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A Study To Examine The Effect Of Curriculum Materials On The Ability Of General Mathematics Students To Solve Verbal Problems

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A Study to Examine the Effect of Curriculum Materials on the Ability of General Mathematics Students to Solve Verbal Problems

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Education in Secondary Education

by

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May, 1980

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Chapter 1

INTRODUCTION

> Methods of improving pupil facility in the solution of verbal or word problems have probably been the subject of more investigations than has any other arithmetic topic. The sheer number of these . . . points to both the difficulty and the importance of this area of instruction (Spitzer, 1963, p. 20).

The above points out the fact that educators and laymen have become more and more concerned about the effectiveness of arithmetic instruction in our schools. Yet, as Grieder (1972) noted, the schools reflect the values of the society they serve. He further noted that the American society is in a state of changing values; hence, the values of the schools are changing also. The standards have been relaxed in many segments of society and the schools have reflected the same relaxing of standards.

In spite of all the attention which has been placed on the mathematics curriculum during the last few decades, most of the teaching occurring in the mathematics classroom today continues to be mechanistic, skill-oriented, and motivated principally by the supposed need for these skills in the next mathematics course (Fitzgerald, 1975).

Recently, the National Assessment of Educational Progress (NAEP) conducted a survey to gather information concerning the level of performance on selected mathematical concepts. Realizing that everyone is a consumer of goods and services, the NAEP survey investigated, among other things, percentages, discounts, averages, estimation of unit prices at a store, converting units of measures, and reading and interpreting of graphs and tables. The survey results demonstrated that "there is considerable room for improvement in putting across the mathematics for everyday living" (Branscombe, 1975).

The ultimate objective of any instruction in arithmetic should be the solution of practical problems of life (Treacy, 1944). The NAEP survey also suggested that today's consumers learn more mathematics from practical experience obtained in the market place. Many students fail to see the relationship between courses in school and the use of mathematics in their everyday living (Education Daily, 1975). Among the recommendations of the Educational Policies Commission concerning the imperative educational needs of youth, it was recommended that "all youth need to know how to purchase and use goods and services intelligently, understanding both values received by the consumer and the economic consequences of their acts" (O'Brien, 1957).

Kline (1973) agreed with Treacy and O'Brien, and further stated that not one in a thousand elementary school students, nor one in a hundred academic high school students will be a mathematician. Therefore, he concluded, only a few students need the highly technical mathematics taught in the schools. O'Brien (1957) used national statistics to show that only a fraction of students enrolled in the schools are continuing in mathematics beyond the ninth grade. She noted that this trend will continue until educators develop courses that are valuable to all students. Mathematics teachers must be able to show how the courses they teach apply to real situations.

In addition to the course content, there are other factors, such as reading, which will determine the student success in the mathematics classroom and if the student will select additional mathematics courses beyond the required number of courses (Cassidy and Sharkey, 1977). Even though reading can and does influence a student's success in mathematics, Aiken (1976) stated that the most important predictor of achievement in mathematics is ability (I.Q.), and attitude is second. Rogers and Baron (1976) agreed with Aiken when they wrote that self-concept and educational achievement cannot be separated. Thus, the teacher who is not willing to sacrifice cognitive development to work on attitudes and self-concept may have limited success in the classroom.

Chase (1960) conducted a study to determine which variables were most effective in solving verbal problems. He placed his results into two categories, primary and secondary. According to Chase, the primary variables for predicting success were: (1) the ability to do computation; (2) the ability to note details in reading; and (3) knowledge of fundamental concepts in arithmetic. The secondary variables for predicting success were: (1) intellectual factors, especially the verbal and number facts; (2) knowledge of the generalizations of the number system; and (3) the ability to apply reading skills to a variety of purposes. The National Council of Teachers of Mathematics (1959) reported that the teacher is the most important single factor contributing to the effectiveness of any program of instruction. The council noted that the teacher must be well-prepared, have a firm grasp of the basic concepts and processes of mathematics, have a positive attitude toward the subject and the student, and have a good imagination and understanding in dealing with people.

The role of the well-prepared teacher cannot be overemphasized. Bean (1959) conducted a study using the Glennon's Test of Basic Mathematical Understanding. His sample consisted of 450 active elementary school teachers representing seven school districts. On the 80-item test, raw scores ranged from 18 to 78 with a mean raw score of 52.46 or 65.68 percent. The results of this study indicated that many elementary teachers did not understand the mathematics they were teaching. Hence, it is impossible for them to teach what they do not understand.

Criticism from the press, the public, and educators has caused the schools to re-examine the mathematics curriculum. Ebel (1976) reported that the mathematics score on the Scholastic Aptitude Test of the College Entrance Examination Board declined from a mean of 502 in the 1962-63 school year to a mean of 473 in the 1974-75 school year. He stated that the mathematics score on the American College Testing Program, a test which is directly related to achievement in subjects studied in high school, declined in a similar manner. Frand (1976) gave the following reasons for the declining scores: (1) dropouts have reached an all-time low; (2) absenteeism has reached an all-time high; (3) the shift in course offering from traditional academic subjects to electives dealing with non-traditional subjects; (4) schools are forced to assume new areas of responsibility, such as drug education and sex education; and (5) the change in family patterns, e.g., the increase in single-parent families and more working mothers.

With much attention focused on the declining test scores, the public pressured for a return to the development of basic skills. Hence, mathematics educators have the challenge of defining basic skills in mathematics, devising a curriculum that will insure that all students can achieve these basic skills, and constructing evaluation instruments for assessing the established levels of competence achieved by students (Mathematics Teacher, 1977). However, the National Council of Supervisors of Mathematics has taken the position that mathematics educators cannot return to basic skill development. They stated that the back to basics movement has resulted in an overemphasis on computation, and the neglect of other important mathematical skills (Gawronski, 1976).

Hill (1976) reported the following results of the back to basics slogan: (1) all textbooks are placing greater emphasis on arithmetic; (2) teachers are devoting an increasing amount of time to drill of arithmetic and algebraic manipulative skills; and (3) state and local school systems are initiating basic skills proficiency tests, which usually focus on arithmetic skills required for graduation. These results indicated that the back to basics movement is geared toward computational skills even though today's society calls for much more.

This writer believes that a student who can perform only the four fundamental mathematical operations upon graduation from high school has been "short-changed." The educational system which graduates this student has committed a great injustice by allowing the student to believe that he or she is competent in mathematics and ready for the "real world" of life. Brody (1977) stated the position of the National Council of Teachers of Mathematics when she reported: "It will do citizens no good to have the ability to compute if they do not know what computations to perform when they meet a problem" (p. 39).

The Statement of the Problem

What is the effect of the type of instructional materials on the acquisition of verbal problem-solving skills of general mathematics students?

The Importance of the Study

The National Assessment of Educational Progress (NAEP) has demonstrated that students and young adults are not able to solve verbal problems with a high degree of success (Reys, 1976). Richardson (1975) stated that if students are expected to solve verbal problems, they must be taught this skill--they do not automatically acquire it.

Because of the "back to basics" movement, "mathematics educators find themselves under considerable pressure from boards of education, legislatures, and citizens' groups who are demanding instructional programs which will guarantee acquisition of computational skills" (National Council of Supervisors of Mathematics, 1976). As a result of this pressure, educators may stress computational skills at the expense of verbal problem-solving skills. This emphasis on computational skills must be avoided, since verbal problem-solving skills more closely parallel real-life problem situations with which individuals must successfully cope in order to successfully survive in modern society.

Thus, the major thrust of this study was to determine if problem-solving skill development, as taught in selected classes following an "unstructured" current traditional mathematics curriculum, is accomplished to the same degree, as when taught in a specially designed mathematics curriculum, in which problem-solving instruction is ensured.

The Limitations of the Study

This study was limited to general mathematics students in the junior high schools in the Clark County School District of Nevada. Participation in the study was voluntary on the part of the teachers in these schools. The study sampled intact classes distributed over the participating schools.

General mathematics students were selected because these students usually do not enroll in additional mathematics courses, and this one Carnegie Unit in mathematics presently meets the state mathematics requirement for graduation in Nevada.

The Assumptions of the Study

The necessary assumptions for this study were:

1. Verbal problem-solving skills can be learned by the general mathematics students;

2. all students need to learn to solve verbal problems;

3. students in general mathematics classes have not been provided with adequate instruction and thus, have not been acquiring verbal problem-solving skills;

4. the experimental mathematics curriculum material used to teach verbal problem-solving skills for this study will improve the students' acquisition of these skills; and

5. although the unit of analysis for the analysis of covariance was the individual student and the independent variable (the experimental mathematics curriculum material) was randomly assigned to intact classes, there was no effect on the results of this study, and thus its outcome.

Definition of Important Terms

For the purpose of this study, the following terms had the given meaning:

Back to basics movement (mathematics): A return to the teaching of traditional mathematics, i.e., emphasis on computational skills.

Basic skills: The arithmetic skills essential for everyday living and for occupations in business and the skilled trades (Mathematics Teacher, 1977).

Computation: Items designed to require straightforward manipulation of problem elements according to the rules of mathematics that the students presumably have learned. Emphasis is upon performing mathematical operations, and not upon deciding which operations are appropriate (Frand, 1976).

Computational skill: The ability to work exercises involving only computation.

Consumer mathematics: Those branches and skills of mathematics useful to the individual in his affairs as a consumer in situations such as installment buying, paying taxes, etc. (Good, 1973).

General mathematics: A term usually referring to a course which is remedial in nature and emphasizes computational facility; such a course may or may not include application (Good, 1973).

Modern mathematics: A term used to describe recent curricular innovations in pre-college mathematics (Good, 1973). Mathematics curriculum emphasizing understanding of the basic concepts of mathematics (Frand, 1976, quoting Begle).

Specially designed mathematics curriculum: For the purpose of this study, specially designed mathematics curriculum is a unit in general mathematics which will ensure that students are given instructions on verbal problem-solving skills.

Traditional mathematics: Mathematics curriculum that can be characterized by memorization of processes and procedures rather than understanding (Kline, 1973).

Unstructured current traditional mathematics curriculum: For the purpose of this study, the unstructured current traditional mathematics curriculum is the general mathematics curriculum as it exists today. Even though instruction in verbal problem-solving skills is included in the curriculum, the teaching of these skills is not ensured.

Verbal problem: A problem so stated in words (rather than in symbols) requiring determination of the operations necessary for solution (Ford, 1962).

Verbal problem-solving skills: Those skills necessary so that a student can acquire the ability to solve verbal problems.

The Design of the Study

Since subjects in established classes were used in this study, the non-equivalent control group design (Campbell and Stanley, 1971) was used.

By random selection, the researcher identified a Control Group and an Experimental Group from established intact classes. The Mathematics Problem Solving Subtest of the Metropolitan Achievement Test (MAT) Form G was used as a pretest. The Experimental Group worked on the specially designed mathematics curriculum materials (the variable) and the Control Group continued with the unstructured current traditional curriculum. At the completion of the specially designed mathematics curriculum materials, a period of two weeks, both groups were posttested with the Problem Solving Subtest of the Metropolitan Achievement Test (Form F). The posttest results were treated using analysis of covariance.

Chapter 2

THE REVIEW OF RELATED LITERATURE

The Review of the Problem Background

By the mid-1950's, the mathematics curriculum had changed emphasis from the traditional program which concentrated on computational skills to modern mathematics which concentrated on theory. Much time and effort were focused on the modern mathematics curriculum which was geared to the high achiever (Beal, 1972). Also, during the 1950's, the emphasis on basic skills declined until the mid-1970's, when low achievement test scores in mathematics signaled the importance of basic skills which became so widely accepted that the National Institute of Education (N.I.E.) and the National Council of Supervisors of Mathematics (N.C.S.M.) held major conferences to discuss and define basic skills in mathematics (N.C.S.M., 1976). Currently, educators and the general public are concerned about minimum competency skills in mathematics to the extent that more than thirty-five states have initiated legislation regarding the measurement of students' competency in mathematics (Gilman, 1978).

Historically, the one goal of mathematics which has been accepted by society is proficiency in computation (Frand, 1976). This, and the renewed emphasis on basic skills, has resulted in the current emphasis on the four basic fundamental mathematical operations of addition, subtraction, multiplication, and division, and using whole numbers, decimal fractions, and common fractions.

Many educators and parents are proposing that the curriculum should concentrate on the basic skills, and to many professionals and laypersons, this implies that more emphasis should be placed on computational skills to the neglect of other needed mathematical skills. For example, in New Hampshire, a mathematics program stressing drill and practice in computation has been established in the schools (Austin and Prevost, 1972), and in California, the state legislature has ordered the state board of education to adopt a new series of mathematics textbooks that emphasize computation (Brody, 1977). The N.C.S.M., however, has taken the position that the skills of yesterday are not suitable for today, and they state that the students need to know more than how to add, subtract, multiply, and divide numbers, i.e., students must learn to apply these skills to solving problems in everyday life (Gawronski, 1976).

