen per cent of the combined fifth grade were able to indicate both types of improper fractions. Thirty-eight per cent gave the two types of improper fractions as both having the numerator larger than the denominator. Other students gave proper fractions and mixed numbers or a combination of all three as the two types of improper fractions. Nineteen per cent did not respond.

The last of the terminology is of, as associated with fractions. Although this term is not only related to fractions, it is of primary importance in the study of fractions in Grade 6. Since this is terminology of sixth grade arithmetic the responses for Grade 5 to both tests were low. Only twenty-seven per cent of the students responded correctly on Test I. Of the remaining students, three defined the term as plus, eighty-six as divided by, and twenty-five as from. In cross checking with the replies given on

Test II these answers were not consistent. In Test II only one person added, two subtracted and fifteen divided. The per cent of correct response rose to forty-one per cent with all groups scoring the same or higher in Test II. Thirty-three persons in Grade 5 did not attempt to solve the problem in Test II.

All terminology related to fractions used in both vocabulary tests should be known to the sixth grade students. The per cent of correct response for these terms for Grade 6 is shown in Table V.

TABLE V

PER CENT OF CORRECT RESPONSE FOR TERMINOLOGY RELATED TO FRACTIONS FOR GRADE 6

Term	Group				
	A1	B1	C1	D1	Total
Mixed numbers					
Test I	100	100	100	93	98
II	100	93	95	83	93
Equal fractions					
Test I	90	88	100	76	89
II	90	85	78	59	78
Cancellation					
Test I	62	61	59	32	54
II	80	78	71	44	68
Lowest terms					
Test I	95	95	85	73	87
II	90	90	80	66	82
Invert					
Test I	100	90	93	73	89
II	100	95	93	90	95
Common denominator					
Test I	32	46	46	22	37
II	90	80	85	63	80
Improper fraction					
Test I	95	98	83	73	87
II	37	44	27	24	33
Of					
Test I	95	88	76	93	88
II	82	76	66	68	73

Table V shows that in Groups A1, B1, and C1 all pupils correctly defined the term mixed numbers but in the identification of a mixed number in Test II only Group A1 was able to hold its perfect score. Results of both tests show little difficulty in the comprehension of this term by any of the groups.

All pupils in Group C1 correctly defined the term equal fractions but only seventy-eight per cent of the group were able to determine a pair of equal fractions in Test II. Group D1 showed the greatest decrease in the rate of correct response dropping from seventy-six per cent on Test I to fifty-nine per cent on Test II. Eighty-nine per cent of the entire sixth grade responded correctly on Test I with seventy-eight per cent able to identify the equal fractions in Test II.

The results of Tests I and II show that the process of cancellation studied in sixth grade arithmetic is not clearly understood in its meaning or application. Only fifty-four per cent of the population tested were able to define the term and sixty-eight per cent were capable of applying the process of cancellation. Table V shows that among the sixth grade students Group D1 had the poorest response on both tests with Group A1 having the best response. Twenty-one per cent of the entire class attempted the problem but failed to solve it with two per cent of Grade 6 leaving the problem undone.

Eighty-seven per cent of Grade 6 understood the meaning of lowest terms and eighty-two per cent were able to reduce a fraction to its lowest terms in Test II. Group D1 had the most difficulty with the term having seventy-three per cent of the group defining it correctly and only sixty-six per cent able to respond correctly on Test II.

Taught in the sixth grade the term invert was known by all pupils in Group A1 on both Tests I and II. Responses for this term on Test II were the same or higher for each group in Grade 6 with ninety-five per cent of the total population tested applying the term correctly. Group D1 showed the greatest increase in correct response between the tests going from seventy-three per cent on Test I to ninety per cent on Test II. While ninety-five per cent of the sixth grade were able to invert a number only eighty-nine per cent understood the meaning of the term as shown on Test I.

Comparing the results of Test I with those of Test II given in Table V, in each group the definition of the term common denominator was more difficult than the application of the term. A thirty-seven per cent correct response on Test I indicates a lack of clear understanding regarding this term although eighty per cent were able to supply a common denominator in a given problem.

A term familiar to sixth grade students is that of improper fractions. Eighty-seven per cent of the sixth grade were able to define the term but only thirty-three per cent were able to respond correctly when asked to give the two types of improper fractions in Test II. Forty-eight per cent of the class gave two fractions both of which had the numerator larger than the denominator, failing to indicate the improper fraction in which the numerator is equal to the denominator. Only two pupils did not respond to the item in Test II.

The definition of the term of as used in fraction was known to eighty-eight per cent of Grade 6. Of the remaining students tested one defined the term as plus, fourteen as divided by, and five chose the meaning to be from. Scores for all sixth grade groups were lower on Test II than those of Test I with a total response of seventy-three per cent. Although one person defined the term as add, two students added the given numbers in Test II, eighteen divided and twelve pupils failed to respond. The inconsistency of the responses on these two tests indicates a lack of clear understanding of this term by some of the students in the sixth grade.

Arithmetical terminology pertaining to decimals is taught in sixth grade or introduced simply at the fifth grade level if sufficient time or the ability of the group permits. Responses to these terms made by Grade 5 naturally will be lower than those of Grade 6. Table VI gives a comparison of the per cent of correct response between Grades 5 and 6 for the terms decimal point, denominator, and decimal fractions as indicated from the results of Tests I and II.

TABLE VI

PER CENT OF CORRECT RESPONSE FOR TERMINOLOGY RELATED TO DECIMALS FOR GRADES 5 AND 6

Term	Grade 5					Grade 6				
	A	B	C	D	Total	A1	B1	C1	D1	Total
Decimal point										
Test I	69	60	49	42	55	95	88	80	78	85
II	95	75	76	82	82	100	98	95	93	96
Denominator										
Test I	24	17	15	32	22	70	68	59	34	58
II	14	0	2	0	4	90	95	80	75	85
Decimal Fraction										
Test I	60	27	46	25	40	77	76	66	49	67
II	88	67	63	65	71	92	90	93	93	92

As shown in Table VI a majority of the fifth grade population were able to recognize the symbol for the decimal point in Test II but only fifty-five per cent were capable of defining it as a symbol used to separate the place value one from the place value one-tenth. At the sixth grade level ninety-six per cent of the class responded correctly in Test II and eighty-five per cent defined the term in Test I.

The denominator when referring to decimal fractions was understood only by four per cent of the fifth grade with Groups B and D failing to have any member respond correctly in Test II. When asked to give the denominator for the decimal .76 the common answers given were 76, 7, or 6. Twenty-two per cent of the entire fifth grade knew how the denominator in a decimal fraction was determined in comparison to fifty-eight per cent of Grade 6.

Scores on Test II for Grade 6 were much higher for each group giving a total response of eighty-five per cent.

The terminology, decimal fraction, was defined by forty per cent of the fifth grade with seventy-one per cent able to distinguish a decimal fraction from other numbers given in Test II. Eighteen per cent of the class listed 5/10 as a decimal fraction, five per cent gave 96, and one per cent chose $4\frac{1}{2}$ as the decimal fraction. In defining the term, twenty-seven per cent of the fifth grade said a decimal fraction was one in which both numerator and denominator were expressed, thirteen per cent said the numerator was not expressed, and twenty per cent stated that the numerator must be larger than the denominator. Table VI shows a marked increase in the per cent of correct response for the term decimal fraction made by Grade 6. Ninety-two per cent selected the decimal fraction and two failed to respond. The per cent of correct response for Test I was considerably lower with sixty-seven per cent responding correctly. Nine per cent said the numerator was not expressed in a decimal fraction, fourteen per cent said both numerator and denominator were expressed, and nine per cent held the numerator to be larger than the denominator. Two pupils left the item blank in Grade 6.

The rate of correct response for the terminology, estimate and reduced, which are often used in daily life are shown in Table VII on the following page.

TABLE VII

PER CENT OF CORRECT RESPONSE FOR TERMINOLOGY USED IN DAILY LIFE FOR GRADES 5 AND 6

Term	Grade 5					Grade 6				
	A	B	C	D	Total	A1	B1	C1	D1	Total
Estimate										
Test I	95	95	76	85	88	100	98	100	95	98
II	66	40	34	35	44	82	85	71	68	77
Reduced										
Test I	98	95	85	92	93	97	100	100	93	98
II	98	82	68	80	82	92	100	95	78	91

An analysis of the term estimate shows that ninety-eight per cent of Grade 6 and eighty-eight per cent of Grade 5 defined the term correctly on Test I. Table VII shows the results for the same term used in Test II to be lower in both grades. Forty-four per cent of the fifth grade and seventy-seven per cent of the sixth grade were able to estimate the cost of four baseball bats at $3.98 each. Among the fifth grade population, thirty-eight of the students found the exact cost while two based their computation on four bats for $3.98. In the sixth grade, six pupils found the exact cost and two misunderstood the problem and assumed all four bats to cost $3.98.

A majority of both fifth and sixth grade students understood the term reduced. Ninety-eight per cent of Grade 6, with Groups B1 and C1 having a perfect score, responded correctly. At the fifth grade level there was a ninety-three per cent correct response with no group having a perfect score on Test I. Table VII shows that Group B1 continued to hold its perfect score on Test II. Ninety-one per cent of Grade 6 applied the term reduced correctly on Test II. Seven pupils added the amount of the reduction to the original price and two failed to subtract accurately. Two of the students in Grade 6 did not respond in Test II. One child in Group D1 wrote the words "Reduce it" but made no attempt to solve the problem. Responses for Grade 5 on Test II show each group scoring the same or lower with eighty-two per cent of the class responding correctly. The remaining eighteen per cent included three pupils who added, three who erred in subtracting, and fifteen others who gave various answers. Eight pupils failed to give any response on Test II.

Rectangle, perimeter, and square, terminology used in fifth and sixth grade arithmetic was better known by Grade 6 as is shown in Table VIII.

TABLE VIII

PER CENT OF CORRECT RESPONSE FOR THE TERMS RECTANGLE, SQUARE AND PERIMETER FOR GRADES 5 AND 6

Term	Grade 5					Grade 6				
	A	B	C	D	Total	A1	B1	C1	D1	Total
Rectangle										
Test I	64	42	46	57	52	72	63	71	41	62
II	64	80	71	82	74	95	88	93	78	89
Square										
Test I	93	75	80	85	83	95	95	98	93	95
II	93	77	63	80	79	95	100	93	78	92
Perimeter										
Test I	40	75	66	62	61	87	80	78	61	77
II	64	67	54	60	61	97	85	83	76	85

A higher per cent of correct response was made by all groups in Grades 5 and 6 on Test II for the term rectangle with the exception of Group A whose score remained the same as on Test I. Ten per cent of Grade 6 and twenty-five per cent of Grade 5 erroneously selected the triangle from the four figures given in Test II. A rectangle was defined as a figure having three sides by thirty-nine per cent of the fifth grade students and twenty-four per cent of the sixth grade population. Among the fifth grade students eighteen per cent answered both items referring to rectangle incorrectly while ten per cent of the sixth grade failed to respond correctly to both items.

Contrasting the responses to the term square in Test I with the same term in Test II, Grade 5 showed an eighty-three per cent correct response on Test I with a slight decrease to seventy-nine per cent in Test II. Three pupils did not attempt the problem in Test II. A slight difference also occurred between the two tests in Grade 6. Ninety-five per cent defined the term in Test I with ninety-two per cent correctly applying the term in Test II. Group B1 had a perfect score on Test II. Ten pupils in Grade 5 and one in Grade 6 failed to respond correctly to the term in either test.

In defining the term perimeter, thirty-four per cent of the fifth grade and twenty-four per cent of the sixth grade confused this definition with the definition for area. Table VIII shows that each group in Grade 6 scored higher in Test II than in Test I This is true only of Group A at the fifth grade level. Sixty-one per cent of Grade 5 had both items correct while seventy-seven per cent of Grade 6 defined the term correctly and eighty-five per cent were able to find the perimeter in a given problem in Test II.