With the current emphasis placed on computation, educators may be satisfied with students who are able to demonstrate their computational skills. However, if a student knows the product of seven and five, but cannot compute the cost of five shirts at seven dollars each, then the mathematical knowledge the student possesses is of limited productive use for survival in society, and that student does not have basic survival skills. Trafton and Suydam (1975) stated that the present focus on computational skills can be a healthy one; however, there should be a balance in which computation receives the necessary attention without dominating the entire mathematics curriculum. They further stated that while a curriculum which ignores computational skills is not valid, neither is a curriculum that is limited to a narrow focus on computational skills, and they further wrote that mathematical skills should be developed in the context of real-world applications. Branscombe (1975) used the results of the N.A.E.P. Assessment to support the teaching of verbal problem-solving skills when he wrote that the schools are not teaching enough of the kind of mathematics that their students need to successfully cope in the market place and in the home. He further stated that the N.A.E.P. Assessment results demonstrated that there is considerable room for improvement in teaching the mathematics needed for everyday living, and since the ultimate objective of education should be survival in the real world, decisions concerning curriculum should be guided by society's needs. Therefore, to survive in today's society, mathematics teachers should provide students with instruction that emphasizes the development and acquisition of verbal problem-solving skills.

Traditional Mathematics versus Modern Mathematics

"The traditional method of teaching results in far too much of only one kind of learning--memorization" (Kline, 1973, p. 7). With this thought in mind, mathematics educators became dissatisfied with the traditional mathematics curriculum and began to develop what has become the modern mathematics curriculum. During the 1950's, mathematics educators agreed that the teaching of mathematics had not met society's goals; hence, a reason for change was established. The advocates of the modern mathematics curriculum stated that when a subject is taught logically and the reasoning behind each step is revealed, students will not have to rely on rote learning. They will understand what is taught (Kline, 1973).

A better understanding of mathematics was only one of the reasons for the move to the modern mathematics curriculum. Additional reasons were: an awareness of the need for greater mathematical substance to meet the nation's scientific and technological needs; a dissatisfaction with the quality of instruction in mathematics; a general dissatisfaction with the quality of mathematics education (Trafton, 1977); and a need to increase the student's ability to solve problems (Cummins, 1974).

Begle (1970) summarized the major support for the modern mathematics curriculum when he stated:

> The chief difference between the old and the new programs is the point of view towards mathematics. No longer is computational skill the be-all and end-all of mathematics. Now there is an equal emphasis on understanding of the basic concepts of mathematics and their interrelationships, i.e., the structure of mathematics (p. 1).

Modern mathematics did not begin without problems. The urgency to implement the new programs created a large problem. The move to the modern mathematics curriculum was much too rapid and many of the present problems can be traced to this source, rather than faulty programs (Hirschi, 1977). The modern mathematics curriculum writers did not test their curricula on a broad scale before pushing it on the public (Kline, 1976). Hirschi (1977) stated that "no district should have adopted the new math program until every mathematics teacher had had at least thirty hours of retraining at the hands of knowledgeable people who knew the program" (p. 244).

In 1962, Max Beberman, one of the proponents of the modern mathematics program stated:

> I think in some cases we have tried to answer questions that children never raised and resolve doubts that they never had, but in effect we have answered our own questions and resolved our own doubts as adults and teachers, but these were not the doubts and questions of children (Kline, 1973, p. 110).

In 1964, Kline quoted Beberman as saying: "We're in danger of raising a generation of kids who can't do computational arithmetic" (Kline, 1973, p. 110). Kline (1973) also quoted from a letter he received from Edward Begle in 1962:

> The SMSG Advisory Board feels that longer range planning and experimentation is (sic) necessary and should be started now. This must be done to prevent the present materials from becoming frozen into a new orthodox pattern that would require another upheaval a few years from now (p. 11).

With concerns about the modern mathematics program coming from its leaders, others began to express their doubts. Modern mathematics received the blame for the decline of computational skills (Dunlap and House, 1976). However, although the leaders of modern mathematics never intended to ignore or neglect computational skills, a series of misinterpretations resulted in the neglect of these skills (Brody, 1977). Brody (1977) also stated that teachers got so involved in teaching "abstract concepts and esoteric vocabulary, that they neglected to teach students how to add, subtract, multiply and divide" (p. 6). In fact, since the introduction of modern mathematics in Vermont, eighth grade computational skills dropped from a mean grade level of 8.3 in 1963 to 7.2 in 1967 (Cummins, 1974). Austin and Prevost (1972) conducted a longitudinal study in New Hampshire, in which they found that students in modern mathematics declined in the computational ability. Their findings pointed to elementary teachers emphasizing modern mathematics at the expense of computational skill. Yet, Frand (1976) reported that an analysis of the Minnesota National Laboratory study which compared a variety of modern mathematics programs with a variety of traditional mathematics programs on computation tests found no significant difference in computational skills, and he reported that the investigators called the modern programs failures because they expected the modern programs to improve computation skills beyond those developed in traditional programs.

This new focus on the modern mathematics programs was brought on by declining standardized test scores, and critics were blaming the declining test scores on the modern mathematics programs (Hill, 1976). Critics of the modern mathematics curriculum stated that the major cause for this decline was that abstract mathematics, emphasizing structure, had replaced the traditional program which emphasized basic skills and applied mathematics (Reys, 1976). Therefore, society and the societal decision makers, who endorsed the modern mathematics curriculum twenty years ago were now demanding a shift back to the basics because the modern mathematics programs failed to increase the student's levels of mathematics proficiency beyond the level of the traditional program (Frand, 1976).

Positive results in mathematics achievement have been documented using the modern mathematics curriculum. Begle (1974) cited results from many dissertations written during the 1960's comparing the modern mathematics curriculum and the traditional mathematics programs. He stated that these studies either found no significant differences in the two programs or that they found students in the modern mathematics curriculum did better than students in the traditional programs. However, Begle also noted that a study by the National Longitudinal Study of Mathematical Abilities found that students using modern mathematics curriculum were a "trifle" below-average on rote computation, but well above-average on mathematics concepts and on concept application to problem solving.

Frand (1976) stated that studies of the modern mathematics curriculum and traditional mathematics curriculum showed that students in the modern mathematics programs did significantly better (at the .01 level) than students in the traditional programs on tests measuring mathematics understanding. At the same time, he reported that most studies showed that there were no significant differences between the students in the modern mathematics program and those students in the traditional program on computational tests.

The Education Digest (1976) reported that in 1974, the Conference Board of Mathematical Sciences appointed the National Advisory Committee on Mathematics Education to prepare and make recommendations for the mathematics curriculum. One of the committee's recommendations was that teachers, administrators, parents and the general public should not allow themselves to be manipulated into a false choice between modern mathematics and traditional mathematics. The mathematics program should contain a balanced combination of the two, and emphasis should be determined by the goals of the program and the nature, capabilities, and circumstances of the students and teachers. Many mathematics educators agreed with the Mathematical Teacher (1959) when it reported: "There have been failures to recognize that not only can the excellence of the old give depth to the perspective of the new, but also that the elegance of the new can add refinement to the interpretation of the old" (p. 389).

The Need for Teaching Verbal Problem-Solving Skills

The back to basics movement in the mathematics curriculum has tended to concentrate on computational skills (Hill, 1976; Gawronski, 1976), and with more emphasis placed on computation, the public and some educators may be satisfied and led to believe that a student is competent in mathematics if the student can demonstrate computational skills in the four fundamental mathematical operations of addition, subtraction, multiplication, and division. Many elementary school teachers believe that computation and drill are the mathematics program--they incorrectly equate mathematical ability with computation (Quast, 1969).

The N.C.S.M. stated that the basic mathematical skills of yesterday are not suitable for the world in which today's student lives. Contemporary students need to know more than just how to add, subtract, multiply, and divide. They must learn to apply these skills to solve problems in everyday situations (Gawronski, 1976).

Today, as in the past, many mathematics teachers are reluctant and unwilling to teach verbal problem-solving methods and techniques. If a teacher is expected to teach the basics, the teacher will elect to concentrate on computational skills because the teacher can drill students on these skills and be able to see positive results from most students in a shorter period of time than the teacher could if he taught verbal problem-solving techniques. Hence, the teacher is searching for, and is satisfied with, reaching an immediate goal (computational skills) that is less important than a long-range goal (the acquisition of verbal problem-solving skills). Brune (1953) noted this point when he stated: ". . . drill devoid of understanding did not enhance learning. Pupils could operate--they could add, subtract, multiply, divide, factor and recite proofs--but many failed to solve problems" (p. 188). Drill should be used to reinforce computational skills, not as a technique for learning (Quast, 1969).

Nelson and Kirkpatrick (1977) stated:

> It is quite common even today to hear someone claim that a child faced with pages of computation exercises is solving problems. This activity is not problem-solving, for practical exercises do not establish any kind of relation between a real situation and its mathematical model (p. 71).

Yet, there are times when this type of activity is beneficial to the students. Students who have trouble with computation skills will certainly have a difficult time solving verbal problems. The improvement of computation skills is very important in developing the problem-solving ability of the student; however, the improvement of computation alone has little, if any, measureable effect upon the student's ability to solve verbal problems (Riedesel, 1969). Even though the importance of computational skills cannot be denied, real-life problems require more than just computing. Real-life problems require: (1) a decision for the correct operations; (2) a decision for what numerical values to use; (3) a decision for where to use them; and (4) ability to use them correctly (Reys, 1976). The important point for the teacher to remember is that he is to build on the computation skills, and relate computation to solving verbal problems. The ability to solve verbal problems is, in fact, the main reason for learning computational skills (Trafton and Suydam, 1975).

In many of the verbal problems presented in mathematics textbooks, the initial difficulty posed for the student is the translation of the verbal problem into an arithmetic operation (N.C.T.M., 1969). In other words, the most important part of solving verbal problems is the writing of a mathematical sentence that states the same conditions of the verbal problem. The ability to translate the verbally described situation to an appropriate mathematical sentence enables a person to understand and solve a larger number of general problems in mathematics. The translation of a given real-life situation into a mathematics sentence is considered the most useful tool in problem solving (N.C.T.M., 1969). Trafton (1977) stated:

> Some (educators) view arithmetic in terms of computational skills, with proficiency in them as an end in itself; they see proficiency as the result of an emphasis on procedural aspect of computing alone. Others focus on the use of arithmetic understandings and skills in familiar practical situations; they argue that number aspects of applied situations are sufficient to develop these understandings and skills (p. 17).

To the surprise of many educators, verbal problems can be an aide for teaching computational skills to those students who have not learned the fundamental mathematical operations of addition, subtraction, multiplication, and division. Many students do not accept a need for learning these operations. Actual operational experiences with real-life-meaning problems can create an interest for learning and demonstrate the need for learning these operations.

Teaching problem solving is generally acknowledged to be an appropriate objective of the mathematics curriculum. The Progressive Education Association Committee on the Function of Mathematics in General Education reported that problem solving is the basic reason for mathematics in the secondary schools (Sowder, 1972). Through solving verbal problems, students learn to use the arithmetic processes in functional situations. Brownell wrote in 1947 that through solving verbal problems, students see the chance to use their ideas and skills to further some end, and they use these ideas and skills for a purpose. Spitzer (1954) stated that a purpose for teaching verbal problem-solving skills is to teach students to solve the type of problems that they will meet in real life, such as finding averages, the cost of installment buying, etc. And Carpenter, Coburn, Reys, and Wilson (1976) believed that learning to solve verbal problems is a significant hurdle in learning mathematics. Failure to learn the skills needed to solve such problems can significantly inhibit a student's progress in school.

Educators agree that learning to solve verbal problems helps to "bridge the gap" between the mathematics classroom and the real world. Students need help to make this adjustment. O'Brien said in 1957 that all active citizens need competence in mathematics, not just the mathematics specialist. She further noted that to be practical consumers, people will need to know how to purchase goods and services intelligently. Additionally, these students will need to demonstrate their mathematics competency to obtain employment. Recently, employers have complained about the lack of the applicant's ability to solve verbal problems (Lambert, 1964). This demonstrates the need for students from all walks of life to obtain this skill.

The importance of showing the relationship of verbal problems to the real world is needed. Timmer (1974) stated that in selecting material for the mathematics curriculum, educators must be sure that it will help the student to learn to solve verbal problems. Smith (1963) agreed with Brownell and Spitzer when he stated that in teaching students how to solve verbal problems, the teacher should allow students to have a chance to use these skills to solve problems that are meaningful to them.

The mathematics teacher should realize that problem solving is a skill that can be transferred to other areas, and that problems to be solved are not limited to the mathematics curriculum. Problem solving can and does arise in other disciplines, such as the physical and biological sciences, and the social sciences. The verbal problem-solving process, and the experiences the student gained from the process, can help him to find patterns helpful for solving problems in areas other than mathematics (National Council of Mathematics

Teachers, 1969; Grossnickle, 1964). Carpenter, Coburn, Reys, and Wilson (1976) stated:

> Learning to solve word problems is one of the most valuable skills to be gained in studying arithmetic, not so much as a goal of mathematics instruction, but as a starting point toward (general) problem-solving ability and the ability to apply and use mathematics (p. 393).

It can be stated that instruction in how to solve verbal problems is the weakest part of the mathematics curriculum (Smith, 1963; Avis, 1954). One reason is that teachers have failed to confront their students with, or help them formulate, real problems (Henderson, 1953). Yet, Richardson (1975) wrote that verbal problem solving is at the very heart of the mathematics program. It represents a skill that requires continuous development and refinement throughout the student's mathematics program, even though learning to solve verbal problems is frequently a cause of frustration for both students and teachers. He noted that successful experiences in solving verbal problems in the early elementary school grades are desperately needed. The teacher must realize that techniques for solving verbal problems need to be developed and practiced; students do not automatically learn them. Polya (1957) summarized this with the following statement:

> A teacher of mathematics has a great opportunity. If he fills his allotted time with drilling his students in routine operations he kills their interest, hampers their intellectual development, and misuses his opportunity. But if he challenges the curiosity of his students by setting them problems proportionate to their knowledge, and helps them solve their problems with stimulating questions, he may give them a taste for, and some means of, independent thinking (p. V).

Difficulties in Teaching Verbal Problem-solving Techniques

> The pre-eminence of increased problem solving ability as a goal of mathematics has been admitted; but like the weather, problem solving has been more talked about than predicted, controlled, or understood (Kilpatrick, 1969, p. 523).

There is no lack of evidence, stemming from research as well as opinion, that teaching verbal problem-solving methods has been a weak area in the mathematics curricula of this country. Much time and energy have gone into studies for the reasons for the prevalent weakness in verbal problem-solving ability among elementary school pupils, as well as among high school and college students, and even adults, without making any marked progress toward improvement of the situation (Thorpe, 1961).

Thorpe (1961) indicated that teaching verbal problem-solving skills has been a problem for many years. It has been demonstrated that the major problem areas for teaching these verbal problem-solving skills were: reading (Gilmay, 1967; Henney, 1971); vocabulary (H. C. Johnson, 1944); lack of interest or motivation (Bowers, 1957); poor computational skills (Davis, 1973); and lack of reflexive, analytical thinking skills (Davis, 1973).

> In problem solving situations that involve verbal materials, a person is ordinarily expected to read a statement, analyze the data, use computational skills, and arrive at the correct situation. All of these steps are important, but none more important than the first (Smith, 1971, p. 559).

Studies by Aiken (1972) found the correlation between reading ability and mathematics achievement to range from .40 to .86. Studies by Gilmay (1967) and Henney (1971) indicated that additional instruction in reading will improve the verbal problem-solving performance of students. The same conclusion was reached by Call and Wiggin (1966), and Spilman and Weiner (1972), as a result of their studies. Therefore, when teaching verbal problem-solving skills, the mathematics teacher must be aware of the reading level of the materials and the student's reading ability, because the ability to read the material can and does influence the student's success in the area of solving verbal problems. The teacher has the responsibility for helping those students who have poor reading skills to become better readers and thus, eventually better verbal problem solvers.

Henney (1971) reported that students find reading mathematics to be different and more difficult than reading other materials. She stated that students need to be taught how to correctly read mathematics because many incorrect solutions are the result of difficulties created by the language of mathematics. Henderson and Pingry (1953) also stated that reading verbal problems in mathematics texts requires a different reading technique than reading descriptive material or fiction. They stated that verbal problems are written in a brief, highly compact style using many technical words. Hence, the technical words have to be meaningful to the student before he can understand the problem. The student should not read hurriedly. He should read deliberately to insure that he has read and understood all of the words in the problem.

A study conducted by H. C. Johnson (1944) demonstrated a need for vocabulary work in the mathematics classroom. In his study, the experimental group received instruction on selected arithmetic vocabulary for fourteen weeks, and they made significantly higher gains (at the .01 level) in solving verbal problems which involved some of the words taught. Studies conducted by Eagels (1948) and J. T. Johnson (1949) also demonstrated the importance of vocabulary building in the mathematics classroom.

"Problem solving requires a high degree of reflexive, analytical thinking, whereas performing a computation operation involves only the application of a process that has been practiced to the point of being mechanical, habitual or routine" (Davis, 1973, p. 84). Carpenter, Coburn, Reys, and Wilson (1976) reported that the Michigan Educational Assessment Program (MEAP) was used to test fourth graders, and the results demonstrated that verbal problems tended to be more difficult for fourth graders than most computational problems, and that proficiency with mathematical concepts is a necessary, and perhaps a dominant factor in solving verbal problems. Spilman and Weiner (1972) stated that a common belief about verbal problems is that they are more difficult than problems of identical mathematics content presented solely in numerals, not only because of reading, but also because they require recognition of the mathematical process appropriate to the problem's solution. Davis (1973) reported that even students who have experienced little difficulty in computation, very often have great difficulty when they attempt to solve verbal problems.

Brueckner and Grossnickle (1959) listed the following reasons why students experience failure when attempting to solve verbal problems: (1) failure to comprehend the problem; (2) reading difficulties; (3) inability to perform the necessary computation;

(4) lack of understanding of the process; (5) lack of knowledge of essential facts; and (6) lack of mental ability to understand the relations implied. In 1957, Bowers stated that if students are to have a chance of correctly solving verbal problems, then they must be motivated; possess mathematical knowledge, including number facts; understand the relationship between quantities and the technical vocabulary; and be able to perform the fundamental mathematics operation.

In 1973, Davis reported that some of the reasons for the difficulty in teaching verbal problem-solving skills were: (1) inability to read analytically in order to select details, locate and remember information, organize what is read, separate essential data from non-existent data, distinguish between what is known and what is unknown, and make generalizations; (2) failure to understand what is read because of one's lack of experience, inability to visualize the situation, limited vocabulary, and imprecision of language; (3) lack of knowledge of quantitative relationships implied in problems such as inches, feet, and yards; (4) lack of basic understanding of the differences among and between fundamental operations; (5) inability to determine the reasonableness of an answer; (6) inability to translate verbal statements into mathematics sentences; and (7) failure to see a relationship between reality and the situation presented in verbal problems.

Much has been written about the mathematics curriculum from a philosophical viewpoint. The literature verifies a need for teaching verbal problem-solving skills, and identifies difficulties in teaching verbal problem-solving skills. Yet, the importance of a student acquiring this needed skill cannot be minimized.

Even though there have been studies which have examined the relationship of such characteristics as: reading and verbal problem-solving skills; mathematics computation and verbal problem-solving skills; mathematics concepts and verbal problem-solving skills; and scholastic ability and verbal problem-solving skills, the researcher was unable to locate any evidence in the literature of a study which examined the effects of a specially designed mathematics curriculum unit on a student's ability to solve verbal problems. Thus, the researcher designed this study, not only to fill the void, but hopefully, to provide information that will enable teachers of general mathematics to improve their students' skills in verbal problem solving and thus their ability to cope with the demands of today's society.

Chapter 3

RESEARCH PROCEDURES

Introduction

Chapter 3 is divided into six sections: The selection of the subjects; the development of the experimental materials; the design of the study and the procedure; the measurement instruments; the null hypothesis tested in the study; and the collection of data.

The Selection of the Subjects

In many school districts, the successful completion of one Carnegie unit in mathematics fulfills the state's mathematics requirement for a high school diploma (Wolfe, 1976). Successful completion of a general mathematics class can generally fulfill this graduation requirement. Usually, students who enroll in general mathematics classes score in the lower three stanines of standardized achievement tests and they do not normally enroll in additional mathematics classes. From the literature search and from conferences with experienced mathematics teachers, the writer concluded that teachers of general mathematics classes elect to emphasize computational skills over verbal problem-solving skills. Yet, students in general mathematics classes will need verbal problem-solving skills in order for them to become intelligent consumers, and in order for them to survive in modern-day society. Thus, students in ninth grade general mathematics classes were selected for subjects in this study and particularly those general mathematics students in the ninth grade were selected since they will very likely take no additional mathematics.

The Development of the Experimental Materials

Experimental mathematics curriculum materials, reflecting practical, everyday, real-world situations were developed for use in this study (see Appendix A). The experimental curriculum material was designed to be a two-week unit of study in which teachers instructed students in verbal problem-solving skills in a step-by-step method. The solutions to the verbal problems in the unit required the use of single- and multi-mathematical operations and these were scattered throughout the unit. (See Appendix B for a summary of these operations.)

Brownell (1946) stated that through learning to solve verbal problems, students see the chance to use ideas and skills to further some end. Spitzer (1954) wrote that the purpose for teaching verbal problem-solving skills is to teach students to solve problems of a similar nature to those they will meet in life. Therefore, the problems in the experimental curriculum material emphasized, but were not limited to, the following areas: income tax; savings accounts; comparative shopping; purchasing and operating costs of a vehicle; salaries (net and gross); borrowing money; and the real cost of purchases. The problems included in the experimental curriculum were designed to be motivational to this age group of students, and were not of the type found in many mathematics textbooks.

Spitzer and Flourney (1956) stated: "The most widely used procedure (for teaching the solution method for verbal problems) is that of just having students work problems without specific directions or suggestions" (p. 177). They further wrote: "It is recommended that most of the instructional time assigned to problem-solving then, be devoted to use of specific techniques" (Spitzer and Flourney, p. 177). Based upon the findings in the literature, the researcher developed a specific procedure to be used for this unit. The steps used in the procedure were: (1) read carefully and be sure you understand the problem; (2) decide what is given and what is to be found; (3) decide which operations and numbers are to be used; (4) estimate an answer; (5) compute your answer; and (6) check your answer.

Before using the experimental curriculum materials in the study, they were placed in a junior high school ninth grade remedial reading class and in a senior high school remedial reading class to determine the readability. A total of 55 students were involved in this readability test of the curriculum materials. The students in these remedial reading classes were instructed to circle any words they did not understand. If 10 percent or more of the students circled a given word, it was concluded that the experimental curriculum materials were written above the student's reading comprehension level, and the circled portion(s) of the experimental curriculum materials were rewritten at a less difficult reading comprehension level.

During the first readability trial, 64 words were circled, thus indicating that they were beyond the students' level of reading comprehension. The appropriate portions of the experimental curriculum materials were then rewritten, with the researcher substituting words with the same meaning, but at a lower reading comprehension level. (See Appendix C for the results of the first readability trial.)

After substituting the new words, the experimental curriculum materials were returned to the same two remedial reading classes for confirmation of the reading comprehension of the substituted words. The same instructions were given to the students for the second readability trial. The students were able to read the materials successfully this time, i.e., less than 10 percent of the students circled any given word in the experimental curriculum materials.

After it was determined that the experimental curriculum materials were written at the reading comprehension level of the students that they were intended for, the curriculum materials were used in two remedial mathematics classes of the same general characteristics as those for which the materials were intended, in order to determine if the students could follow the directions given for solving verbal problems, and to determine if the students could perform the necessary computations. A questionnaire was designed to gather input from the teachers who used the experimental curriculum materials to aid the researcher in evaluating its useability and whether the students for whom the experimental mathematics curriculum was intended could do the necessary computations.

(See Appendix D for the results of this questionnaire.) Upon completion of this trial, it was concluded that students of the same general characteristics as those for whom the experimental curriculum materials were intended, could follow the stated directions and could perform the necessary computations.

After determining the readability and useability of the problem-solving curriculum materials, it was concluded that the materials were ready for use in the experiment. Using the Fry Readability formula, the experimental curriculum materials were evaluated at the fourth grade reading level; and using the Flesch Readability formula, the experimental curriculum materials were evaluated as easy reading. The reading level of the experimental curriculum materials was important because the materials were written to be used in general mathematics classes. Aiken (1972) found the correlation between reading ability and mathematics achievement to range from 0.04 to 0.86. Therefore, if these students were low achievers in reading, there was a high probability that they would be low achievers in mathematics.

The Design of the Study and the Procedure

For many research projects which involve school children as subjects, a researcher must use established intact classes. Since it was not possible to randomly assign students to the Experimental Group and the Control Group for this study, a true experimental design could not be used; thus, a quasi-experimental design, the non-equivalent Control Group was selected (Campbell and Stanley, 1971).

The Control Group, Group I, and an Experimental Group, Group II, were identified and intact classes were randomly assigned to these groups for this study. Both groups were selected from established intact general mathematics classes; hence, both groups were similar in ability and achievement.* However, this similarity did not permit the researcher to eliminate a pretest.

The study was designed to last two weeks. During these two weeks, the Control Group continued with the unstructured current traditional general mathematics curriculum and the Experimental Group used the specially designed experimental curriculum materials. No instructions were given to the participating teachers who used the experimental curriculum materials in order not to introduce any bias from this source. At the end of two weeks, the four participating classroom teachers administered the Mathematics Problem Solving Subtest of the MAT, Form F, and the results were collected by the researcher for use as the posttest.

The data collected were treated using Analysis of Covariance (ANCOVA). The ANCOVA was selected for the treatment procedure because it is the appropriate method for treating data which is subject to the influence of other factors. That is, the posttest means of the Experimental Group and the Control Group will be adjusted.