Item ten of Test II related to item thirty-nine of Test I called for the knowledge and application of the term annex. Table IX given below shows that the definition of the term was known to ninety-four per cent of the sixth graders with all pupils in Group C1 responding correctly. As shown in the table each group in Grade 6 scored considerably lower in Test II with Group C1 dropping to fifty-six per cent.

TABLE IX

PER CENT OF CORRECT RESPONSE FOR THE TERM ANNEX FOR GRADES 5 AND 6

Test	Grade 5					Grade 6				
	A	B	C	D	Total	A1	B1	C1	D1	Total
I	60	50	51	45	52	95	95	100	88	94
II	69	35	24	37	41	72	56	56	49	58

One zero was annexed by twenty-four per cent of the pupils and nine per cent annexed three zeros. As these pupils annexed zeros to the given number it can be assumed that there was a partial understanding of the term in so far as they knew that annex meant to add on to something. However they did not know how many zeros were necessary to make the given number one hundred times larger. Lack of comprehension of the term was shown by one pupil who added three zeros in front of the number and another who changed the number to 142.

Since the term annex is a part of the vocabulary of sixth grade arithmetic scores for the fifth grade are lower than those for Grade 6. Forty-one per cent of Grade 5 annexed the necessary number of zeros. No understanding of the term was shown by 5 pupils who changed the number to 142 while 21 others made no attempt to solve the problem. With the exception of Group A, all scores for the term were higher on Test I with fifty-two per cent of the entire class responding correctly.

The last term, equal, used in both vocabulary tests is a term which the child has used in the lower grades. Using the symbol = in Test I, fifty-six per cent of Grade 5 correctly understood that the numbers to the left of this symbol had to be equal in value to the numbers to the right of the symbol. On Test II all scores for this term were lower as is shown in Table X with forty-eight per cent of the entire class responding correctly.

TABLE X

PER CENT OF CORRECT RESPONSE FOR THE TERM
EQUAL FOR GRADES 5 AND 6

Test	Grade 5					Grade 6				
	A	B	C	D	Total	A1	B1	C1	D1	Total
I	64	55	51	55	56	62	59	61	63	61
II	52	42	46	50	48	75	68	68	32	61

A similar picture as a result of both tests is presented by

Grade 6. A total of sixty-one per cent of the entire sixth grade understood the meaning of the symbol in Test I. As shown in Table X, all groups with the exception of Group D1 scored higher in Test II with a total response of sixty-one per cent.

Three terms, divided by, sum, and average were used only in Test II. At the fifth grade level thirty-nine per cent of the class knew that divided by meant to divide the first number by the second. However they were not able to solve the problem as it involved division of fractions not yet known to the fifth grade. Only two pupils multiplied the two numbers but fifty-one others showed no indication as to what they would do, merely writing a number on their paper. Thirty of the students failed to give any type of response to the question. One child not knowing how to divide by a fraction subtracted the divisor from the dividend until he had a remainder of zero. He then went back, counted the number of times he had subtracted and put the correct answer on his paper. As is shown in Table XI only nine per cent of the entire fifth grade responded correctly to this item in Test II.

TABLE XI

PER CENT OF CORRECT RESPONSE FOR THE TERMS DIVIDED BY, SUM, AND AVERAGE FOR GRADES 5 AND 6

Term	Grade 5					Grade 6				
	A	B	C	D	Total	A1	B1	C1	D1	Total
Divided by	21	0	12	2	9	85	83	61	49	70
Sum	90	85	73	82	83	95	95	93	73	89
Average	95	65	73	75	77	92	90	100	76	90

To six per cent of the sixth graders tested, divided by meant to divide the second number by the first, reversing the position of the numbers. An additional two per cent also reversed the numbers and then multiplied by fifteen rather than dividing. Five per cent failed to invert the divisor. Other errors were made by the remaining seventeen per cent including two students who did not respond to the item.

The term sum gave neither of the grades much difficulty. The most common error made by ten pupils in Grade 5 and eleven pupils in Grade 6 was in giving 16 - 8 as the solution for finding a sum. The total response of eighty-nine per cent for Grade 6 was slightly higher than the eighty-three per cent correct response for Grade 5.

Responses to average were ninety per cent correct in Grade 6 and seventy-seven per cent correct in Grade 5. There was no one type of error in either grade. Two students in Grade 5 and one in Grade 6 failed to give any solution.

No term in Test II was known by all pupils at either level. Low scores at the fifth grade level occurred on those terms not yet known to these students. Low scores were also found on some terms of which a fifth grade student should have knowledge and understanding. All terms were known by at least fifty per cent of the sixth grade with the exception of the terms minuend and improper fractions. Table XII shows the number of terms known by both grades at the various per cents of correct response.

TABLE XII

DISTRIBUTION OF PER CENT OF RESPONSE
FOR GRADES 5 AND 6 ON TEST II

Per cent of correct response	Grade 5	Grade 6
100 per cent	0	0
90 per cent or more	0	0
75 to 90 per cent	6	10
50 to 75 per cent	6	6
25 to 50 per cent	7	2
Below 25 per cent	6	0

The per cent of correct response for Grade 5 to all terminology used in Test I is found in Table XIII. Comparing this with Table XIV containing the responses for Grade 6, it is noted that Grade 6 consistently scored higher than Grade 5 throughout the entire test. An exception to this is the term dozen on which the fifth grade scored one point higher. Appendix III contains all test scores for each pupil in Grades 5 and 6 according to groups. Each group has been arranged according to intelligence quotients, the highest being listed at the top.

TABLE XIII

PER CENT OF CORRECT RESPONSE FOR EACH TERM
VOCABULARY TEST I GRADE 5

Vocabulary I	Group A	Group B	Group C	Group D	Combined Fifth Grade
addend	76	57	68	77	70
borrow	98	87	76	95	89
square	93	75	80	85	83
mixed number	98	95	90	87	93
perimeter	40	75	66	62	61
÷	95	100	98	100	98
estimating	95	95	76	85	88
place value	86	70	56	77	72
minuend	26	22	24	25	24
lowest terms	83	52	66	65	67
reduced	98	95	85	92	93
Roman numeral	69	65	54	72	65
rectangle	64	42	46	57	52
selling price	93	95	76	82	87
product	83	37	34	65	[illegible]
common denominators	19	27	24	22	23
improper fraction	57	60	68	45	58
$\overline{)\quad\quad}$	100	97	98	100	99
equal fractions	64	85	59	62	68

TABLE XIII (continued)

PER CENT OF CORRECT RESPONSE FOR EACH TERM
VOCABULARY TEST I GRADE 5

Vocabulary I	Group A	Group B	Group C	Group D	Combined Fifth Grade
as much as	95	80	73	70	80
length	90	75	76	60	75
P. M.	83	72	85	65	77
purchased	100	97	76	87	90
earned	95	90	85	77	87
difference	76	57	54	60	62
minuend	45	45	41	37	42
remainder	48	52	68	65	58
subtrahend	57	52	66	40	54
multiplier	93	85	85	85	87
partial products	69	50	24	50	48
product	95	70	54	72	73
multiplicand	93	70	51	80	74
dividend	76	67	59	60	66
remainder	88	85	80	75	82
quotient	88	75	54	57	69
divisor	90	85	73	62	78
-	90	95	83	82	88
=	64	55	51	55	56
annexed	60	50	51	45	52

TABLE XIII (continued)

PER CENT OF CORRECT RESPONSE FOR EACH TERM
VOCABULARY TEST I GRADE 5

Vocabulary I	Group A	Group B	Group C	Group D	Combined Fifth Grade
cancellation	38	45	20	30	33
two places to the left	10	10	17	17	13
denominator	43	45	22	37	34
deposit	88	85	73	67	79
common fraction	81	72	63	60	69
income	50	30	31	35	37
decimal point	69	60	49	42	55
decimal fraction	60	27	46	25	40
volume	17	15	2	15	12
invert	52	52	66	37	52
capacity	66	70	54	70	65
of	10	47	39	12	27
hundredths	5	7	2	2	4
decimal fraction - denominator	24	17	15	32	22
century	60	60	71	77	66
leap year	100	77	73	87	85
"	55	52	49	50	52
graph	55	67	46	75	60
dimensions	50	37	49	37	44
terms	50	40	29	32	38

TABLE XIII (continued)

PER CENT OF CORRECT RESPONSE FOR EACH TERM
VOCABULARY TEST I GRADE 5

Vocabulary I	Group A	Group B	Group C	Group D	Combined Fifth Grade
square inch	88	70	41	67	67
millions	86	85	88	77	84
weight	98	95	98	87	94
depth	86	67	68	67	72
gross	52	65	41	70	57
5280 feet	90	100	68	85	86
cubic foot	76	50	46	45	55
x	83	77	73	82	79
reasonable answer	14	15	17	20	16
twice	88	82	73	80	81
2000 pounds	98	92	83	90	91
dozen	98	100	100	95	98
tens place	24	17	27	5	15
foot	93	82	78	77	83
total	95	90	73	82	85
unlike fractions	93	77	68	82	80

TABLE XIV

PER CENT OF CORRECT RESPONSE FOR EACH TERM
VOCABULARY TEST I GRADE 6

Vocabulary I	Group A1	Group B1	Group C1	Group D1	Combined Sixth Grade
addend	95	98	93	85	93
borrow	97	95	98	95	96
square	95	95	98	93	95
mixed number	100	100	100	93	98
perimeter	87	80	78	61	77
÷	100	100	100	100	100
estimating	100	98	100	95	98
place value	97	98	95	73	91
minuend	77	76	51	51	64
lowest terms	95	95	85	73	87
reduced	97	100	100	93	98
Roman numeral	92	93	88	71	86
rectangle	72	63	71	41	62
selling price	97	93	85	85	90
product	82	85	71	68	77
common denominators	32	48	46	22	37
improper fraction	95	98	83	73	87
)‾‾‾‾	100	100	100	100	100
equal fractions	90	88	100	76	89

TABLE XIV (continued)

PER CENT OF CORRECT RESPONSE FOR EACH TERM
VOCABULARY TEST I GRADE 6

Vocabulary I	Group A1	Group B1	Group C1	Group D1	Combined Sixth Grade
cancellation	62	61	59	32	54
two places to the left	40	29	29	15	25
denominator	45	51	46	49	48
deposit	82	93	90	71	84
common fraction	90	90	88	76	86
income	65	49	54	41	52
decimal point	95	88	80	78	85
decimal fraction	77	76	66	49	67
volume	25	22	10	7	16
invert	100	90	93	73	89
capacity	87	83	83	66	80
of	95	88	76	93	88
hundredths	10	15	15	12	13
decimal fraction - denominator	70	68	59	34	58
century	90	73	100	71	67
leap year	97	95	95	95	96
"	97	90	90	73	88
graph	92	88	100	88	92
dimensions	87	68	66	49	67

TABLE XIV (continued)

PER CENT OF CORRECT RESPONSE FOR EACH TERM
VOCABULARY TEST I GRADE 6

Vocabulary I	Group A1	Group B1	Group C1	Group D1	Combined Sixth Grade
terms	72	63	51	46	58
square inch	75	73	68	61	69
millions	100	95	98	88	94
weight	100	100	100	100	100
depth	95	98	88	73	90
gross	60	59	76	37	58
5280 feet	100	90	90	83	91
cubic feet	70	71	61	49	63
x	95	90	85	85	89
reasonable answer	60	51	63	49	56
twice	97	98	98	88	95
2000 pounds	100	100	95	95	98
dozen	100	100	93	95	97
tens place	30	24	24	22	25
foot	100	98	83	83	91
total	95	98	85	88	91
unlike fractions	95	95	88	83	90

Table XV gives the distribution of terms for Test I according to the per cent of correct response for Grades 5 and 6.