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*In the selected school district, students were placed in general mathematics classes according to their standardized test scores in ability and achievement in mathematics, usually below the fourth stanine.

for these two groups with respect to the covariate, which previously has been determined to be an influence on the dependent variable. Kirk (1968) noted that through ANCOVA, the dependent variable (the ability to solve verbal problems) can be adjusted to remove the effects of uncontrolled sources of variation. In this study, the score on the Mathematics Problem Solving Subtest of the MAT, Form G, was used as the covariate. Also, since intact classes were used instead of a random sample of subjects, the ANCOVA was selected as the appropriate statistical method to test the null hypothesis.

Finally, Kirk (1968) further noted that there can be interpretation difficulties involving the results of ANCOVA when using intact classes; thus, the pre-study data were additionally considered in relationship to the findings of this study, and those of another author, i.e., Chase (1960), by considering the pre-study data as discriminating variables in the statistical procedure of discriminant analysis.

The Measurement Instruments

The Mathematics Problem Subtest for the MAT, Form G, was used as a pretest. This subtest of the MAT was administered during the spring semester to all eighth grade students in the chosen school district; therefore, the results of this subtest were available for all students who were potential subjects in this study. An alternate form, Form F, of the Mathematics Problem Solving Subtest of the MAT was used as the posttest, which was administered to the Control Group and the Experimental Group at the conclusion of the two-week study. A complete list of the pre-study data collected can be found in Appendix E.

The Null Hypothesis Tested in the Study

> Ho: There is no significant difference between the mean posttest scores of the students in the Control Group, Group I, and the students in the Experimental Group, Group II, as measured by the Mathematics Problem Solving Subtest of the Metropolitan Achievement Test (Form F) at the .05 level.

The Collection of Data

Scores from the Metropolitan Achievement Test (MAT) and Otis-Lennon Mental Ability Test (OLMAT) were collected for use in the study and were obtained from the individual student's cumulative files. The following data were retrieved from the OMLAT and MAT results in each student's cumulative file and comprised the pre-study data: scholastic ability (I.Q.); reading; mathematics computation; mathematics concepts; and mathematics problem solving (see Appendix E.). These tests, the OMLAT and the MAT (Form G), were administered to all eighth grade students in the chosen school district during the spring semester immediately preceding the study.

The Problem Solving Subtest of the MAT, Form F, was used for the postest for this study (see Appendix F), and the scores obtained from the special administration of this subtest, upon conclusion of the two-week period, served as the posttest data for the participating subjects.

Chapter 4

THE DATA AND THE DISCUSSION OF THE DATA

Chapter 4 will present the data collected during the study, and immediately following each collection of data will be the discussion of the data. Chapter 4 will give the data in the following order: The subjects; the pre-study information; the selection of the covariate; the ANCOVA; and additional data considerations.

The Subjects

Initially, the subjects selected for participation in this study were 138 ninth grade students enrolled in nine intact general mathematics classes in four different schools. These students had been studying general mathematics for eight months as individual groups, each class with its respective teacher for the entire period. Of the 138 students comprising these intact classes, complete pre-study data for only 90 students were available. Therefore, only these 90 students for whom complete pre-study data were available were included as subjects in the study.

Since only intact classes were available for use in the study, the subjects in five classes in two of the four schools were randomly assigned to Group II, the Experimental Group (n=57). Students in the four classes in the remaining two schools were designated Group I, the Control Group (n=33). Each class retained its regular teacher for the duration of the study, and only one teacher from each of the four schools participated in the experiment. (See Appendix G for a listing of teacher qualifications.)

The Pre-study Information

During the spring of the subjects' eighth grade school year, i.e., the academic year immediately preceding the study, the MAT and the OMLAT were administered to them. The results of these tests were available in the subjects' cumulative folder and also on microfilm in the selected school district's Department of Research and Development. Both sources were needed in order to collect the complete sets of pre-study data on each subject included in the study. The OMLAT provided each subject's I.Q. score, and the subtests of the MAT provided raw scores, as well as standard scores, percentiles, and stanines, in the following areas: Reading; Mathematics Computation; Mathematics Concepts; and Mathematics Problem Solving. In addition to the pre-study information, each subject's sex was recorded. (Appendix E provides a summary of the pre-study data collected for the 90 subjects who participated in the study and the membership of each subject in either Group I or Group II.)

The Selection of the Covariate

In order to select the appropriate covariate from the pre-study data. a Pearson Product Moment Correlation Coefficient matrix was calculated for the complete collection of data. Table 1 gives a summary of the matrix for those characteristics most likely to serve as the covariate. (See Appendix H for the complete Pearson Product Moment Correlation Coefficient matrix.)

Table 1

Pearson Product Moment Correlation Coefficient with the Posttest

	I.Q.	Reading	Computation	Concepts	Problem Solving (Pretest)
Problem-Solving Posttest	.54	.45	.53	.54	.63

The mathematics problem-solving pretest had the highest correlation with the posttest; thus, it was selected as the covariate for this study.

The Analysis of Covariance

After completion of the experimental procedure (described in Chapter 3), the Mathematics Problem Solving Subtest of the MAT, Form F, was administered as a posttest to the 90 subjects participating in the study during the spring semester of 1979. The pretest means, the posttest means, and the adjusted posttest means are listed in Table 2 for the Control Group and the Experimental Group. (The results of the posttest are listed in Appendix F.)

The analysis of covariance (ANCOVA) was performed using sub-program ANOVA of the Statistical Package of Social Sciences (SPSS Version 7.0 - June 27, 1977). The results of the ANCOVA are given in Table 2.

Table 2

Pretest Means, Posttest Means, and Adjusted Posttest Means for the Mathematics Problem Solving Subtest of the MAT

	Pretest Mean Form G	Posttest Mean Form F	Adjusted Posttest Mean Form F
Control Group (n=33)	13.9	17.00	16.39
Experimental Group (n=57)	16.40	19.09	19.27
Overall (n=90)	15.49	18.32	---

The ANCOVA results led to the decision to reject the null hypothesis:

> There is no significant difference between the mean posttest score of the students in the Control Group, Group I, and the students in the Experimental Group, Group II, as measured by the Mathematics Problem Solving Subtest of the Metropolitan Achievement Test (Form F) at the .05 level.

On the use of ANCOVA with intact groups, although common in educational research, Kirk (1969) stated:

> A note of caution concerning the use of intact groups is needed here. Experiments of this type are always subject to interpretation difficulties that are not present when random assignment is used in forming the experimental groups.

Table 3

Analysis of Covariance Results

Source of Variation	Sum of Squares	DF	Mean Squares	F
Main Effects	1081.82	2	540.91	28.94
Group ID	91.09	1	91.09	4.88*
Covariate	990.72	1	990.72	53.01
Explained	1081.72	2	540.91	28.94
Residual	1625.84	87	18.69	
Total	2707	89	30.42	

*Significant at the .03 level.

Null hypothesis rejected.

> Even when analysis of covariance is skillfully used, we can never be certain that some variable that has been overlooked will not bias the evaluation of an experiment. This problem is absent in properly randomized experiments because the effects of all uncontrolled variables are distributed among the groups in such a way that they can be taken into account in the test of significance. The use of intact groups removes this safeguard (p. 452).

Since randomization of the subjects' assignment to groups was not possible for this study, additional consideration of the data may provide some insight regarding the results obtained.

Additional Data Considerations

Studies by Chase (1960), Aiken (1972), Davis (1973), Brueckner and Grossnickle (1959), and other researchers have found positive relationships between the characteristics measured by the pre-study data, and the ability of students to solve verbal problems. Hence, the researcher used these pre-study data as discriminating variables in the statistical procedure of Discriminant Analysis (Sub-Program Discriminant, SPSS, Version 7.0 - June 27, 1977) to provide some additional insights regarding the results of the ANCOVA in this study. Discriminant Analysis was selected because its classification function is useful in predicting a student's success or lack of success (pass or fail) in solving verbal problems on the basis of the characteristics measured by the pre-study data, and thus an examination of these characteristics might prove fruitful for the above purpose.

This study was conducted to test the effect of specially developed experimental mathematics curriculum materials on the ability of general mathematics students to solve verbal problems; however, approximately 50 percent of those students who used these experimental materials in the study failed the posttest ($x < 20$)*. Therefore, the author looked to the pre-study data for additional information to determine if it was possible to statistically distinguish between the students who passed the posttest ($x \geq 20$) and those who failed the posttest, thus establishing the classification

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*A score of 20 on the Mathematics Problem Solving Subtest of the MAT was selected as a passing score because it converts to the 30th percentile for students at the beginning of the ninth grade. The writer noted that for other grades, scores at the 30th percentile for the beginning of a grade level did not drop below the fourth stanine when converted for the end of the grade level; thus, the writer designated the fourth stanine or higher ($x \leq 20$) as passing. These conversions were based upon national norms.

function of Discriminant Analysis. All five categories of the pre-study data were used to determine if the subjects in the study could be classified into two groups, i.e., pass or fail.

Examination of the posttest results for the Control Group and the Experimental Group (see Appendix F) showed that some subjects in the Control Group (Group I) passed the posttest with a score of 20 or greater, while some subjects in the Experimental Group (Group II) failed the posttest with a score of 19 or less. Thus, two new groups were constructed from each of Group I and of Group II, i.e., a group consisting of those who passed the posttest, and a group consisting of those who failed the posttest. These new groups are referred to as Group P and Group F, respectively. (See Appendix I for subject membership in Group P and Group F.)

Table 4 summarizes the pre-study data mean raw scores for those students in the Control Group who failed the posttest and those students in the Control Group who passed the posttest. The mean raw score for every variable for those subjects who passed the posttest was observed to be greater than the mean raw score for those subjects who failed the posttest, thus indicating that all five variables were important in the acquisition of verbal problem-solving skills, as indicated by the measured ability to solve verbal problems. Twenty-seven percent of the Control Group passed the posttest, even though they did not experience the specially designed curriculum materials. This, plus the fact that approximately 50 percent of the Experimental Group failed the posttest, provided additional incentive to examine the pre-study data for information that might possibly provide some insights regarding the outcome of the ANCOVA.

Table 4

The Pre-study Data Mean Raw Scores for the Pass Subgroup and the Fail Subgroup of the Control Group

Variable	Fail Group[a] $\bar{x}$	Pass Group[b] $\bar{x}$	Difference between the Means
Sub. I.Q.	87	97	10
MAT Read.	38	48	10
MAT Comp.	16	20	4
MAT Cpts.	13	20	7
MAT Ps.	12	19	7

[a] n=24

[b] n=9

Table 5 summarizes the pre-study mean raw scores for those students in the Experimental Group who failed the posttest and those students in the Experimental Group who passed the posttest. The mean raw score for every variable for those subjects who passed the posttest was observed to be greater than the mean raw score for those subjects who failed the posttest. These data again indicated that all five variables were important to the acquisition of verbal problem-solving skills, as indicated by the measured ability to solve verbal problems.

Table 5

The Pre-study Data Mean Raw Scores for the Pass Subgroup and the Fail Subgroup of the Experimental Group

Subtest	Fail Group[a] $\bar{X}$	Pass Group[b] $\bar{X}$	Difference between the Means
Sub. I.Q.	88	97	9
MAT Read.	39	52	13
MAT Comp.	16	21	5
MAT Cpts.	16	21	5
MAT Ps.	14	19	5

[a]n=29

[b]n=28

A comparison of the difference between mean raw scores for the subjects in the Control Group (Table 4) and the subjects in the Experimental Group (Table 5) indicated that the pass group, within the Control Group and the Experimental Group, had approximately the same range between them and the students in the fail group, within the Control Group and the Experimental Group. Also, a comparison of mean scores of subjects in the Control Group who failed the posttest and subjects in the Experimental Group who failed the posttest shows that these students have similar scores on the five pre-study variables. The same can be said for students in the Control Group and students in the Experimental Group who passed the posttest.

These comparisons provided additional support for the writer's decision to further examine the pre-study data as it related to the students' acquisition of mathematics verbal problem-solving skills.

Table 6 lists the students in the newly constructed F group of the Control Group whose pre-study data scores resulted in discriminant scores that gave them a higher probability of being in the pass group; in other words, those who failed and had a higher probability of passing according to their discriminant scores. There were two students in the Control Group (n=33) who were misclassified, and both of them failed. Visual comparison of their pre-study data with that in Table 4 did not exhibit a pattern to the researcher.

Table 6

Pre-study Data and Discriminant Scores for Those Students in the Control Group Who Were Incorrectly Classified by the Discriminant Analysis

Stud. #	Actual Group	Higher Prob. Group	I.Q.	Read.	Comp.	Conc.	Prob. Sol. (Pretest)	Discr. Score
27	Fail	Pass	94(28)[a]	38(16)	21(32)	21(40)	16(26)	-1.302
29	Fail	Pass	88(22)	55(38)	18(24)	16(22)	16(26)	- .995

[a]Percentile ranks are enclosed in parentheses.