TABLE XV

DISTRIBUTION OF PER CENT OF RESPONSE FOR GRADES 5 AND 6 ON TEST I

Per cent of correct response	Grade 5	Grade 6
100 per cent	0	3
90 per cent or more	8	30
75 to 90 per cent	21	22
50 to 75 per cent	29	14
25 to 50 per cent	9	4
Below 25 per cent	8	2

The distribution of scores on Vocabulary Test I for Grades 5 and 6 are given in Figure 1. The mean score for Grade 5 was 59.19 with a standard deviation of 6.12. Grade 5 had a mean score of 47.85 and a standard deviation of 9.96. Median scores for Test I show that Grade 6 with a median of 60.56 had a higher rate of correct response than did Grade 5 with a median of 49.52. Table XVI shows the mean, median, and standard deviation for each group in Grades 5 and 6 on Test I. Group D of the fifth grade having the poorest children has a mean score greater than Group C

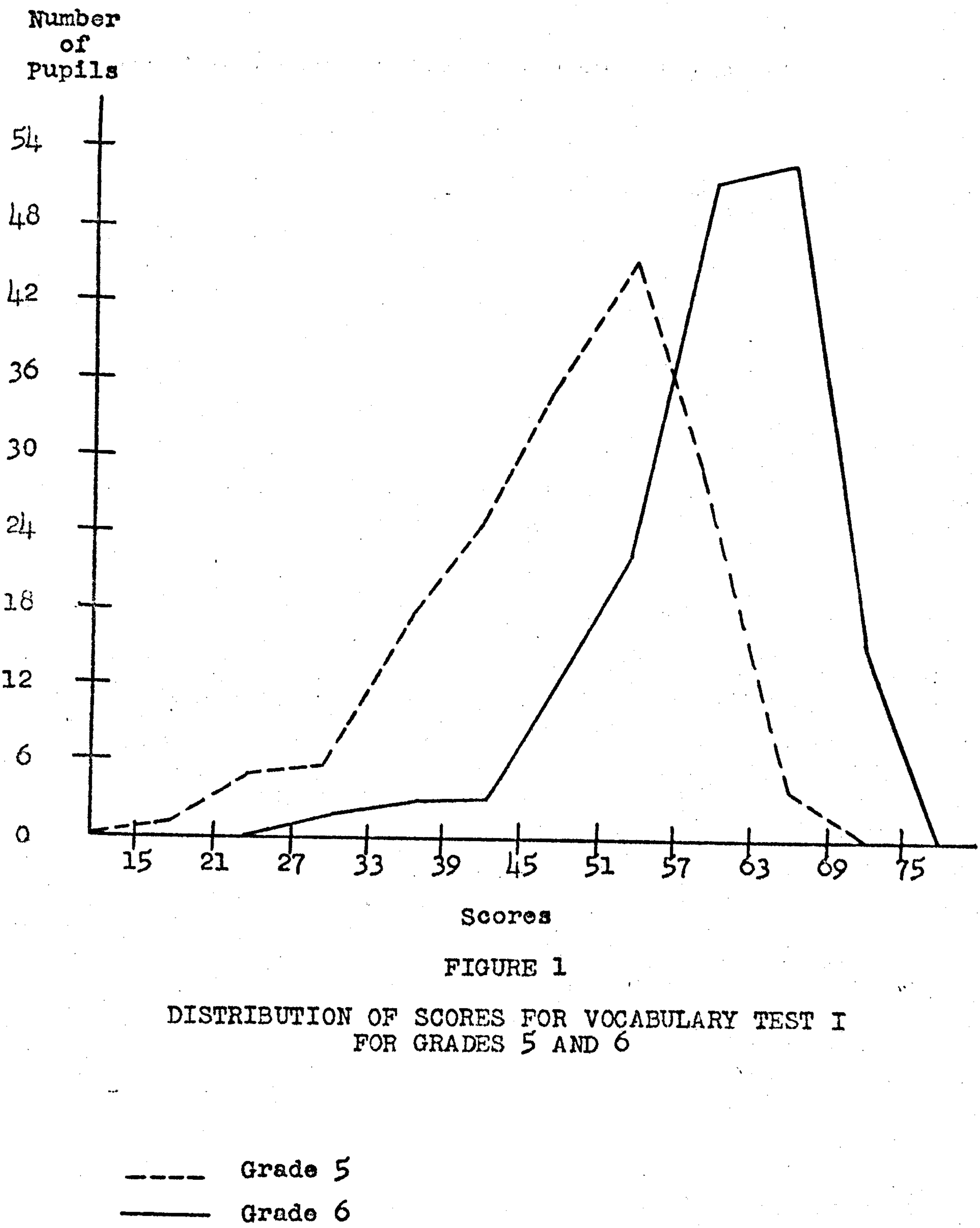


FIGURE 1

DISTRIBUTION OF SCORES FOR VOCABULARY TEST I FOR GRADES 5 AND 6 and a median greater than Groups B or C. Among the sixth grade groups there is no such deviation. Group A1, containing the best pupils has the highest mean and median while Group D1, consisting of the slower students has the lowest.

TABLE XVI

MEAN, MEDIAN, AND STANDARD DEVIATION FOR EACH GROUP IN GRADES 5 AND 6 ON TEST II

Group	Mean	Median	Standard deviation
A	52.64	53.5	6.32
B	48.7	48.79	8.34
C	43.72	42.1	11.3
D	46.5	49.41	11.03
A1	64.15	64.9	5.69
B1	61.88	62.35	3.62
C1	60.49	61.6	6.21
D1	56.75	56.13	9.76

The distribution of scores attained by Grades 5 and 6 on Test II are shown in Figure 2. The mean score on Test II for Grade 6 was 19.6 with a standard deviation of 4.41. Grade 5 whose responses on Test II were lower than those of Grade 6 had a mean score of 12.6 and a standard deviation of 4.33. The

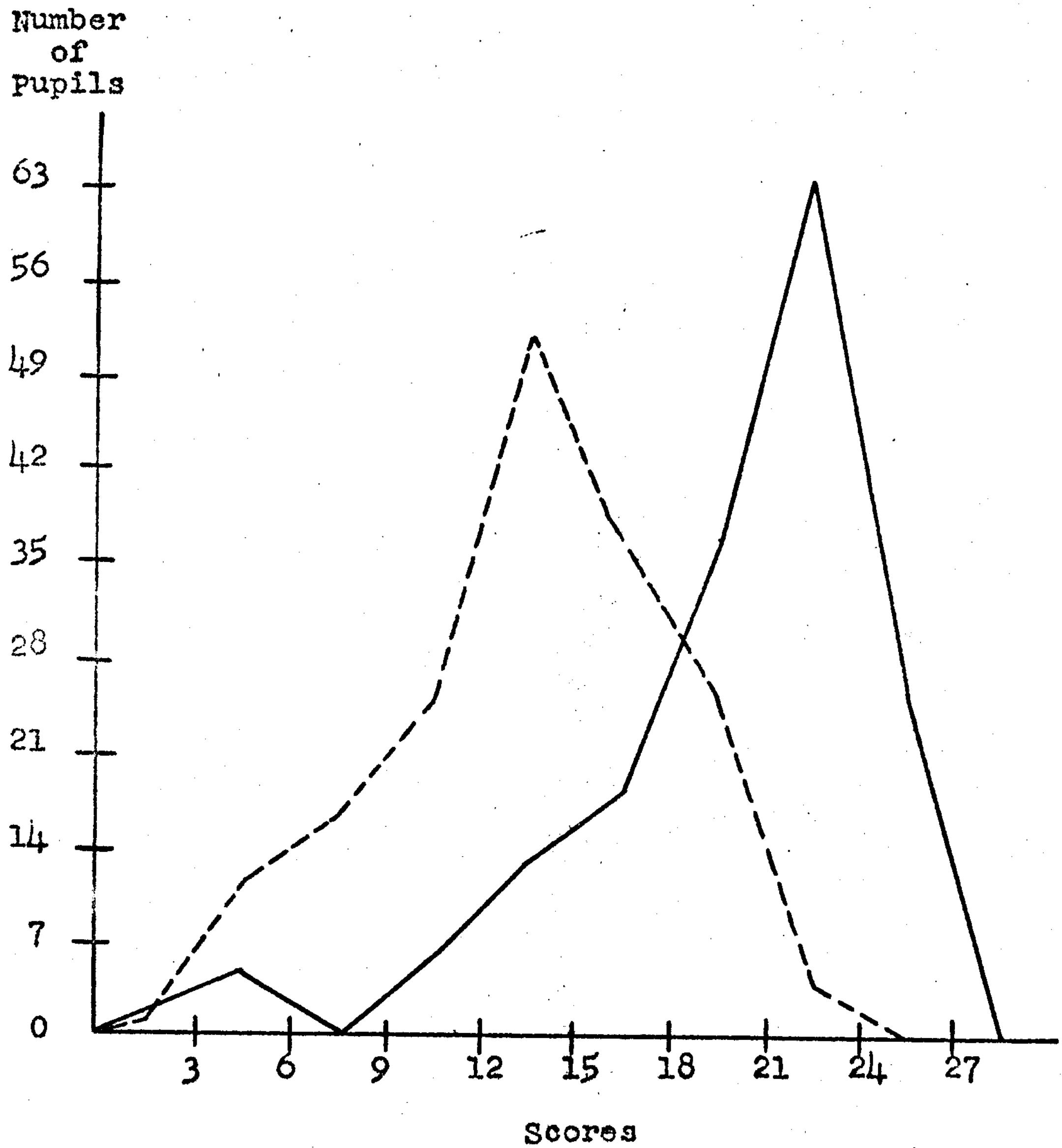


FIGURE 2

DISTRIBUTION OF SCORES FOR VOCABULARY TEST II

FOR GRADES 5 AND 6

median for the fifth grade 12.96 corresponded closely to the mean indicating an approximately normal distribution of the scores. The median score for Grade 6 was 21.36. Table XVII gives the mean, median, and standard deviation for each group in both grades. The table shows the mean score and the median to be greater for Group D than for Groups B or C. Groups in Grade 6 show no deviations from the highest to the lowest groups.

TABLE XVII

MEAN, MEDIAN, AND STANDARD DEVIATION FOR EACH GROUP IN GRADES 5 AND 6 ON TEST I

Group	Mean	Median	Standard deviation
A	15.31	14.88	3.10
B	12.15	11.3	3.64
C	11.79	12.13	4.62
D	12.7	13.32	4.94
A1	22.0	22.3	2.51
B1	20.84	21.6	3.33
C1	19.57	21.0	4.17
D1	16.6	18.5	5.26

The results of the arithmetic computation test showed the sixth grade population to have a median grade equivalent score and a mean score of 7.95. The degree of variability as measured by the standard deviation was 1.42. Results of the same test showed

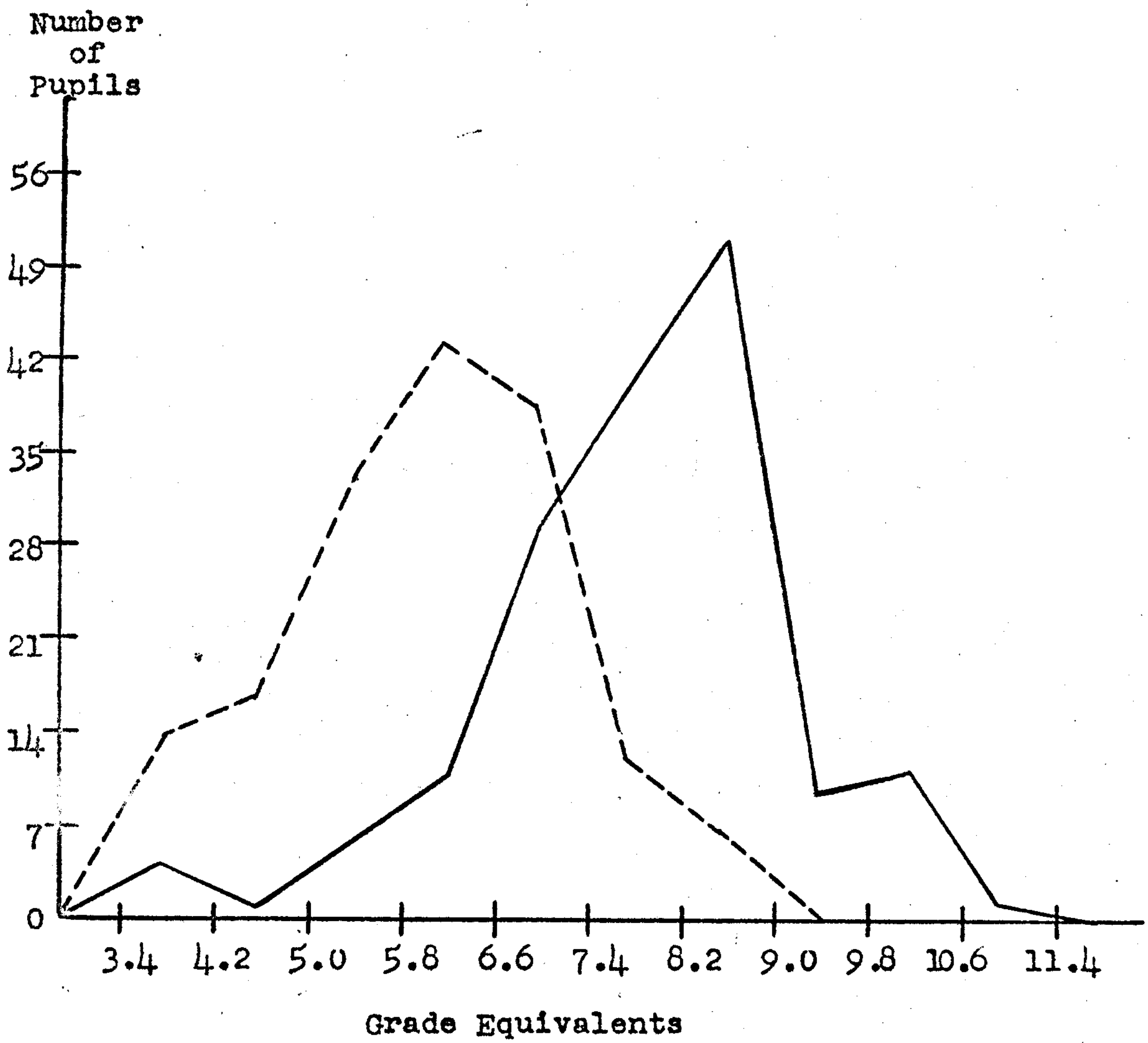


FIGURE 3

DISTRIBUTION OF GRADE EQUIVALENTS FOR THE STANFORD ARITHMETIC COMPUTATION TEST FOR GRADES 5 AND 6 a slight difference between the median and mean scores for Grade 5 with a median of 6.07 and a mean score of 6.1. The standard deviation or variability was 1.13.

Figure 3 on the preceding page gives the distribution of the scores for the arithmetic computation test according to grade equivalents. The graph shows that students at the sixth grade level had a wider range of equivalent scores while both grades had pupils on a third grade level in arithmetic.

Table XVIII gives a comparison of the mean, median, and standard deviation for each group on the arithmetic computation test.

TABLE XVIII

MEAN, MEDIAN, AND STANDARD DEVIATION FOR EACH GROUP IN GRADES 5 AND 6 ARITHMETIC COMPUTATION TEST

Group	Mean	Median	Standard deviation
A	6.27	6.35	.94
B	5.81	5.78	1.20
C	6.16	6.06	1.28
D	5.96	6.15	1.21
A1	8.4	8.27	3.76
B1	8.05	8.06	1.27
C1	7.79	7.53	1.00
D1	7.13	7.52	1.55

Intelligence quotients as measured by the Otis Quick-Scoring Mental Ability Tests for the fifth grade ranged from 81 to 145 with a median for the entire grade of 112.48. The mean score for Grade 5 was 111.96 with a variability as measured by the standard deviation of 10.36. The sixth grade intelligence quotients ranging from 75 to 135 had a class median of 112.25 which varied slightly from that of Grade 5. The mean score of 112.23 showed only a very slight difference from that of the median. The standard deviation was 9.87.

The mean, median, and standard deviation for each group given in Table XIX show the median intelligence quotient for Group D to be higher than that of Group C.

TABLE XIX

MEAN, MEDIAN, AND STANDARD DEVIATION FOR THE INTELLIGENCE TEST FOR EACH GROUP IN GRADES 5 AND 6

Group	Mean	Median	Standard deviation
A	117.69	118.7	10.23
B	112.75	112.75	9.24
C	108.67	108.64	9.89
D	108.2	111.07	9.05
A1	118.85	119.75	8.56
B1	114.51	114.86	8.56
C1	110.56	111.57	7.79
D1	104.90	105.25	8.50

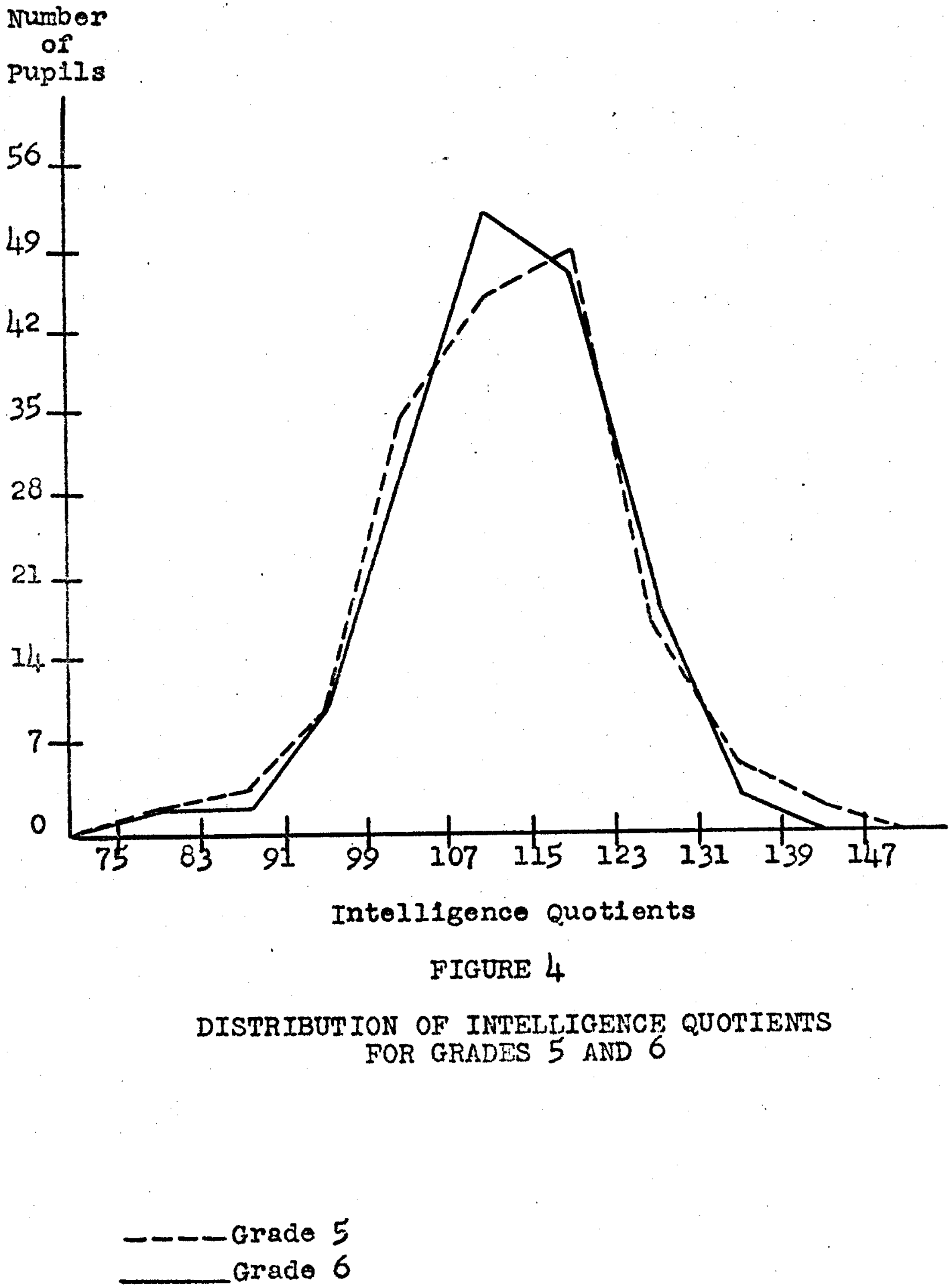


FIGURE 4

DISTRIBUTION OF INTELLIGENCE QUOTIENTS FOR GRADES 5 AND 6

Figure 4 giving the distribution for the intelligence quotients for Grades 5 and 6 shows both grades relatively equally distributed forming an approximately normal curve. The graph indicates the range of intelligence quotients for Grade 5 to be slightly greater than the range for Grade 6.

Relationship between the arithmetic computation test, the vocabulary test, and the intelligence quotients is shown by means of partial correlation. This method of correlation endeavors to show the relationship existing between two variables when the influence of the third variable is withdrawn. In this research, the two variables, arithmetic computation and arithmetical vocabulary were correlated while holding the third variable, the intelligence quotient constant. For the computation of the partial correlation the combined results of vocabulary Tests I and II were used.

The Pearson product-moment coefficient of correlation between the arithmetic computation test and the arithmetic vocabulary test for Grade 5 was .72. The partial correlation, removing the influence of the intelligence quotient, showed the relationship between arithmetic computation and arithmetic vocabulary to be .46. To determine the significance of the partial correlation, Fisher's z transformation was used. The correlation .46 was found to be significant at the .05 per cent level. Table XX on the following page shows the product-moment correlation and the partial correlation for each group in Grade 5. After the influencing factor of the intelligence quotient has been removed the correlation between arithmetic computation and arithmetical vocabulary is lowered. An accurate measure of intelligence also includes the knowledge of arithmetic skills and reading ability. Using the partial correlation these factors are held constant by presuming all students to have the same intelligence quotients.

TABLE XX

COEFFICIENTS OF CORRELATION FOR GRADE 5

Group	Product-moment correlation	Partial correlation
A	.46	.13
B	.72	.47
C	.85	.68
D	.84	.63

The computation of the partial standard deviation for each variable and the comparison of these with the original standard deviations of each variable are given in Table XXI, on the following page. The table shows that the variability of arithmetic computation, arithmetical vocabulary, and intelligence quotients are reduced approximately by one-half.

TABLE XXI

DEVIATIONS FROM THE MEAN FOR EACH VARIABLE IN GRADE 5

Variable	Standard deviation	Partial standard deviation
Arithmetic computation	1.13	.78
Arithmetic vocabulary	12.87	6.54
Intelligence quotients	10.36	5.90

The partial standard deviation is freed of the influence exerted upon its variability by the other two variables. Thus the partial standard deviation for arithmetic computation is freed of the influence of the arithmetical vocabulary and the intelligence quotient, the partial standard deviation for arithmetical vocabulary is freed of the influence of arithmetic computation and the intelligence quotient, while the partial standard deviation for the intelligence quotient is freed of the influence of arithmetic computation and vocabulary.

At the sixth grade level, the product-moment correlation between arithmetic computation and arithmetical vocabulary was .76. Removing the influence of the intelligence quotient, the relationship between these two variables as determined by partial correlation was .59. Using Fisher's z transformation the correlation .59 was found to be significant at the .05 per cent level. Table XXII gives the product-moment correlation and the partial correlation for each group in Grade 6.