Table 7 lists the students in the Experimental Group whose pre-study data scores resulted in discriminant scores that gave them a

Table 7

Pre-study Data and Discriminant Scores for Those Students in the Experimental Group Who Were Incorrectly Classified by the Discriminant Analysis

Stud.#	Actual Group	Higher Prob. Group	I.Q.	Read.	Comp.	Conc.	Prob. Sol.	Disc. Score
38	Fail	Pass	104(51)[a]	37(16)	15(18)	12(10)	13(16)	-.382
47	Fail	Pass	92(26	36(14)	20(30)	14(16)	19(36)	-.136
51	Fail	Pass	82(12)	38(16)	33(78)	22(44)	30(82)	-.949
52	Fail	Pass	99(33)	59(44)	24(40)	24(50)	17(30)	-1.140
56	Fail	Pass	99(41)	50(32)	16(20)	11(8)	17(30)	-.414
75	Fail	Pass	93(35)	60(48)	20(30)	21(40)	18(32)	-.425
88	Fail	Pass	98(51)	60(48)	13(12)	18(28)	13(16)	-.015
39	Pass	Fail	87(18)	60(48)	13(12)	12(10)	19(36)	.536
69	Pass	Fail	78(8)	26(6)	21(32)	9(4)	12(14)	1.312
70	Pass	Fail	91(36)	31(10)	19(26)	13(14)	8(4)	.613
72	Pass	Fail	88(22)	51(32)	20(30)	18(28)	18(32)	.057
76	Pass	Fail	86(14)	32(10)	17(22)	17(26)	16(26)	.751
79	Pass	Fail	99(40)	43(22)	9(4)	18(28)	9(6)	.604
83	Pass	Fail	97(36)	35(14)	18(24)	17(26)	12(14)	-.009

[a]Percentile ranks are enclosed in parentheses.

higher probability of being in the other group; in other words, those who failed and had a higher probability of passing, and those who passed and had a higher probability of failing.

Comparing Table 7 with Table 6, it can be seen that more students in the Experimental Group (16 percent) were misclassified than in the Control Group (6 percent). Further inspection of Table 7 showed that seven students who passed should have failed and seven students who failed should have passed. Visual comparison of these students'

Table 8

Discriminant Analysis Summary
for the Control Group

Step Number	Variable Entered	F to Enter	Number Included	Wilk's Lambda
1	Mat Ps.	41.45	1	.42768
2	Sub. I.Q.	6.83	2	.34847
3	MAT Cpts.	1.11	3	.33560
4	MAT Comp.[a]	.24	4	.33277
5	MAT Read.[a]	.22	5	.33012

[a]Very little contribution.

Table 9

Discriminant Analysis Summary
for the Experimental Group

Step Number	Variable Entered	F to Enter	Number Included	Wilk's Lambda
1	Sub. I.Q.	21.59	1	.71814
2	MAT Comp.	8.03	2	.62513
3	MAT Ps.	1.05	3	.61296
4	MAT Read.[a]	.24	4	.61009

[a]Very little contribution.

pre-study data in Table 7 with that in Table 5 did not exhibit a pattern to the researcher; however, a visual comparison of Table 4 with Table 5 did indicate the importance of these variables, in that the P group scored higher in every category than the F group.

Table 8 summarizes the results for the stepwise selection of variables procedure for discriminant analysis using the minimum Wilk's Lambda as criterion for inclusion. The variables (pre-study data) were entered stepwise in order of the highest correlation with the posttest to the lowest correlation with the posttest. Thus, all five variables were entered into the stepwise procedure, and none were removed. This indicated that all five variables contributed to the placement of a student in the pass group or the fail group. Hence, it was concluded that if a student in the Control Group is expected to obtain a passing score ($x \geq 20$) on the Problem Solving Subtest (Form F) of the MAT, that student must have similar scores on the five pre-study categories (i.e., variables) as those who passed the posttest (see Table 4). Further, an examination of the data in Table 1 showed a positive correlation between the posttest and these variables. Thus, it was concluded that this positive relationship between the five variables and the posttest was a source of influence on the ANCOVA results.

Table 9 summarizes the results of the discriminant analysis for the Experimental Group. The variables (pre-study data) were entered stepwise in order of the highest correlation with the post-test to the lowest correlation with the posttest. Of the five variables, four were included in the discriminant analysis and the fifth, the mathematics concepts raw score, was not included. The change in the Wilk's Lambda for the mathematics concepts score was not large enough to indicate that it made a significant contribution to the calculation of the discriminant scores. This indicated that the four variables listed in Table 9 contributed to the discriminant score for each subject in the Experimental Group, and thus, their placement in the pass group or fail group, as measured by the Form F Problem Solving Subtest of the MAT. Hence, it was concluded that if a student uses the experimental mathematics curriculum materials (see Appendix A), and is expected to obtain a passing score ($x \geq 20$) in solving verbal problems as measured by the Mathematics Problem Solving Subtest of MAT, Form F, that student must have scores similar to those for these four variables as listed in Table 5. Further, a comparison of the data in Table 1 showed positive correlations between the posttest and these four variables. Thus, it was concluded that this positive relationship between the four variables and the posttest was a source of influence on the ANCOVA results.

Even though the ANCOVA result led the researcher to reject the null hypothesis at the .05 level, it did not yield to the researcher any information regarding the pre-study variables' effect on the student's ability to solve verbal problems. From Table 1, it can be seen that each variable had a positive correlation with the posttest; hence, it was concluded that each variable had an effect on the student's ability to solve verbal problems. Yet, the question of the importance of each variable remained unanswered. Thus, the researcher used discriminant analysis to further examine the pre-study data. By examining Tables 4 and 5, the importance of each pre-study variable can be seen; the mean raw score of each pre-study data category (variable) for students who passed the posttest was greater than the mean raw score on each pre-study data category (variable) for those students who failed the posttest. Tables 6 through 9 established the relative importance of each pre-study data category (variable) and combinations of the variables. The information in Tables 4 through 9 may prove useful in predicting which students will be successful in acquiring verbal problem-solving skills as measured by the Problem Solving Subtest of the MAT, Form F. Additionally, the examination of the pre-study data categories verified the results of several other researchers, i.e., Aiken (1972), Chase (1960), Davis (1973), and others, who examined the effects of these same variables (I.Q., reading, mathematics computation, and mathematics concepts) on problem-solving ability of students. Finally, the additional examination of the pre-study data allowed the researcher to gather objective information regarding these variables, and thus, their effect on a student's ability to solve verbal problems, which manifested itself as an influence on the ANCOVA results.

Chapter 5

SUMMARY AND RECOMMENDATIONS

Summary

As noted in Chapter 2, students enrolled in general mathematics courses have not had ample instruction in solving verbal problems. Several reasons were given, including: (1) emphasis was placed on computation; (2) reluctance on the part of the teacher to teach verbal problem-solving techniques and methods; (3) lack of expertise on the part of the teacher to teach verbal problme-solving techniques and methods; and (4) lack of specific curriculum materials to use with general mathematics students.

The purpose of this study was to determine the effect of a specially prepared curriculum material on the verbal problem-solving ability of general mathematics students. The specific research question inventigated was: What is the effect of the type of instructional materials on the acquisition of verbal problem-solving skills of general mathematics students? This research question was examined by testing the null hypothesis, Ho: There is no significant difference between the mean posttest scores of the students in the Control Group, Group I, and the students in the Experimental Group, Group II, as measured by the Mathematics Problem Solving

Subtest of the Metropolitan Achievement Test (Form F) at the .05 level. The null hypothesis was tested using 90 subjects selected from nine classes from four different junior high schools in a selected school district in Nevada, with 33 subjects in the Control Group and 57 subjects in the Experimental Group.

The null hypothesis was tested, using the ANCOVA, and was rejected, with the experimental results significant at less than the .05 level. However, interpretation difficulties for ANCOVA, based in the non-random assignment of subjects to groups in the study, led the author to additional data considerations using the pre-study data as discriminating variables and the posttest results as a classification criterion in a discriminant analysis.

The results of the discriminant analysis, using the pre-study data, were in agreement with the results of a study conducted by Chase in 1960 to determine which factors were most effective in predicting success in solving verbal problems. The results of the discriminant analysis led this author to agree with the earlier researchers that reading, intellectual factors, mathematics computation, and a knowledge of mathematics concepts are effective in predicting success in the acquisition of verbal problem-solving skills, and thus, these variables may have influenced the outcome of the ANCOVA of this study.

Recommendations for Further Research

Related studies of the following types may provide useful information to educators in the area of verbal problem-solving instruction.

1. A repeat of this study using a true experimental design, i.e., a random sample of general mathematics students as subjects, thus eliminating the interpretation of the ANCOVA results problem experienced with intact classes (Kirk, 1969).
2. A study utilizing the five pre-study variables, and use of discriminant analysis to predict success or failure of the subjects.
3. A study utilizing the five pre-study variables, the experimental mathematics materials, and a true experimental design, and use of discriminant analysis to predict success or failure of the subjects.
4. A study utilizing discriminant analysis to determine which pre-study data characteristics, or combination of characteristics, are most important for student acquisition of verbal problem-solving skills.
5. A study to determine which students, i.e., below-average, average, or above-average, might benefit most from curriculum materials of the type used in this study.
6. Using the experimental mathematics materials (Appendix A), determine which parts of the experimental materials contributed most to the acquisition of verbal problem-solving skills of a student, and which pre-study data contributes most to this skill development for each part of the curriculum materials.

References

Aiken, L. R. Language factors in learning mathematics. Review of Educational Research, 1972, 42(2), 359-387.

Assessment finds poor consumer math skills. Education Daily, 1975, 8 (144), 1-2.

Austin, G. R., & Prevost, F. The results of a longitudinal study in mathematics in New Hampshire. Mathematics Teacher, 1972, 65(8), 746-747.

Avis, P. M. A series of word problems using sixth grade arithmetic processes and paralleling sixth grade social studies. Unpublished project, University of Southern California, 1954.

Beal, J. L. An evaluation of activity oriented materials developed to help the low achiever attain basic mathematics competencies (Doctoral dissertation, University of Nebraska, 1972). Dissertation Abstracts International, 1973, 33, 3249A-3250A. (University Microfilm No. 73-101)

Bean, J. E. Arithmetic understandings of elementary school teachers. The Elementary School Journal, 1959, 59(8), 447-450.

Begle, E. G. Mathematics education: The sixty-ninth yearbook of the National Society for the Study of Education. Chicago: University of Chicago Press, 1970.

Begle, E. G., & Selfridge, O. What's all the controversy about? Two reviews of why Johnny can't add. The National Elementary Principle, 1974, 6111(2), 26-34.

Bent, D.H., Hull, C. H., Jenkins, J. G., Nie, N. H., & Steinbrenner, K. Statistical package for the social sciences (2nd ed.). New York: McGraw Hill, 1975.

Bowers, J. E. Procedure to strengthen ability to solve arithmetic problems. School Science and Mathematics, 1957, 62(6), 485-493.

Branscombe, A. Checkout on consumer math. American Education, 1975, 11(8), 21-24.

Brody, J. What ever happened to the new math. The American School, 1977, 164(3), 36-39.

Brownell, W. Problem solving. The psychology of learning. The forty-first yearbook of the National Society for the Study of Education, Part II. Bloomington, Illinois: Public School Publishing Co., 1942.

Brownell, W. The place of meaning in the teaching of arithmetic. The Elementary School Journal, 1947, 48(5), 256-265.

Brueckner, L., & Grossnickle, F. E. Discovering meanings in arithmetic. Philadelphia: J. C. Winston Co., 1959.

Brune, I. H. Language in mathematics. The learning of mathematics: It's theory and practice. Twenty-first Yearbook, The National Council of Teachers of Mathematics, Washington, D. C., 1953.

Call, R. J., & Wiggin, N. A. Reading and mathematics. Mathematics Teacher, 1966, 59(2), 149-157.

Campbell, D. T., & Stanley, J. D. Experimental and quasi-experimental designs for research. Chicago: Rand McNally, 1966.

Carpenter, T. P., Coburn, T. G., Reys, R. E., & Wilson, J. W. Notes from national assessment: Word problems. Arithmetic Teacher, 1976, 23(5), 389-393.

Cassidy, J., & Sharkey, V. 'Rithmetic reading. Teacher, 1977, 94(5), 50-54.

Chase, C. I. The position of certain variables in the prediction of problem solving in arithmetic. Journal of Educational Research, 1960, 54(1), 9-14.

Cummins, J. K. The arithmetic achievement of sixth-grade pupils and the effect of short-term well designed practice on their computational abilities (Doctoral dissertation, University of California, Los Angeles, 1974). Dissertation Abstracts International, 1975, 35, 4031B-4023B. (University Microfilms No. 75-2221)

Davis, E. C. Practice in problem solving. The Instructor, 1973, 82(8), 84-88.

Dunlap, W. P., & House, A. D. Why can't Johnny compute. Journal of Learning Disabilities, 1976, 9(4), 210-214.

Eagle, F. The relationship of certain reading abilities to success in mathematics. Mathematics Teacher, 1948, 41, 175-179.

Ebel, R. L. Declining scores: A conservative explanation. Phi Delta Kappan, 1976, 58(4), 306-310,

Editorial Panel. The question of minimum competency. Mathematics Teacher, 1977, 70(2), 100.