TABLE XXII

COEFFICIENTS OF CORRELATION FOR GRADE 6

Group	Product-moment correlation	Partial correlation
A1	.51	.28
B1	.71	.36
C1	.56	.42
D1	.86	.72

Partial standard deviations computed for each variable and the original standard deviation for each variable at the sixth grade level are shown in Table XXIII, on the following page. The variability of arithmetic computation and arithmetic vocabulary freed from the influence of the other two variables are reduced approximately by one-half. The variability of the intelligence quotient is reduced about one-third when the influence of the other two variables has been removed.

TABLE XXIII

DEVIATIONS FROM THE MEAN FOR EACH VARIABLE IN GRADE 6

Variable	Standard deviation	Partial standard deviation
Arithmetic computation	1.42	.92
Arithmetic vocabulary	12.4	6.1
Intelligence quotients	9.87	6.03

The results of the testing program for both fifth and sixth grades show that a definite relationship exists between the terminology used in arithmetic and problem solving.

CHAPTER IV

SUMMARY AND CONCLUSIONS

The purpose of this research was to determine possible relationships between definitions of arithmetical terminology known by a group of fifth and sixth grade students and their understanding and ability to apply these terms in given problem solving situations.

The procedure used for the collection of data for this thesis may be summarized as follows: first, a standardized arithmetic computation test was administered to determine the pupil's ability to solve computational exercises independent of technical terminology; second, a vocabulary test consisting of two parts was given to each student, the first part to determine his understanding of arithmetical terminology used at his specific grade level and the second part to test his use of this terminology in problem solving; third, the administration of a standardized intelligence test to determine the mental ability of each pupil participating in the testing program.

All testing was carried on during normal school days by the principal of the school and two sixth grade teachers. The tests were then corrected and tabulated. The results of all tests were compiled and the statistics for each group and each grade were calculated.

From the results of the tests used in this research it may be concluded that terminology having a high rate of correct response on Test I and a low per cent of response on Test II indicates that while the person could define the term in isolation he was unable to make use of this definition when included as part of a problem. Existing differences between the definitions of the terms and their application to a specific problem may be the result of memorization of the definitions of such terms without the development of an understanding of their relationship to a particular phase of arithmetic. It may be concluded that true understanding of a term involves more than the ability to define it. It necessarily includes the ability to make a practical application of the given terminology. Those terms having a high rate of correct response on Test II and a low per cent of response on Test I for the definition of the term show no actual understanding of the term. The pupil uses the term as a cue to the operation he is to perform and then does the desired computation mechanically, without any realization or understanding as to why he is using this particular aspect of arithmetic rather than another process. Terminology responded to correctly on one test does not indicate ability to respond correctly to the same term on another type of test. Those terms showing a similar per cent of correct response on both Tests I and II indicate understanding of the term as well as ability to apply this understanding correctly in a given situation.

The tables giving the per cent of correct response for the terminology used in the tests show that among the fifth grade, Group D has a higher rate of response on some terms than Groups B or C. On other terms, pupils in Group D were able to score higher than those in Group A. Since the students in Group D formed the majority of the slowest students in Grade 5 scores for this group would normally be lower than the scores of the other groups containing the brighter children. The results of these tests indicate the responsibility that lies with each individual teacher to see that the technical terminology of a subject is made useful in application. A superficial knowledge of the terminology may be considered adequate unless the teacher gears the methods of instruction to its use in the problem situation. Arithmetical terminology should be taught with as much care and exactness as is given to the teaching of new vocabulary in a reading lesson. The research results indicate a definite difference between the understanding of arithmetical terms as such and the ability to use these terms when contained in problems at the fifth grade level. The study of arithmetic should involve more than mere practice in order to perform well on computational exercises. It should broaden the pupil's understanding of these operations so that he not only knows what to do but more important why he is doing it.

Studying the test results for the sixth grade it will be noted that the results are in the order which might normally be expected on the basis of the divisions, that is A1, B1, C1, and D1. Since the departmental system is used at the sixth grade level, one teacher is responsible for the teaching of arithmetic to these four groups. Thus, what is taught to one group is taught to all four groups with the methods and techniques of presenting the materials varying to suit the abilities of the particular group.

Those terms related to the fundamental processes show little comprehension by the students. As long as the student understands the basic concepts involved in these fundamental operations, the terms such as product, addends, multiplicand, minuend, or subtrahend have little value or importance as far as the comprehension of the fundamental processes are concerned. If the child is able to understand the processes of addition, subtraction, multiplication, and division, why and how they operate and when to apply them, it matters little what he calls the answers to these processes or the numbers used in the specific problem. In a given problem solving situation, the child is not taught to label his answer product, difference, sum, or quotient as such. Rather, he applies to the answer the terminology of the specific problem he is solving, giving his answer a term such as dollars, pounds, feet, or cubic inches. Emphasis should be placed on developing an understanding of these processes and the ability to make a practical application as to when to use them without relying on any given oue in an arithmetic reasoning problem.

Significant at the .05 per cent level, the partial correlation of .46 for Grade 5 and .59 for Grade 6 show a definite relationship between arithmetic computation and its terminology and therefore the necessity of understanding the vocabulary used in the statement of problems. Since this relationship does exist, the teaching of the vocabulary of arithmetic should become an integral part of the arithmetic curriculum. The child's ability to pronounce a word is no indication of his comprehension of the term. Arithmetical terminology should be taught concretely as a vital part of the arithmetic program. Understanding of this vocabulary should be evaluated by the teacher either through the use of written tests or orally during the arithmetic period. As a result of this evaluation, terms showing a lack of comprehension should be retaught and clarified in the mind of the child.

Of the terminology used in both Tests I and II, ten terms were correctly defined in Test I and accurate application of the term in Test II was accomplished by seventy-five per cent or more of the sixth grade. Test results for Grade 5 show only three terms used in both tests were known by at least seventy-five per cent of the class. Comparing the rate of response between the terms used in Test I and the same terms appearing in Test II, it was found, at the fifth grade level, on Test I, two terms were known by ninety per cent or more of the pupils, two by seventy-five to ninety per cent, twelve by fifty to seventy-five per cent, three by twenty-five to fifty per cent, and three terms were known to less than twenty-five per cent of Grade 5. Results of Test II for these same terms show that no term was known by ninety per cent or more of the class. Six terms were known by seventy-five to ninety per cent, six by fifty to seventy-five per cent, seven by twenty-five to fifty per cent, and six by less than twenty-five per cent of the class.

For Grade 6, Test I, seven terms were known by ninety per cent or more of the students, nine terms by seventy-five to ninety per cent, five terms by fifty to seventy-five per cent, and one term by twenty-five to fifty per cent of those tested. No term was known to less than twenty-five per cent of Grade 6. Comparing this with the results of Test II, seven terms were known to ninety per cent or more, ten terms by seventy-five to ninety per cent, six terms by fifty to seventy-five per cent, and two terms by twenty-five to fifty per cent. No terms were known to less than twenty-five per cent of the entire class. None of the terms used in both Tests I and II were known to the entire fifth or sixth grade.

Appendix III, giving the results of all tests for each group in fifth and sixth grade shows twenty-three students or fourteen per cent of the sixth grade were below grade level (6.8) at the time the testing took place. More serious retardation is seen at the fifth grade level with sixty-four students or thirty-nine per cent of the class below grade level (5.8). The years of retardation for both grades varies from two months to three years four months. According to intelligence quotients, most of the students below grade level in either fifth or sixth grade have the ability to perform at a higher level. A study of the reasons why these pupils are not achieving would be beneficial.

A re-evaluation of the arithmetical terminology is necessary. This terminology should include only those terms having a vital role in a meaningful understanding of the concepts of arithmetic. Terminology used in daily life should be of primary importance in the arithmetic program and should be thoroughly explained until it is understood by the child. This should include development of arithmetical terminology as used in the business field and arithmetical terminology as it applies to the sciences.

Reconstruction of the arithmetical program within the school to insure the teaching of arithmetical terminology by all teachers would be a step toward thedevelopment of an understanding of these terms by the students. Data indicates that the departmental system could prove to be an effective instrument in the improvement of the school's arithmetic program by utilizing the teacher most competent in the field of arithmetic for all sections. A testing program should be devised which would include either written or oral tests or a combination of the two to ascertain if these understanding have been grasped by the pupils.

Very often the child's report card is based upon how well he performs on computational exercises. This grade then is not a true measure of his insight and understanding of arithmetic but how accurately he is able to mechanically manipulate the numbers of a given exercise. Modifying report card grades to include not only his more computational abilities but also the measurement of the pupil's understanding of arithmetic would be another step toward a better and more vital arithmetic program within the school.

BIBLIOGRAPHY

BOOKS

Brink, William G. Directing Study Activities in Secondary Schools. New York, 1937.

Brueckner, Leo J. Diagnostic and Remedial Teaching in Arithmetic. Chicago, 1930.

-----. Improving the Arithmetic Program. Chicago, 1947.

Brueckner, Leo J. and Foster E. Grossnickle. How to Make Arithmetic Meaningful. Philadelphia, 1947.

Buswell, Guy T., ed. Arithmetic 1948. Chicago, 1948.

Buswell, Guy T. and Maurice L. Hartung, eds. Arithmetic 1949. Chicago, 1949.

Buswell, Guy T. and Lenore John. The Vocabulary of Arithmetic. Chicago, 1931.

Chicago Board of Education. Arithmetic Teaching Techniques. Chicago, 1949.

Clark, John R. and Laura K. Eads. Guiding Arithmetic Learning. New York, 1954.

Clark, John R., Charlotte W. Junge, and Harold E. Moser. Growth in Arithmetic. New York, 1957.

Garrett, Henry E. Statistics in Psychology and Education. New York, 1958.

Guilford, J. P. Fundamental Statistics in Psychology and Education. New York, 1956.

Grossnickle, Foster E. and Leo J. Brueckner. Discovering Meanings in Arithmetic. Philadelphia, 1959.

Hollister, George E. and Agnes G. Gunderson. Teaching Arithmetic in Grades 1 and 2. Boston, 1954.

Klapper, Paul. The Teaching of Arithmetic: A Manual for Teachers. New York, 1921.

Lindquist, E. F. Stastical Analysis in Educational Research. Boston, 1940.

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

Monroe, Walter S. and Max D. Engelhart. A Critical Summary of Research Related to the Teaching of Arithmetic. Urbana, 1931.

Morton, Robert Lee. Teaching Children Arithmetic. New York, 1935.

-----. Teaching Arithmetic in the Elementary School. II. New York, 1938.

National Council of Teachers in Mathematics. The Teaching of Arithmetic. X. Edited by W. D. Reeve. New York, 1935.

-----. Arithmetic in General Education. XVI. Edited by W. D. Reeve. New York, 1941.

-----. The Learning of Mathematics: Its Theory and Practice. XXI Edited by Howard F. Fehr. Washington, D. C., 1953.

-----. Instruction in Arithmetic. XXV. Edited by Foster E. Grossnickle. Washington, D. C., 1960.

National Society for the Study of Education. Arithmetic. XXIX. Edited by Guy Montrose Whipple. Bloomington, 1930.

-----. Educational Diagnosis. XXXIV. Edited by Guy Montrose Whipple. Bloomington, 1935.

-----. The Measurement of Understanding. XLV Part I. Edited by Nelson B. Henry. Chicago, 1946.

-----. The Teaching of Arithmetic. L Part II. Edited by Nelson B. Henry. Chicago, 1951.

Pressey, Luella Cole. The Special Vocabularies of the Public School Subjects. Bloomington, 1923.

Rosenquist, Lucy Lynde. Young Children Learn to Use Arithmetic. Chicago, 1949.

Schorling, Raleigh. The Teaching of Mathematics. Ann Arbor, 1936.

Stokes, Newton C. Teaching the Meanings of Arithmetic. New York, 1951.

Tate, Merle W. Statistics in Education. New York, 1955.

Wheat, Harry Grove. Studies in Arithmetic: A Summary of Masters Problems and Theses Dealing with the Subject of Arithmetic. Morgantown, 1945.

ARTICLES

Alexander, Burton F. "Language Development in Mathematics through Vocabularies," Mathematics Teacher, XL (December 1947), 389-390.

Bertotti, Joseph. "The Mathematics Vocabulary of Current Periodical Literature," Mathematics Teacher, XXXIV (November 1941), 317-319.

Bishop, Ray Woodbridge. "Learning the Language," Texas Outlook, XLII (June 1958), 22.

Brown, J. C. "A Summary of Some Significant Conclusions Reached by Investigators Relative to Arithmetic," Elementary School Journal, XXV (January 1925), 346-357.

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

-----. "The Place of Meaning in the Teaching of Arithmetic," Elementary School Journal, XLVII (January 1947), 256-265.

-----. "When is Arithmetic Meaningful?" Journal of Educational Research, XXXVIII (March 1945), 481-498.

Chase, Sara E. "Waste in Arithmetic," Teachers College Record, XVIII (September 1917), 360-370.

Clark, Caroline Hatton. "To Tell - or Not to Tell," Arithmetic Teacher, V (March 1958), 65-68.

Cronbach, Lee J. "An Analysis of Techniques for Diagnostic Vocabulary Testing," Journal of Educational Research, XXXVI (November 1942), 206-217.

Drake, Richard M. "Vocabulary Instruction in Mathematics," Mathematics Teacher, XXXII (April 1939), 166-168.

Dresher, Richard. "Training in Mathematics Vocabulary," Educational Research Bulletin, XIII (November 1934), 201-204.

Eads, Laura K. "Ten Years of Meaningful Arithmetic," Arithmetic Teacher, XI (December 1955), 142-147.

Edwards, A. S. "A Mathematics Vocabulary Test and Some Results of an Examination of University Freshmen," Journal of Educational Psychology, XXVII (December 1936), 694-697.

Foran, T. G. "Pupils' Methods of Solving Problems in Arithmetic," Catholic Educational Review, XXXII (March 1934), 154-164.

-----. "The Reading of Problems in Arithmetic," Catholic Educational Review, XXXI (December 1933), 601-612.

Gibb, E. Glenadine. "Some Approaches to Mathematics Concepts in the Elementary School," Journal of the National Education Association, XLVIII (November 1959), 65-66.

Gorman, Frank H. "The Arithmetic Vocabulary of the Elementary School Teacher," Elementary School Journal, XXXVIII (January 1938), 373-379.

Gunderson, Agnes G. "Nature and Amount of Arithmetic in Readers for Grades I and II," Elementary School Journal, XXXVI (March 1936), 527-540.

Hickerson, J. Allen. "The Semantics and Grammar of Arithmetic Language," Arithmetic Teacher, II (February 1955), 12-16.

John, Lenore. "Difficulties on Solving Problems in Arithmetic," Elementary School Journal, XXXI (November 1930), 202-215.

Johnson, Harry C. "The Effect of Instruction in Mathematical Vocabulary Upon Problem Solving in Arithmetic," Journal of Educational Research, XXXVIII (October 1944), 97-110.

Kerfoot, James F. "Vocabulary in Primary Arithmetic Texts," The Reading Teacher, XIV (January 1961), 177-180.

Koenker, Ralph H. "Measuring the Meanings of Arithmetic," Arithmetic Teacher, VII (February 1960), 93-96.

-----. "Psychology Applied to the Teaching of Arithmetic," Arithmetic Teacher, V (November 1958), 261-264.

Morton, R. L. "Low Visibility, or, Ideas in a Fog," Arithmetic Teacher, V (October 1958), 172-177.

-----. "Language and Meaning in Arithmetic," Educational Research Bulletin, XXXIV (November 1955), 197-204.

McSwain, E. T. and Ralph J. Cooke. "Essential Mathematical Meanings in Arithmetic in Quantitative Thinking, Computation, and Problem Solving," Arithmetic Teacher, V (October 1958), 185-192.

Phillips, Clarence. "The Relationships Between Arithmetic Achievement and Vocabulary Knowledge of Elementary Mathematics," Arithmetic Teacher, VII (May 1960), 240-242.

Pressey, Luella Cole. "The Determination of the Technical Vocabulary of School Subjects," School and Society, XX (July 1924), 91-96.

Pressey, Luella Cole and M. K. Elam. "The Fundamental Vocabulary of Elementary School Arithmetic," Elementary School Journal, XXXIII (September 1932), 46-50.

Pressey, Luella Cole and W. S. Moore. "The Growth of Mathematical Vocabulary From the Third Grade through High School," School Review, XL (June 1932), 449-454.

Rappaport, David. "Testing for Meaning in Arithmetic," Arithmetic Teacher, VI (April 1959), 140-143.

Schubert, Delwyn G. "Formulas for Better Reading in Mathematics," School Science and Mathematics, LV (November 1955), 650-652.

Stevenson, P. R. "Difficulties in Problem Solving," Journal of Educational Research, XI (February 1925), 95-103.

Sueltz, Ben A. "Measuring the Newer Aspects of Functional Arithmetic," Elementary School Journal, XLVII (February 1947), 323-330.

Swart, William L. "Don't Move the Point, Move the Number," Arithmetic Teacher, VII (April 1960), 204-205.

Treacy, John P. "The Relationship of Reading Skills to the Ability to Solve Arithmetic Problems," Journal of Educational Research, XXXVIII (October 1944), 86-96.

Young, William E. "Teaching Quantitative Language," Education Digest, XXII (January 1957), 47-49.

-----. "Language Aspects of Arithmetic," School Science and Mathematics, LVII (March 1957), 171-174.

UNPUBLISHED MATERIALS

Colvin, Jeanne Watts. "Fourth Grade Children's Understanding of Arithmetic Terms." Unpublished Master's Thesis. University of Texas, Austin, 1952.

Faubion, Norma Nell. "Sixth Grade Pupils' Knowledge of the Arithmetical Terms Common to Sixth Grade Arithmetic Textbooks Adopted for Use in the State of Texas." Unpublished Master's Thesis. University of Texas, Austin, 1953.

Forester, Hazel B. "A Study of 329 Fourth Grade Pupils' Understanding of a Selected Arithmetical Vocabulary." Unpublished Master's Thesis. University of Texas, Austin, 1955.

Miller, Elizabeth Collins. "The Effect of Reading Ability Upon Success in Reasoning Problems in Arithmetic." Unpublished Master's Thesis. De Paul University, Chicago, 1940.

Patkowski, Florence. "Selected Factors Related to Achievement in Reading and Arithmetic in the Intermediate Grades." Unpublished Master's Thesis. De Paul University, Chicago, 1950.

Simmons, Edra. "Improving Vocabulary in Arithmetic." Unpublished Master's Thesis. West Virginia University, Morgantown, 1942.

APPENDIX I

VOCABULARY TEST
PART I

This is a test in arithmetic vocabulary. Read each statement carefully and notice the underlined word or symbol. Decide which answer best gives the definition of the word or symbol and circle the letter of your answer on the answer sheet. For answers 25-36 write your answer in the blank provided on the answer sheet.

1. An addend is
   a. the answer to a subtraction problem.
   b. one of the numbers added together in an addition problem.
   c. the answer in an addition problem.
   d. the result of a multiplication problem.

2. In which of the following is it necessary to borrow?

a.	b.	c.	d.
368 145	937 604	527 253	835 522

3. A square is
   a. a figure with four equal sides and four square corners.
   b. a figure having three equal sides.
   c. a four sided figure with four square corners.
   d. a figure having unequal sides.

4. A mixed number is
   a. a Roman numeral.
   b. a number written out of order in a series.
   c. a combination of a whole number and a fraction.
   d. a number less than one.

5. The perimeter is
   a. the distance inside a given figure.
   b. one of the dimensions of a rectangle.
   c. a unit of measure.
   d. the distance around the outside of a figure.

14. The selling price of a piece of furniture is
    - a. the amount paid for having the furniture delivered.
    - b. the amount the furniture dealer paid when getting the furniture from the factory.
    - c. the amount of money a customer must pay when buying the furniture.
    - d. the amount of money a customer would like to pay for the furniture.

15. If asked to find the product, you would
    - a. add the given numbers together.
    - b. multiply one number by the other.
    - c. subtract the smaller number from the larger.
    - d. find out how many times one number is contained in the other.

16. Before adding or subtracting fractions, it is necessary to have common denominators. These are
    - a. two or more fractions having the same value.
    - b. the same denominators for all fraction problems.
    - c. denominators having the same value for each fraction in a given problem.
    - d. none of these.

17. An improper fraction is
    - a. a fraction equal to less than one.
    - b. the same as a whole number.
    - c. a fraction in which the numerator is less than the denominator.
    - d. a fraction in which the numerator is equal to or larger than the denominator.

18. The symbol which means the same as $\overline{)\quad}$ is
    - a. $+$
    - b. $-$
    - c. $\sqrt{\quad}$
    - d. $\div$

19. Equal fractions are
    - a. fractions having the same value.
    - b. fractions having the same numerator.
    - c. fractions having the same denominator.
    - d. fractions with a value of more than one.

20. If a new coat costs as much as the same kind of coat cost last year
    - a. the coat is free this year.
    - b. you would pay less for the coat this year than last year
    - c. you would pay more for the coat this year than last year
    - d. you would pay the same amount this year as last year

21. If you know the length of a room, you know
    a. how wide the room is.
    b. how many people can fit into the room.
    c. how long the room is.
    d. the area of the room.

22. When it is 9 P.M. on a day during the week
    a. you are in school.
    b. you are probably getting ready for bed.
    c. you are eating your breakfast.
    d. you are just getting up after a night's rest.

23. John purchased a hat. John
    a. bought the hat at the store.
    b. took a hat that belonged to someone else.
    c. received the hat as a present.
    d. gave the hat to someone as a present.

24. Tom earned $12.00 this month. Tom
    a. received the money from his father.
    b. was paid for some work he had done.
    c. received the money as a birthday present.
    d. put his money in a bank.

25. - 28. Write the correct numbers after the given terms.

25. Difference ____________
26. Minuend ____________
27. Remainder ____________
28. Subtrahend ____________

```
 2468
  989
 ----
 1479
```

29. - 32.

29. Multiplier ____________
30. Partial Products ____________
31. Product ____________
32. Multiplicand ____________

```
   68
   32
 ----
  136
 204
 ----
 2176
```

33. - 36.

33. Dividend ____________
34. Remainder ____________
35. Quotient ____________
36. Divisor ____________

```
       157
 43 ) 6792
      43
      ---
      249
      215
      ---
       342
       301
       ---
        41
```

37. The word that means the same as the symbol __—__ is
    a. minus.
    b. plus.
    c. add.
    d. divide.

38. When using the symbol __=__ the numbers to the left of the sign
    a. must be exactly the same as the numbers to the right of the sign.
    b. must be twice as large as the numbers to the right.
    c. must be equal in value to the numbers to the right of the sign.
    d. may be smaller than the numbers to the right.

39. If a zero is <u>annexed</u> to a number, it is
    a. taken away from the number.
    b. added to the number after the last digit.
    c. subtracted from the number.
    d. multiplied by the number.

40. In using <u>cancellation</u> to solve a problem
    a. a common factor is removed from both the numerator and the denominator.
    b. the numerator and denominator are multiplied by a common factor.
    c. the same number is added to both the numerator and the denominator.
    d. the same number is subtracted from both the numerator and denominator.

41. When the decimal point in a number is moved <u>two places to the left</u> the number is
    a. being multiplied by one hundred.
    b. ten times larger than the original number.
    c. being divided by one hundred.
    d. one hundred is added to the original number.