Fitzgerald, W. M. The role of mathematics in a comphrehensive problem solving curriculum in secondary schools. School Science and Mathematics, 1975, 75(1), 39-47.

Ford, S. D. Organizing problem solving experiences in fourth grade arithmetic. Unpublished project, University of Southern California, 1962.

Frand, J. L. Mathematical understanding and mathematical proficiency: An analysis of alternative goals and programs in mathematics education (Doctoral dissertation, University of California, Los Angeles, 1976). Dissertation Abstracts International, 1976, 37, 2695A-2696A. (University Microfilms No. 76-25,295)

Gawronski, J. D. What's going on . . . Arithmetic Teacher, 1976, 23(6), 425-426.

Gilmary, S. Transfer effects of reading remediation to arithmetic computation when intelligence is controlled and all other school factors are eliminated. Arithmetic Teacher, 1967, 14(1), 17-20.

Good, G. V. (Ed.) Dictionary of education (3rd ed.). New York: McGraw-Hill Book Company, 1973.

Grieder, C. Have the schools failed society? Education Digest, 1972. 38(3), 35.

Henderson, K. B., & Pingry, R. E. Problem solving in mathematics. The learning of mathematics: Its theory and practice. Twenty-first yearbook. The National Council of Teachers of Mathematics, Washington, D. C., 1953.

Henny, M. Improving mathematics verbal problem solving ability through reading instruction. Arithmetic Teacher, 1971, 18(4), 223-229.

Hill, S. Issues from the NACOME report. Mathematics Teacher, 1976, 69(6), 440-446.

Hirschi, L. E. The new math. Arithmetic Teacher, 1977, 24(3), 241-245.

Johnson, H. C. The effect of instruction in mathematical vocabulary upon problem solving in arithmetic. Journal of Educational Research, 1944, 38(2), 92-110.

Johnson, J. T. On the nature of problem solving in arithmetic. Journal of Educational Research, 1949, 43, 110-115.

Kilpatrick, J. Problem solving in mathematics. Review of Educational Research, 1969, 39(4), 523-534.

Kirk, R. E. Experimental design: Procedures for the behavioral sciences. Belmont, California: Brooks/Cole Publishing Co., 1968.

Kline, M. Why Johnny can't add: The failure of new math. New York: St. Martin's Press, 1973.

Kline, M. NACOME: Implications for curriculum design. Mathematics Teacher, 1976, 69(6), 449-454.

Lambert, E. W. A survey of arithmetic skills required of high school students for employment. Unpublished project, University of Southern California, 1964.

National Council of Supervisors of Mathematics. Position paper on basic mathematical skills, 1977.

National Council of Teachers of Mathematics. Hints for problem solving. More topics in mathematics for elementary school teachers. Thirtieth yearbook, The National Council of Teachers of Mathematics, Washington, D. C., 1977.

Nelson, D., & Kirkpatrick, J. Problem solving. Mathematics learning in early school. Thirty-seventh yearbook, The National Council of Teachers of Mathematics, Washington, D. C., 1977.

O'Brien, M. L. A study of objectives of secondary mathematics for non-college students. Unpublished project, University of California, 1962.

O'Ferrall, A. F. Mathematics for the average pupil in junior high school. Unpublished project, University of Southern California, 1962.

Polya, G. How to solve it (2nd ed.). Garden City, N.Y.: Doubleday Anchor Books, 1957.

Quast, W. G. On computation and drill. Arithmetic Teacher, 1969, 16, 627-630.

Recommendations and perspectives for school mathematics. Education Digest, 1976, 42(2), 16-19.

Reys, R. E. Consumer math: Just how knowledgeable are U.S. young adults. Phi Delta Kappan, 1976, 58, 258-260.

Richardson, L. I. The role of strategies for teaching pupils to solve verbal problems. Arithmetic Teacher, 1975, 22, 414-421.

Riedesel, C. A. Problem solving: Some suggestions from research. Arithmetic Teacher, 1969, 16, 54-58.

Rogers, V. R., & Baron, J. Declining scores: A humanistic explanation. Phi Delta Kappan, 1976, 58, 311-313.

The Secondary School Curriculum Committee of the National Council of Teachers of Mathematics. The secondary mathematics curriculum. Mathematics Teacher, 1959, 52, 309-317

Smith, F. The readability of sixth grade word problems. School Science and Mathematics, 1971, 71, 559-562.

Smith, H. P. Helping fourth grade children solve work problems. Unpublished project, University of Southern California, 1963.

Sowder, L. Teaching problem solving: Our lip service objective. School Science and Mathematics, 1972, 72, 113-116.

Spillman, H., & Weiner, M. A study of student performance on arithmetic presented in verbal and non-verbal forms. Measurement and Evaluation in Guidance, 1972, 5, 446-449.

Spitzer, H. F. The teaching of arithmetic (2nd ed.). Cambridge, Mass.: Houghton Mifflin Co., 1954.

Spitzer, H. G. What research says about teaching arithmetic (rev. ed.). Department of Classroom Teachers, American Education Research Association of the National Education Association, Washington, D. C., 1963.

Spitzer, H. F., & Flournoy, F. Developing facility in solving verbal problems. Arithmetic Teacher, 1956, 3(5), 177-182.

Timmer, H. F. Make way for the right math. Teacher, 1974, 91(9), 12-17.

Thorpe, C. B. Those problem solving perplexities. Arithmetic Teacher, 1961, 8(4), 152-156.

Trafton, P. The curriculum. Mathematics learning in early childhood. Thirty-seventh yearbook, National Council of Teachers of Mathematics, Washington, D. C., 1977.

Treacy, J. P. The relationship of reading skills to the ability to solve arithmetic problems. Journal of Educational Research, 1944, 38(2), 86-96.

Wolfe, M. S. Mathematics programs and trends. NASSP Bulletin, 1976, 60(396), 91-96.

Bibliography

Aiken, L. R. Update on attitudes and other affective variables in learning mathematics. Review of Educational Research, 1976, 46 (2), 293-311.

Arter, J., & Clinton, L. Time and error consequences of irrelevant data and question placement in arithmetic word problems II: Fourth grade. Journal of Educational Research, 1974, 68(I), 28-31.

Ballew, H. Restoration of prestige to practical mathematics. The High School Journal, 1974, 63(3), 101-111.

Balow, I. H. Reading and computation ability as determinants of problem solving. Arithmetic Teacher, 1964, 11(1), 18-22.

Barney, L. The first and third R's. Today's Education, 1973, 62(3), 57-58.

Bell, M., Esty, E., Payne, J. N., & Suydam, M. N. Hand-held calculators: Past, present, and future. Organizing for mathematics instruction. 1977 yearbook, National Council of Teachers of Mathematics, Washington, D. C.: The Council, 1977.

Blecha, M. K. Helping children understand verbal problems. Arithmetic Teacher, 1959, 6(2), 106-107.

Boersig, T. M. The DPPC method - an opposing view. School Science and Mathematics, 1973, 73(8), 641-645.

Borota, N., & Veith, G. M. Mathematics for the learning laboratory to teach basic skills to tenth, eleventh, and twelfth graders in a culturally deprived area. Mathematics Teacher, 1970, 63(1), 55-56.

Brodinsky, B. Back to basics: The movement and its meaning. The Education Digest, 1977, 42(9), 2-5.

Brown, G. W., & Kinney, L. B. Let us look again at general mathematics. School Science and Mathematics, 1975, 75(7), 615-620.

Burton, G. M. Word problems - a mirror of society. Arithmetic Teacher, 1974, 21(1), 33-36.

Carpenter, T. P., Coburn, T. G., Reys, R. E., & Wilson, J. W. Results and implications of the NAEP mathematics assessment: Secondary school. Mathematics Teacher, 1975, 68(6), 453-470.

Carpenter, T. P., Coburn, T. G., Reys, R. E., & Wilson, J. W. Results and implications of NAEP assessment: Elementary school. Arithmetic Teacher, 1975, 22(6), 438-450.

Clements, Z. J. Humanizing and back to the basics: The perfect blend for the '70s and beyond. The National Association of Secondary School Principal's Bulletin, 1977, 61(409), 98-108.

Cooper, F. F. Math as a second language. The Instructor, 1971, 81, 76-77.

Corle, C. G. Thought processes in grade six problems. Arithmetic Teacher, 1958, 5(4), 193-203.

Cox, L. S. Diagnosing and remediating systematic errors in addition and subtraction computation. Arithmetic Teacher, 1975, 22(2), 151-157.

Dahmus, M. E. How to teach verbal problems. School Science and Mathematics, 1970, 70(2), 121-138.

Dickey, J. W. The value of estimating answers to arithmetic problems and examples. Elementary School Journal, 1934, (1), 24-31.

Drive to make high school diplomas mean somthing. U. S. News and World Report, 1976, 80(25), 47.

Egerton, J. Back to basics. The Progressive, 1976, 40(9), 21-24.

Elam, S. E. Florida: Back to basic poverty. Phi Delta Kappan, 1976, 58(4), 305.

Engen, H. V. Twentieth century mathematics for the elementary school. Arithmetic Teacher, 1959, 6(2), 71-76.

Faulk, C. G., & Landry, T. R. An approach to problem-solving. Arithmetic Teacher, 1961, 8(4), 157-160.

Forbes, J. E. Course content in mathematics - our cultural heritage versus current relevancy. School Science and Mathematics, 1972, 72(6), 475-480.

Gay, L. R. Educational research: Competencies for analysis and application. Columbus, Ohio: Charles E. Merrill Publishing Company, 1976.

Grossnickle, F. . Verbal problem solving. Arithmetic Teacher, 1964, 11(1), 12-17.

Hanson, C. W. Factors associated with successful achievement in problem solving in sixth grade arithmetic. Journal of Educational Research, 1944, 38(2), 111-118.

Harris, E. C. Mathematics teachers can't go back to basics leaders say. Education Daily, 1976, 9(144), 4.

Hater, M. A., Kane, R. B., & Byrne, M. A. Building reading skills in the mathematics class. Arithmetic Teacher, 1974, 21(8), 662-668.

Hestwood, D. L., & Taylor, R. Big bad basic skills--or, what one school system is doing to help low achievers. Mathematics Teacher, 1973, 66(6), 440-446.

Junge, C. W. Teach for meaning. National Education Association Journal, 1953, 42, 167-168.

Klas, W. L. Problems without numbers. Arithmetic Teacher, 1961, 8(1), 19-20.

Koenker, R. G. Twenty methods for improving problem solving. Arithmetic Teacher, 1958, 5(2), 74-78.

Landis, E. H. Secondary students' mathematics competencies in relation to employment tests (Doctoral dissertation, University of Southern California, 1968). Dissertation Abstracts International, 1968, 28, 4051A-4052A. (University Microfilms No. 68-5869)

Lankford, F. G. Consumer mathematics in general education of secondary schools. The High School Journal, 1974, 58(3), 79-85.

Lazarus, M. Toward a new program in mathematics. The National Elementary Principal, 1974, 53(2), 72-81.

Lees, F. Mathematics and reading. Journal of Reading, 1976, 19(8), 621-626.

Lewis, H. The nature of the consumer mathematics course. The High School Journal, 1974, 58(3), 86-93.

Martin, W. H., & Wilson, J. W. The status of national assessment in mathematics. Arithmetic Teacher, 1974, 21(1), 49-53.

McCormack, M. J. Computational program for gifted students. Mathematics Teacher, 1976, 69(3), 365.

Meaning of low test scores. U. S. News and World Report, 1976, 81 (12), 52.

Moody, E. B. Beyond computation. Arithmetic Teacher, 1975, 22(1), 22-26.

NIE plans research on the third R. Education Daily, 1975, 8(21), 4.

National assessment report on math skills. Education Daily, 1975, 8(37), 5.

Pace, A. Understanding and the ability to solve problems. Arithmetic Teacher, 1961, 8(5), 226-233.

Palardy, J. M., & Eisels, J. E. Competency based education. The Clearing House, 1972, 46(9), 545-548.

Parnell, D. Survival competencies: New Oregon graduation requirements. Education Digest, 1974, 34(9), 62.

Plumleigh, G. Achievement test scores: Are they of any use? Phi Delta Kappan, 1977, 58(81), 614-615.

Rosenthal, D. J. A., & Resnick, L. B. Children's solution processes in arithmetic word problems. Journal of Educational Psychology, 1974, 66, 817-825.

Schramm, C. F. Comparing schools by academic achievement scores. Phi Delta Kappan, 1976, 58, 324-326.

Shaw, R. A. The pendulum swings back in junior high/middle school math. NASSP Bulletin, 1974, 58(384), 90-95.

Sherrill, J. M. The effects of different presentations of mathematical word problems upon achievement of tenth grade students. School Science and Mathematics, 1973, 73, 277-282.

Sinner, C. The problem of problem solving. Arithmetic Teacher, 1959, 6(3), 158-159.

Spencer, P. L., & Russell, D. H. Reading in arithmetic. Instruction in arithmetic. Twenty-fifth yearbook, the National Council of Teachers of Mathematics, Washington, D. C., 1960.