42. A <u>denominator</u>
    a. indicates the number of equal parts into which something has been divided.
    b. is a number that must always equal the numerator.
    c. indicates the number of equal parts being considered.
    d. is a kind of fraction.

43. To <u>deposit</u> money means to
    a. withdraw the money from the bank.
    b. loan the money to a friend.
    c. put the money into a bank.
    d. borrow the money from a bank.

44. A common fraction is
a. a mixed number.
b. a fraction in which only the numerator is expressed.
c. a fraction in which only the denominator is expressed.
d. a fraction in which the numerator and the denominator are expressed.

45. Income refers to
a. the amount of money saved each year.
b. the amount of money earned each year.
c. the amount of money spent during the year.
d. the amount of money given as a gift.

46. A decimal point can be thought of as
a. a mark used when we abbreviate a word.
b. a symbol used to separate the place value one from the place value one-tenth.
c. a period.
d. a mark that tells us where to pause when reading.

47. A decimal fraction is a fraction in which
a. the denominator is ten or some power of ten and is not expressed.
b. the numerator is not expressed.
c. the numerator and denominator are both expressed.
d. the numerator must be larger than the denominator.

48. Volume refers to
a. the amount of space in a three dimensional object.
b. one of a number of books in a series.
c. the amount of space in a two dimensional object.
d. the area of a room.

49. To invert a fraction is to
a. multiply by the fraction
b. reverse the position of the numbers in a fraction.
c. find the sum of the fractions.
d. find the common denominator.

50. The capacity of an elevator is
a. how much the elevator weighs.
b. how high the elevator goes.
c. how much weight the elevator can safely carry.
d. how old the elevator is.

51. In 1/6 of 12, the word of means
a. plus
b. divided by.
c. times.
d. from.

52. What number is in hundredths place? 762.43
- a. 7
- b. 3
- c. 4
- d. 6

53. In a decimal fraction the denominator is determined by
- a. the number of places to the right of the decimal point.
- b. the number of places to the left of the decimal point.
- c. the number of zeros in the decimal.
- d. the largest number in the decimal.

54. A century is
- a. a long time.
- b. every hundredth year.
- c. a period of ten years.
- d. a period of one hundred years.

55. Leap year occurs
- a. every year.
- b. every fourth year.
- c. every other year.
- d. every tenth year.

56. If something is marked 6", we know that it
- a. weighs 6 pounds.
- b. is 6 feet long.
- c. is 6 yards long.
- d. is 6 inches long.

57. A graph is
- a. a part of a common fraction.
- b. a picture used to show relationship of a series of numbers to each other.
- c. a puzzle to be solved.
- d. the distance around a circle.

58. Dimensions means
- a. to cut something in half.
- b. to reduce the size of something.
- c. the length, width, or height of an object.
- d. the distance around an object.

59. The terms of a fraction are
- a. proper and improper fractions.
- b. mixed and whole numbers.
- c. the numerator and denominator.
- d. the lowest terms of a fraction.

60. A square inch is
    a. a four sided figure that is one inch long and one inch wide.
    b. a three sided figure measuring one inch on each side.
    c. a figure whose perimeter is one inch.
    d. one inch on your ruler.

61. How many millions are there in 49,306,428?
    a. 49
    b. 9
    c. 306
    d. 493

62. The weight of an object is
    a. how heavy it is
    b. how long it is.
    c. how high it is.
    d. how far it can be carried.

63. Depth refers to
    a. how wide an object is.
    b. how much money a person owes.
    c. how deep an object is.
    d. how many sides an object has.

64. A gross is
    a. 1 dozen things.
    b. 6 dozen things.
    c. 12 dozen things.
    d. 10 dozen things.

65. The unit of measure that is equal to 5280 feet is called a
    a. yard.
    b. pound.
    c. rod.
    d. mile.

66. A cubic foot is a measure that is
    a. one foot long, one foot wide, and one foot deep.
    b. one foot long and one foot wide.
    c. wider than it is long.
    d. higher than it is long or wide.

67. What does the symbol X mean in 8 ft. X 12 ft.?
    a. 8 ft. from 12 ft.
    b. 8 ft. by 12 ft.
    c. 8 ft. plus 12 ft.
    d. 8 ft. or 12 ft.

68. Which of the following is a reasonable answer for 7.3 - 6.42?
    a. 13.342
    b. 71.5
    c. 13.45
    d. 13.72

69. If your father is paid twice a month he receives his pay
    a. once every month.
    b. on two different days during the month.
    c. every week.
    d. every other month.

70. The unit of measure that is 2000 pounds is the
    a. ounce.
    b. yard.
    c. gross.
    d. ton.

71. A dozen is
    a. 12 things.
    b. 2 things.
    c. 6 things.
    d. 13 things.

72. The number 468.32 has a ___ in tens place.
    a. 3
    b. 8
    c. 6
    d. 2

73. A foot is
    a. a part of the human body.
    b. a unit of measure equal to 12 inches in length.
    c. a unit of measure equal to 36 inches in length.
    d. something used for walking.

74. The total is
    a. the whole or entire amount or quantity.
    b. what is left after subtracting two numbers.
    c. the heaviness of an object.
    d. a unit of measurement.

75. Unlike fractions are
    a. fractions having the same denominators.
    b. fractions with equal denominators.
    c. fractions equal to one.
    d. fractions that are not equal to one another.

NAME ____________ ANSWER SHEET - TEST I

1. a b c d	26. ________	51. a b c d
2. a b c d	27. ________	52. a b c d
3. a b c d	28. ________	53. a b c d
4. a b c d	29. ________	54. a b c d
5. a b c d	30. ________	55. a b c d
6. a b c d	31. ________	56. a b c d
7. a b c d	32. ________	57. a b c d
8. a b c d	33. ________	58. a b c d
9. a b c d	34. ________	59. a b c d
10. a b c d	35. ________	60. a b c d
11. a b c d	36. ________	61. a b c d
12. a b c d	37. a b c d	62. a b c d
13. a b c d	38. a b c d	63. a b c d
14. a b c d	39. a b c d	64. a b c d
15. a b c d	40. a b c d	65. a b c d
16. a b c d	41. a b c d	66. a b c d
17. a b c d	42. a b c d	67. a b c d
18. a b c d	43. a b c d	68. a b c d
19. a b c d	44. a b c d	69. a b c d
20. a b c d	45. a b c d	70. a b c d
21. a b c d	46. a b c d	71. a b c d
22. a b c d	47. a b c d	72. a b c d
23. a b c d	48. a b c d	73. a b c d
24. a b c d	49. a b c d	74. a b c d
25. ________	50. a b c d	75. a b c d

APPENDIX II

VOCABULARY TEST II

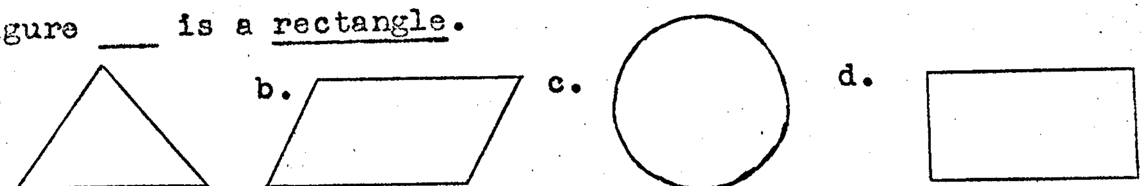
This is a test in arithmetic vocabulary. Read each statement carefully and notice the underlined word or phrase. Decide what this word or phrase means and then do what is necessary to arrive at the correct solution to each problem.

1. Estimate the cost of 4 baseball bats that are sold for \$3.98 each.

2. 15 divided by $2\frac{1}{2}$.

3. Figure ___ is a rectangle.

a. b. c. d.



4. Given the following addends, 7649 and 3275, solve the problem.

5. Which of the following is a mixed number?
    a. 76
    b. 19/4
    c. 3/4
    d. $7\frac{1}{4}$

6. If a square is 2 ft. on one side, what are the dimensions of the other sides?

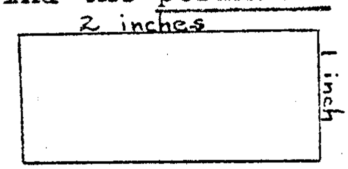
7. "Radios reduced \$5.00." What would you pay for a radio that usually sells for \$38.95?

8. Find the product of 37 and 82.

9. Which are equal fractions?
   a. 3/4 and 1/2
   b. 2/3 and 8/12
   c. 2/6 and 1/2
   d. 3/6 and 1/3

10. Annex the number of zeros necessary to make the number 42, one hundred times larger.

11. Find the perimeter of the following figure.



12. Using cancellation, solve the problem 3/4 x 6/15.

13. Which set of numbers is equal in value?
   a. $27\frac{1}{2} = 2/4$
   b. $5\ 2/3 = 4\ 5/3$
   c. $4 + 2 = 4 \times 2$
   d. $6 - 3 = 6 \div 3$

14. Change 16/24 to lowest terms.

15. Invert the following fraction, 2/3.

16. To find a sum, which problem would you solve?
   a. 16 - 8
   b. 16 + 8
   c. 16 ÷ 8
   d. 16 x 8

17. A car travels 320 miles in 8 hours. What is the average speed of the car per hour?

18. In adding the fractions 3/8 + 2/3 + 5/6, what is the least common denominator that can be used?

19. In the number 43.69 you call the .
    a. a period.
    b. a cents mark.
    c. a comma.
    d. a decimal point.

20. What is the denominator in the decimal .76?

21. Find 5/6 of 42.

22. The subtrahend is 406, the difference is 197. Find the minuend.

23. Give two types of improper fractions.

24. Name the decimal fraction.
    a. 96
    b. 5/10
    c. .72
    d. 4½

25. Find the quotient for 1308 ÷ 12.

APPENDIX III

TEST SCORES FOR EACH PUPIL IN
GRADE 5 GROUP A

Pupil	Intelligence quotient	Arithmetic Computation		Vocabulary Test	
		Grade Equivalent	Number right	I Number right	II Number right
1	145	7.5	36	64	21
2	134	7.5	36	62	18
3	133	8.5	40	61	17
4	132	6.6	31	58	15
5	131	7.3	35	52	19
6	129	6.8	32	55	18
7	126	5.5	24	57	14
8	126	6.2	29	57	15
9	124	7.1	34	60	17
10	124	6.4	30	58	19
11	124	6.2	29	52	17
12	123	5.6	25	58	13
13	123	6.6	31	54	16
14	122	6.1	28	54	16
15	121	5.8	26	59	15
16	121	6.6	31	46	12
17	120	6.6	31	51	18
18	120	5.2	22	59	15
19	120	6.4	30	56	18
20	118	6.8	32	56	19
21	118	5.2	22	57	13
22	118	8.0	38	56	18
23	118	5.6	25	55	19
24	118	5.8	26	49	16
25	117	7.1	34	53	15
26	117	6.0	27	51	12
27	116	5.8	26	48	15
28	116	6.8	32	56	15
29	115	6.4	30	50	11
30	115	5.6	25	45	13
31	112	5.3	23	49	12
32	111	6.8	32	47	8
33	109	8.0	38	52	15

TEST SCORES FOR EACH PUPIL IN
GRADE 5 GROUP A (continued)

Pupil	Intelligence quotient	Arithmetic Computation		Vocabulary Test	
		Grade Equivalent	Number right	I Number right	II Number right
34	109	5.0	21	38	13
35	108	5.5	24	42	12
36	108	6.4	30	43	12
37	104	5.5	24	48	12
38	103	6.8	32	51	14
39	103	5.3	23	61	13
40	102	4.0	14	50	11
41	97	4.8	19	42	10
42	95	4.8	19	42	7