Sueltz, B. A. Drill-practice-recurring experience. The learning of mathematics: Its theory and practice. Twenty-first yearbook, The National Council of Teachers of Mathematics, Washington, D. C., 1953.

Suydam, M. Continuing the mathematics revolution. American Education, 1970, 6(1), 26-30.

Taylor, R. NACOME: Implications for teaching K-12. Mathematics Teacher, 1976, 69, 458-463.

Trafton, P. Let's put it all together. Arithmetic Teacher, 1976, 23, 400-401.

Trent, J. H., Ray, F., & Zimmerman, D. Effectiveness of University of Illinois Committee on School Mathematics (UICSM) stretchers and shrinkers and motion geometry materials in improving arithmetic ability. School Science and Mathematics, 1972, 72, 822-827.

Uprichard, A. E., & Collura, C. The effect of emphasizing mathematical structure in the acquisition of whole number computational skills (addition and subtraction) by seven and eight year olds: A clinical investigation. School Science and Mathematics, 1977, 77, 97-101.

Wardrop, R. F. Mathematics in everyday life. School Science and Mathematics, 1974, 74, 62-66.

Webb, L. F., & Sherrill, J. M. The effects of differing presentations of mathematical word problems upon the achievement of preservice elementary teachers. School Science and Mathematics, 1974, 74, 559-565.

Where do you stand? Computational skill is passe. Mathematics Teacher, 1974, 67, 485-488.

Young, G. The mathematician's responsibility to education. NASSP Bulletin, 1976, 60(396), 91-96.

Zacharias, J. R. The importance of quantitative thinking. The National Elementary Principal, 1974, 53(2), 8-13.

APPENDIXES

APPENDIX A

The Experimental Mathematics

Curriculum Material

MESSAGE TO STUDENTS

This unit on story problems is to give you a chance to use your math skills to solve problems from real life. In real life, problems such as: 8X7; $4.59 + $5.49; or $62.50 - $12.00 are not found by themselves. By themselves, these are exercises in math and their purpose is for you to practice adding, subtracting, multiplying and dividing. They have very little meaning in real life and are not giving you a chance to solve problems.

In real life, you will find the following kinds of problems:

Example 1). Eight track tapes cost $6.00 each. How much will five of these tapes cost?

Example 2). The red t-shirt costs $4.95 and the blue t-shirt costs $5.49. Ann bought one of each color. How much did she pay for the two t-shirts?

Example 3). Last week, Bill made $62.50. His boss kept $12.50 for income tax. How much was his take-home pay?

To be able to work the above problems and other problems like them, you must be able to add, subtract, multiply and divide. These are the types of problems your teachers had in mind when they were teaching you to add, subtract, multiply and divide. They were not teaching you 3X5, 2+7, 9-3 and other facts just for the sake of learning them. They knew that you would need these facts to solve problems you will meet in real life.

This unit is written to give you a chance to practice solving problems from real life using the math skills you have learned. Solving real-life problems or story problems is a skill which does not come easy for most students. Most students have to work to learn this much-needed skill. Therefore, if you are not able to solve these problems in the beginning, don't give up. Keep trying. This unit is written to help you learn to solve problems from real life--the kind of problems that you will be faced with in a very few years.

STEPS FOR SOLVING VERBAL PROBLEMS

Your teachers know that there are other steps that can be used to solve real-life problems. Your teachers know that there are some real-life problems that you can read and answer without going through all of the steps below. However, there are many real-life problems that cannot be solved so easily. It is for these problems that we need to practice using the steps below. Then, when we meet one of these, we can use the steps to solve it.

You will find that by using these steps, you will be able to solve real-life problems easier. Be sure you go through each step for every problem, no matter how simple it may appear to you. When you get to the harder problems, you will see how easy they are to solve. Don't forget, use all of the steps for each and every problem.

Steps

1). READ CAREFULLY AND BE SURE YOU UNDERSTAND THE PROBLEM. This is a big step. You must read carefully to find the problem. Do not be a wise guy and read through quickly. This is not a course in speed reading. Careful reading saves time because you do not have to go back and read the problem again. It is not fun to work long and hard on a problem and then find out that you did not understand the problem. If you are not sure you understand the problems, ask your teacher for help.

2). DECIDE WHAT IS GIVEN. Before you try to solve any problem, you must decide what you are given to help you solve the problem. You must be able to sort this out.

3). DECIDE WHAT IS TO BE FOUND. You cannot begin to solve a problem if you do not know what is to be found. You should be able to sort out what is given from what is to be found. This step should be done with care. You do not want to spend time solving a problem and find out that you did not find what was asked for.

4). DECIDE WHICH OPERATIONS AND NUMBERS TO USE. Are you going to add, subtract, multiply, divide or do more than one of these to find the answer. If you read carefully and understand the problem, you should be able to decide. If you are having trouble with this step, ask your teacher for help.

5). ESTIMATE YOUR ANSWER. By performing this step, you will have an idea of what the right answer should be. However, you should not guess. It may take a little time to estimate the answer, but it is well worth it. If your final answer and your estimated answer are far apart, then you either have a poor estimate or your final answer is wrong. If this happens, then you should re-work the problem. Most estimates are found by rounding off the numbers and working the problems using these numbers.

6). FIND YOUR ANSWER. In finding the answer, be careful and try to avoid silly and careless mistakes. Many students make mistakes because they are in a hurry, careless, or don't know how to add, subtract, multiply or divide. Perform this step carefully.

7). CHECK YOUR ANSWER. Read the problem again. Check your final answer with your estimated answer. Are they close? Does your final answer appear to answer the problem? Does it make sense to you? If your answer to any of these questions is "no," then you should work the problem again.

GOAL STATEMENTS

After you complete this unit, you should be able to:

1). Read and understand real-life (story) problems;

2). Decide what is given in a real-life (story) problem;

3). Decide what is to be found in a real-life (story) problem;

4). Decide which operations and numbers to use to solve a real-life (story) problem;

5). Estimate an answer for a real-life (story) problem;

6). Find the correct answer for a real-life (story) problem; and

7). Decide whether or not you have correctly solved the problem.

1) Sue pays $45.00 a month for car insurance. How much doe she pay a year?

STEPS:

1) READ CAREFULLY

2) GIVEN: Car insurance - $45.00 a month

3) FIND: Cost for the year

4) OPERATIONS: Multiplication

5) ESTIMATE: $50.00 x 10 =

6). COMPUTE: $45.00 x 12 =

7) CHECK

2) Amy has $12.00 in her savings account. She takes out $35.00 for a trip to Disneyland. How much is left in her account?

STEPS:

1) READ CAREFULLY

2) GIVEN: Amount in savings account - $120.00
Amount taken out - $35.00

3) FIND: How much is left in the account

4) OPERATIONS: Subtractions

5) ESTIMATE: $120.00 - $40.00 =

6) COMPUTE: $120.00 - $35.00 =

7) CHECK

3) Jim worked with C.E.T.A. last summer. Out of four checks, he saved $35.00, $17.50, $42.75 and $20.00. How much did he save?

STEPS:

1) READ CAREFULLY

2) GIVEN: Amounts saved: $35.00, $17.50, $42.75 and $20.00

3) FIND: Total savings

4) OPERATIONS: Addition

5) ESTIMATE: $40.00 + $20.00
+ $40.00 + $20.00

6) COMPUTE: $35.00 + $17.50
$42.75 + $20.00 =

7) CHECK

4) Randy purchased two record albums. One cost $4.95 and the other cost $5.95. The sales tax is .40¢. How much change should Randy receive from a $20.00 bill?

STEPS:

1) READ CAREFULLY

2) GIVEN: Cost of records: $4.95 + $5.95
Sales tax: .40¢
Amount of money - $20.00

3) FIND: Change from $20.00

4) OPERATIONS: Addition and subtraction

5) ESTIMATE: $5.00 + $6.00 + 0 = ______
$20.00 - ____ = __________

6) COMPUTE: $4.59 + $5.95 _ .40¢ = ____
$20.00 - ___________ = ____

7) CHECK

5) Pete's new job pays $2.60 an hour. If he works four hours a day for five days a week, how much will he make?

STEPS:

1) READ CAREFULLY

2) GIVEN: Amount an hour - $2.60
Hours worked per day - 4
Days worked per week - 5

3) FIND: Pete's salary each week

4) OPERATIONS: Multiplication

5) ESTIMATE: $3.00 x 4x5 =

6) COMPUTE: $2.60 x 4x5

7) CHECK

6) Sue's car averages 18 miles per gallon of gas. If gas cost .70¢ a gallon and she drove 144 miles last week, how much did she pay for gas?

STEPS:

1) READ CAREFULLY

2) GIVEN: Amount paid for gas
Cost of gas - .70¢
Miles driven - 144

3) FIND: Amount paid for gas

4) OPERATIONS: Division and multiplication

5) ESTIMATE: 140 ÷ 20 = ____
____ x .70 = ____

6) COMPUTE: 144   18 = ____
____ x .70 = ____

7) CHECK

7) Jack's gross pay is $110.00 a week Deductions are: $22.00 for income tax; $15.00 for Social Security; $5.00 for union dues. How much is Jack's take-home pay?

STEPS:

1) READ CAREFULLY

2) GIVEN: Gross pay - $11.00
Income tax - $22.00
Social Security - $15.00
Union dues - $5.00

3) FIND: Take-home pay

4) OPERATIONS: Addition, subtraction

5) ESTIMATE: $20.00 + $15.00 + $5.00 = ____

$110.00 - ____ = ____

6) COMPUTE: $22.00 + $15.00 + $5.00 = ____
$110.00 - ____ = ____

7) CHECK

8) Sam wants to purchase a cycle which costs $1,800.00. If he pays $300.00 down and $64.00 a month for 36 month, how much will the cylce cost?

STEPS:

1) READ CAREFULLY

2) GIVEN: Cost of cycle - $1,800.00
Down payment - $300.00
Monthly payments - $64.00
Number of months - 36

3) FIND: True cost of cycle

4) OPERATIONS: Subtraction, multiplication, addition

5) ESTIMATE: $1,800.00 - $300.00 = ____
$70.00 x $40.00 = ____

6) COMPUTE: $1,800.00 - $300.00 = ____
$64.00 x 36 = ____
____ x ____ = ____

7) CHECK

9) Compute the weekly salary. Porters wanted. $4.50 an hour, 6-hours shift, five days a week.

STEPS:

1) READ CAREFULLY

2) GIVEN: $4.50 per hour
   6 hours per shift
   5 days a week

3) FIND: Weekly salary

4) OPERATION: Multiplication

5) ESTIMATE: $4.00 x 6x5 = _____

6) COMPUTE: $4.50 x 6x5 = _____

7) CHECK

10) Compute the weekly salary. Nurses wanted. Two years experience. Night shift, five nights a week, $7.25 per hour.

STEPS:

1) READ CAREFULLY

2) GIVEN: 8 hours per shift
   5 nights per week
   $7.25 per hour

3) FIND: Weekly salary

4) OPERATION: Multiplication

5) ESTIMATE: $7.00 x 8x5 = ________

6) COMPUTE: $7.25 x 8x5 + ________

7) CHECK

11) Sharpie's Auto Sales has a car for $500.00. If you pay $29.00 down and $49.00 per month for 24 months, how much will the car cost? Is this a good deal?

STEPS:

1) READ CAREFULLY

2) GIVEN: Cost of car - $500.00
   Down payment - $29.00
   Monthly payment - $49.00
   Number of payments - 24

3) FIND: True cost of car

4) OPERATIONS: Multiplication and addition

5) ESTIMATE: $50.00 x 20 = _____
   ______ + 30 = _____

6) COMPUTE: $49.00 x 24 = _____
   ______ + $29.00 = ______

7) CHECK

12) If Jerry saved $2.00 a week for 8 years, how much would he have?

STEPS:

1) READ CAREFULLY

2) GIVEN: Amount saved per week - $2.00
   Length of time - 8 years

3) FIND: Savings

4) OPERATIONS: Multiplication

5) ESTIMATE: $2.00 x 8 x 50 = _____

6) COMPUTE: $2.00 x 8 x 52 = _____

7) CHECK

13) Last week, John earned $23.00 washing cars, $37.00 mowing lawns, and $17.00 boxing groceries. If he needed $125.00 to buy a 10-speed bike, how much more does he need?

STEPS:

1) READ CAREFULLY

2) GIVEN: 1)
2)
3)
4)

3) FIND:

4) OPERATIONS: 1)
2)

5) ESTIMATE:

6) COMPUTE:

7) CHECK

14) If you scored 18 points, 9 points, 15 points, and 27 points in four basketball games, what is your average?

STEPS:

1) READ CAREFULLY

2) GIVEN: 1)
2)

3) FIND:

4) OPERATIONS: 1)
2)

5) ESTIMATE:

6) COMPUTE:

7) CHECK

15) Jackie has saved $48.00 to buy a 10-speed bike. If this bike costs $125.00 including taxes, how much does she have to borrow from her parents to buy the bike?