TEST SCORES FOR EACH PUPIL IN
GRADE 5 GROUP B

Pupil	Intelligence quotient	Arithmetic Computation		Vocabulary Test	
		Grade Equivalent	Number right	I Number right	II Number right
1	131	7.5	36	65	19
2	129	6.1	28	54	17
3	129	7.5	36	58	15
4	128	8.8	41	64	19
5	126	5.6	25	60	13
6	123	7.0	33	64	16
7	123	6.4	30	56	12
8	122	6.4	30	44	11
9	120	5.8	26	57	16
10	119	4.8	19	52	9
11	119	6.6	31	52	12
12	119	6.4	30	50	14
13	118	7.3	35	55	18
14	118	5.6	25	49	14
15	117	8.2	39	56	15
16	116	4.9	20	44	11
17	116	6.8	32	60	13
18	115	7.1	34	48	16
19	115	7.0	33	53	13
20	113	6.6	31	47	8
21	110	6.8	32	41	13
22	109	5.8	26	54	12
23	108	6.4	30	46	10
24	108	4.9	20	49	10
25	108	5.0	21	39	8
26	108	3.8	12	40	4
27	107	6.1	28	48	14
28	107	4.3	16	31	6
29	105	4.0	14	40	9
30	105	4.3	16	45	11
31	105	4.4	17	48	9
32	103	5.0	21	43	11
33	103	5.8	26	39	11
34	103	3.9	13	42	8
35	102	4.9	20	37	6
36	102	5.3	23	37	7
37	102	4.8	19	42	9
38	101	5.3	23	51	11
39	98	4.9	20	49	9
40	96	4.8	19	33	7

TEST SCORES FOR EACH PUPIL IN GRADE 5 GROUP C

Pupil	Intelligence quotient	Arithmetic Computation		Vocabulary Test	
		Grade Equivalent	Number right	I Number right	II Number right
1	125	6.4	30	54	13
2	124	8.0	38	50	18
3	122	6.0	27	49	12
4	121	6.1	28	53	16
5	120	8.5	40	59	19
6	120	7.1	34	55	20
7	119	8.0	38	59	22
8	119	7.3	35	56	15
9	118	8.2	39	60	14
10	118	6.0	27	50	14
11	117	7.1	34	40	13
12	117	8.5	40	61	17
13	116	7.0	33	53	17
14	115	7.1	34	56	16
15	114	7.7	37	57	17
16	113	6.4	30	44	12
17	112	6.1	28	50	14
18	111	6.4	30	39	12
19	111	6.6	31	53	13
20	109	5.5	24	35	12
21	108	5.0	21	38	11
22	107	8.0	38	53	13
23	107	4.8	19	42	12
24	106	4.1	15	41	8
25	106	8.2	39	59	15
26	106	5.0	21	29	5
27	104	5.5	24	33	6
28	103	5.0	21	31	7
29	102	5.8	26	35	11
30	102	6.4	30	35	13
31	102	5.3	23	33	9
32	102	5.3	23	41	11
33	101	5.0	21	36	3
34	101	6.2	29	49	6
35	100	5.5	24	34	4
36	99	5.3	23	35	7
37	99	5.2	21	33	6
38	93	4.8	19	30	3
39	91	5.0	21	34	9
40	86	3.5	10	22	8
41	84	4.1	15	22	5

TEST SCORES FOR EACH PUPIL IN
GRADE 5 GROUP D

Pupil	Intelligence quotient	Arithmetic Computation		Vocabulary Test	
		Grade Equivalent	Number right	I Number right	II Number right
1	122	7.3	35	53	18
2	121	6.1	28	51	13
3	120	7.0	33	59	17
4	120	6.1	28	49	13
5	118	7.3	35	59	18
6	118	6.1	28	52	12
7	115	6.4	30	52	15
8	113	7.1	34	53	18
9	113	7.5	36	52	17
10	113	7.1	34	47	17
11	113	6.6	31	48	15
12	113	6.2	29	53	18
13	112	7.1	34	50	17
14	112	5.3	23	41	12
15	112	7.3	35	52	14
16	112	7.3	35	56	18
17	112	7.0	33	56	16
18	112	5.3	23	49	14
19	112	5.8	26	51	13
20	111	6.2	29	60	17
21	111	8.0	38	61	20
22	110	6.0	27	45	12
23	109	6.8	32	50	17
24	109	5.2	22	48	12
25	108	4.9	20	53	12
26	108	6.4	30	43	12
27	107	5.6	25	43	14
28	107	6.1	28	50	10
29	106	6.0	27	54	13
30	104	4.9	20	33	9
31	103	3.9	13	27	3
32	102	5.8	26	49	14
33	101	5.8	26	47	11
34	100	4.1	15	25	7
35	98	7.1	34	49	4
36	96	4.0	14	28	5
37	95	3.8	12	44	12
38	91	3.8	12	22	3
39	85	3.4	9	17	0
40	81	3.8	12	24	4

TEST SCORES FOR EACH PUPIL IN
GRADE 6 GROUP A1

Pupil	Intelligence quotient	Arithmetic Computation: Grade Equivalent	Arithmetic Computation: Number right	Vocabulary Test I: Number right	Vocabulary Test II: Number right
1	135	10.5	44	73	24
2	133	8.5	40	70	24
3	132	9.4	42	70	23
4	130	7.0	33	68	23
5	129	10.5	44	70	23
6	128	7.7	37	71	22
7	127	8.0	38	71	21
8	127	9.4	42	70	23
9	126	7.5	36	65	23
10	125	10.0	43	69	23
11	124	9.4	42	66	22
12	124	8.5	40	66	20
13	123	8.0	38	66	24
14	122	10.0	43	72	23
15	121	9.4	42	66	21
16	121	6.4	30	60	20
17	121	8.5	40	62	22
18	121	8.8	41	72	24
19	120	8.8	41	68	24
20	120	7.7	37	56	18
21	120	7.1	34	64	24
22	119	8.2	39	59	21
23	119	7.5	36	59	19
24	119	8.0	38	60	24
25	119	8.0	38	68	23
26	118	9.4	42	65	23
27	116	8.2	39	62	24
28	116	8.8	41	69	22
29	114	8.2	39	59	21
30	114	8.5	40	57	21
31	112	10.0	43	64	22
32	111	8.8	41	57	16
33	110	8.2	39	65	24
34	109	8.2	39	62	23
35	108	8.5	40	59	21
36	108	7.7	37	68	19
37	107	6.1	28	60	15
38	104	7.7	37	50	15
39	102	7.1	34	56	19
40	101	6.4	30	59	17

TEST SCORES FOR EACH PUPIL IN GRADE 6 GROUP B1

Pupil	Intelligence quotients	Arithmetic Computation Grade Equivalent	Arithmetic Computation Number right	Vocabulary Test I Number right	Vocabulary Test II Number right
1	130	7.7	37	64	24
2	130	8.8	41	65	21
3	129	11.0	45	69	22
4	128	8.5	40	67	24
5	128	10.5	44	69	24
6	126	10.0	43	67	24
7	126	8.0	38	70	24
8	122	8.0	38	66	22
9	122	7.3	35	61	24
10	121	8.8	41	68	23
11	121	8.2	39	65	22
12	120	8.5	40	68	23
13	117	9.4	42	57	23
14	117	6.8	32	60	15
15	117	8.8	41	63	25
16	117	7.1	34	59	18
17	117	9.4	42	67	22
18	116	10.0	43	67	23
19	116	8.8	41	68	22
20	115	5.0	21	55	21
21	114	8.2	39	67	23
22	114	8.2	39	65	24
23	113	8.0	38	64	23
24	112	6.2	29	54	20
25	112	8.2	39	60	20
26	111	8.0	38	63	21
27	111	7.7	37	57	20
28	110	9.4	42	64	20
29	109	7.3	35	62	20
30	108	8.2	39	62	22
31	107	7.1	34	61	17
32	107	7.7	37	58	19
33	107	7.5	36	60	18
34	106	7.5	36	62	21
35	105	6.8	32	55	17
36	104	7.5	36	61	24
37	103	8.8	41	53	20
38	102	7.3	35	59	14
39	101	7.5	36	62	16
40	101	6.2	29	48	14
41	100	5.3	23	47	11

TEST SCORES FOR EACH PUPIL IN
GRADE 6 GROUP C1

Pupil	Intelligence quotients	Arithmetic Computation Grade Equivalent	Arithmetic Computation Number right	Vocabulary Test I Number right	Vocabulary Test II Number right
1	122	8.2	39	59	23
2	122	7.3	35	67	22
3	120	8.5	40	67	24
4	120	8.5	40	66	22
5	120	7.5	36	64	22
6	119	9.4	42	68	23
7	118	7.5	36	62	23
8	118	10.0	43	67	24
9	117	8.5	40	65	21
10	117	9.4	42	68	24
11	116	7.0	33	59	18
12	116	8.2	39	52	22
13	116	8.5	40	67	22
14	116	8.8	41	69	24
15	115	8.2	39	66	21
16	114	8.5	40	63	21
17	113	8.5	40	64	25
18	113	8.2	39	64	22
19	113	8.2	39	60	16
20	112	10.5	44	73	24
21	111	7.5	36	57	14
22	111	7.0	33	65	22
23	111	6.8	32	61	20
24	110	6.8	32	59	17
25	109	7.3	35	57	20
26	109	7.3	35	56	15
27	108	7.7	37	61	19
28	108	7.5	36	68	21
29	107	6.4	30	55	16
30	107	7.0	33	54	15
31	107	8.0	38	62	18
32	105	8.2	39	56	19
33	105	7.0	33	50	12
34	105	7.0	33	56	18
35	104	7.5	36	49	13
36	104	8.0	38	67	22
37	102	7.5	36	63	20
38	96	6.1	28	46	13
39	95	7.1	34	51	14
40	92	6.1	28	55	20
41	91	6.0	27	47	5

TEST SCORES FOR EACH PUPIL IN
GRADE 6 GROUP D1

Pupil	Intelligence quotient	Arithmetic Computation		Vocabulary Test	
		Grade Equivalent	Number right	I Number right	II Number right
1	125	8.5	40	62	25
2	117	8.0	38	66	23
3	116	7.7	37	58	19
4	115	7.0	33	64	23
5	115	8.5	40	59	19
6	112	8.2	39	59	21
7	112	8.2	39	61	21
8	112	10.0	43	61	23
9	112	8.2	39	66	19
10	111	7.7	37	64	21
11	110	8.2	39	57	22
12	109	6.0	27	51	14
13	109	8.5	40	57	16
14	109	8.0	38	64	20
15	109	8.8	41	62	19
16	108	8.2	39	63	19
17	108	6.6	31	58	18
18	108	8.0	38	57	15
19	108	7.5	36	53	16
20	107	7.5	36	50	18
21	105	8.2	39	58	21
22	104	7.7	37	55	21
23	104	7.7	37	56	20
24	103	7.3	35	52	19
25	103	4.0	14	46	12
26	102	4.4	17	47	9
27	102	6.8	32	35	9
28	101	5.3	23	42	17
29	101	7.3	35	52	17
30	100	7.1	34	56	16
31	99	8.8	41	60	21
32	99	8.2	39	59	21
33	99	7.5	36	50	14
34	98	6.6	31	56	14
35	98	5.6	25	33	10
36	97	7.3	35	51	14
37	97	5.2	22	49	14
38	96	5.8	26	40	9
39	95	3.5	10	31	4
40	89	4.0	14	35	4
41	75	3.5	10	30	3

APPROVAL SHEET

The thesis submitted by Sister Mary Sharon Jakicic, C.S.J. has been read by three members of the Department of Education.

The final copies have been examined by the director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated, and that the thesis is therefore given final approval with reference to content, form, and mechanical accuracy.

The thesis is therefore accepted in partial fulfillment of the requirements for the Degree of Master of Arts.

Jan. 25, 1962
Date

Carter N. Fichey
Signature of Adviser