STEPS:

1) READ CAREFULLY

2) GIVEN: Amount saved - $48.00
Cost of bike - $125.00

3) FIND: Amount Jackie has to borrow

4) OPERATION: Subtraction

5) ESTIMATE: $130.00 - $50.00 = ______

6) COMPUTE:

16) Janice earns $1.25 an hour for babysitting. If she works 15 hours a week, how much does she make a week?

STEPS:

1) READ CAREFULLY

2) GIVEN: Amount an hour - $1.25
Hours worked - 15

3) FIND: Amount earned per week

4) OPERATION: Multiplication

5) ESTIMATE: $1.00 x 15 = ______

6) COMPUTE:

17) Ken estimates that it costs him $50.00 a week to pay for and operate his car. How much does it cost him for a year?

STEPS:

1) READ CAREFULLY

2) GIVEN: Weekly cost - $50.00
Length of time - 1 year

3) FIND: Cost for year

4) OPERATIONS: Multiplication

5) ESTIMATE: $50.00 x 50 = _____

6) COMPUTE:

7)

18) Susie works as a waitress. She makes $3.10 an hour and $10.00 a shift in tips. If she works 7 hours a day and 4 days a week, how much is her monthly salary, including tips? Use four weeks for a month.

STEPS:

1) READ CAREFULLY

2) GIVEN: Hourly salary - $3.10
Daily tips - $10.00
Hours worked per day - 7
Days worked per week - 4
Weeks in a month - 4

3) FIND: Monthly salary

4) OPERATIONS: Multiplication and addition

5) ESTIMATE: $3.00 x 7 x 4 x 4 = _____
$10.00 x 4 x 4 = _____
______ + _________ = _____

6) COMPUTE:

7)

19) During registration, Sam paid $2.50 for a t-shirt, $2.70 for P.E. shorts, $8.00 for towel service, and $4.00 for an art card. How much did he pay at registration?

STEPS:

1) READ CAREFULLY

2) GIVEN: Cost of t-shirt - $2.50
Cost of P.E. shorts - $2.70
Cost of towel service - $8.00
Cost of art card - $4.00

3) FIND: Total paid during registration

4) OPERATIONS: Addition

5) ESTIMATE: $3.00 + $3.00 + $8.00

6) COMPUTE:

7)

20) Toby earns $288.88 every 2 weeks. Deductions are: Income tax - $51.00; Social Security - $31.60; union dues - $17.30; and United Fund - $2.50. How much is left after deductions?

STEPS:

1) READ CAREFULLY

2) GIVEN: Amount earned - $288.88
Deductions:
Income tax - $51.00
Social Security - $31.60
Union dues - $17.30
United Fund - $2.50

3) FIND: Salary after deductions

4) OPERATIONS: Addition, subtraction

5) ESTIMATE: $50.00 + $30.00 + $20.00 + $3.00 = ___________
$300.00 - _____ = _____

6) COMPUTE:

7)

21) The cheerleaders at Dudley High School want to buy new uniforms. One store lists the complete unifrom for $70.00. Shopping around the city, the cheerleaders found the following prices for the items needed: Sweater - $16.50; skirt - $14.95; shoes - $15.50; socks - $3.59. Which is the better buy?

STEPS:

1) READ CAREFULLY

2) GIVEN: Amount for complete uniform - $70.00
   Amount for sweater - $16.50
   Amount for skirt - $14.95
   Amount for shoes - $15.50
   Amount for socks - $3.95

3) FIND: Total cost for second uniform; Which is a better buy? Amount saved

4) OPERATIONS: Addition, subtraction

5) ESTIMATE: $16.00 + $15.00 + $16.00 + $4.00

6) COMPUTE:

7)

22) Ray's parents gave him $500.00 to open a checking account when he went to college. He wrote a check for $75.80 to buy books and $35.00 for a used typewriter during the first week of school. How much is left in his account?

STEPS:

1) READ CAREFULLY

2) GIVEN: Amount in checking account - $500.00
   Check for books - $57.80
   Check for typewriter - $35.00

3) FIND: Amount left in checking account

4) OPERATIONS: Addition, subtraction

5) ESTIMATE: $80.00 + $40.00 = _____
   $500.00 - _____ = _____

6) COMPUTE:

7)

23) The Human Relations Club is planning a trip to Magic Mountain. There are 62 members in the club and the total cost of the trip will be $1,426.00. How much will each member have to contribute?

STEPS:

1) READ CAREFULLY

2) GIVEN: Members in club - 62
   Total cost of trip - $1,426.00

3) FIND: Amount each member has to pay

4) OPERATIONS: Division

5) ESTIMATE: $1,400.00 ÷ 60

6) COMPUTE:

7)

24) The club members decided to have three fund-raising activities to help pay the cost of their trip. They made $225.00 profit from a dance, $80.00 profit from a car wash, and $115.00 profit from a movie. How much did they raise for their trip?

STEPS:

1) READ CAREFULLY

2) GIVEN: Profit from dance - $225.00
   Profit from car wash - $80.00
   Profit from movie - $115.00

3) FIND: Amount raised

4) OPERATIONS: Addition

5) ESTIMATE: $200.00 + $100.00 + $100.00 = _________

6) COMPUTE:

7)

25) If the Governor of Nevada makes $38,000.00 a year, how much will he make in four years?

STEPS:

1) READ CAREFULLY

2) GIVEN: Yearly salary - $38,000.00

3) FIND: Salary earned in four years

4) OPERATIONS: Multiplication

5) ESTIMATE: $40,000.00 x 4 = _____

6) COMPUTE:

7)

26) How much does the governor make each month?

STEPS:

1) READ CAREFULLY

2) IVEN: Yearly salary - $38,000.00

3) FIND: Monthly salary

4) OPERATIONS: Division

5) ESTIMATE: $40,000.00 ÷ 10 = _____

6) COMPUTE:

7)

27) Sonny's new car cost $4,862.00, including taxes. If taxes were $169.00, how much was the price of the car without taxes?

STEPS:

1) READ CAREFULLY

2) GIVEN: 1)
2)

3) FIND:

4) OPERATIONS:

5) ESTIMATE:

6) COMPUTE:

7) CHECK

28) Pete's dad won $1,500.00. He paid $350.00 on an unpaid bill, and $625.00 on his truck. How much does he have left?

STEPS:

1) READ CAREFULLY

2) GIVEN: 1)
2)
3)

3) FIND:

4) OPERATIONS: 1)
2)

5) ESTIMATE:

6) COMPUTE:

7) CHECK

29) Jean deposited $25.25 in her savings account. Her new balance is $118.38. How much did she have in her account before the deposit?

STEPS:

1) READ CAREFULLY

2) GIVEN: Deposit - $25.25
New balance - $118.38

3) FIND: Balance before deposit

4) OPERATIONS: Subtraction

5) ESTIMATE:

6)

7)

30) In four tournament games, Sam scored 24 points, 17 points, 13 points, and 30 points. What was his average for the tournament?

STEPS:

1) READ CAREFULLY

2) GIVEN: Points scored - 24, 17, 13 and 30
Number of games played - 4

3) FIND: Average

4) OPERATIONS: Addition, division

5) ESTIMATE:

6)

7)

31) Read the following ad: How much does this job pay per hour? Wanted: Auto Mechanic, $380.00 per week. Five days a week. Eight hours a day. Must have at least two years experience.

STEPS:

1) READ CAREFULLY

2) GIVEN: Weekly salary - $380.00
Days worked - 5
Hours per day - 8

3) FIND: Salary per hour

4) OPERATIONS: Multiplication and division

5) ESTIMATE:

6)

7)

32) Sally earns $3.40 per hour. If she goes to work at 10:00 A.M. and gets off at 4:00 P.M., how much does she make each day?

STEPS:

1) READ CAREFULLY

2) GIVEN: Salary per hour - $3.40
Starting time - 10:00 A.M.
Ending time - 4:00 P.M.

3) FIND: Daily salary

4) OPERATIONS: Addition, subtraction, multiplication

5) ESTIMATE:

6)

7)

33) Zeke and Josie got married after graduating from high school. Zeke had a job which paid $90.00 a week and Josie's job paid $60.00 a week. Together, how much did they make a month? (Use four weeks for a month)

STEPS:

1) READ CAREFULLY

2) GIVEN: Zeke's weekly salary - $90.00
Josie's weekly salary - $60.00

3) FIND: Total monthly salary

4) OPERATIONS: Addition, multiplication

5) ESTIMATE:

6)

7)

34) Zeke and Josie's monthly expenses are: $125.00 for rent; $115.00 for car expenses and payment; $55.00 for furniture; $25.00 for union dues; $50.00 for insurance; and $55.00 for utilities. How much is left each month for food, clothing, entertainment and savings?

STEPS:

1) READ CAREFULLY

2) GIVEN: $125.00 for rent
$115.00 for car
$55.00 for furniture
$25.00 for union dues
$50.00 for insurance
$55.00 for utilities

3) FIND: Amount left each month

4) OPERATIONS: Addition, subtraction

5) ESTIMATE:

6)

7)

35) Terry needs to change the oil in his car. A quart can of motor oil will cost .69¢ and a gallon can will cost $2.10. Terry needs four quarts or one gallon. Which is the better buy and how much will he save?

STEPS:

1) READ CAREFULLY

2) GIVEN: Price of oil - .69¢ a quart, $2.10 a gallon
Amount needed - 4 quarts or one gallon

3) FIND: Cost for 4 quarts
Which is the better buy?
How much saved?

4) OPERATIONS: Multiplication and subraction

5) ESTIMATE:

6)

7)

36) Joe's Discount Records gives customers a coupon each time they buy an album. After buying five albums at $6.00 each, the customer can turn in the five coupons and get a sixth album free. Next door at Alice's Record Shop, all albums are $4.50 each. If you want six albums, which shop is cheaper? How much will you save?

STEPS:

1) READ CAREFULLY

2) GIVEN: Cost of albums - $6.00 at Joe's
$4.50 at Alice's
Number of records - 5 from Joe's
6 from Alice's

3) FIND: Total cost for albums at each store
Which store is cheaper?
How much will you save?

4) OPERATIONS: Multiplication, subtraction

5) ESTIMATE:

6)

7)

37) Pop costs .30¢ a can in a machine In the store, it costs $1.26, including tax, for six cans. If you want to buy six, how much can you save if you buy them in a store?

STEPS:

1) READ CAREFULLY

2) GIVEN: Cost of opp - .30¢ a can, $1.26 for six

3) FIND: Amount saved when bought in store

4) OPERATIONS: Multiplication and subtraction

5) ESTIMATE:

6)

7)

38) Dudley High School basketball team will travel to New Orleans for a four-day tournament. If the total cost for the trip is $4,878.00 and there are 15 people going, how much will the trip cost for each person?

STEPS:

1) READ CAREFULLY

2) GIVEN: Cost of trip - $4,878.00 Number of people - 15

3) FIND: Cost per person

4) OPERATIONS: Division

5) ESTIMATE:

6)

7)

39) A basketball uniform costs $72.50. How much will 15 uniforms cost?

STEPS:

1) READ CAREFULLY

2) GIVEN: Cost of uniforms - $72.50 Number needed - 15

3) FIND: Total cost

4) OPERATIONS: Multiplication

5) ESTIMATE:

6)

7)

40) In four years, Jack scored 1,272 points. How many points did he average each year?

STEPS:

1) READ CAREFULLY

2) GIVEN: Total points - 1,272 Number of years - 4

3) FIND: Average number of points each year

4) OPERATIONS: Division

5) ESTIMATE:

6)

7)

41) Janet had $5.00. She spent $2.15 for lunch. How much does she have left?

STEPS:

1) READ CAREFULLY

2) GIVEN: 1)
2)

3) FIND:

4) OPERATIONS:

5) ESTIMATE:

6) COMPUTE:

7) CHECK

42) David saved $50.00. He spent $22.00 for a baseball glove. How much does he have left?

STEPS:

1) READ CAREFULLY

2) GIVEN: 1)
2)

3) FIND:

4) OPERATIONS:

5) ESTIMATE:

6) COMPUTE:

7) CHECK

43) 8,479 people paid to see the boy's championship game and 5,313 paid to see the girl's championship game. How many people paid to see these games?

STEPS:

1) READ CAREFULLY

2) GIVEN Paid for boys game - 8,479
Paid for girl's game - 5,313

3) FIND: Total number paid

4) OPERATIONS:

5)

6)

7)

44) If tennis balls cost $3.75 for 3, how much will you pay for a dozen tennis balls?

STEPS:

1) READ CAREFULLY

2) GIVEN: Cost of tennis balls - 3 for $3.75

3) FIND: Cost for one dozen tennis balls

4) OPERATIONS:

5)

6)

7)

45) Johnny wants to panel one wall of his room. The wall is 8 feet high and 16 feet long. The size of each sheet of panel is 8 feet high and 4 feet long. How many sheets of panel does Johnny need to buy?

STEPS:

1) READ CAREFULLY

2) GIVEN: Size of wall - 8' x 16'
Size of panel - 8' x 4'

3) FIND: Number of sheets needed

4) OPERATIONS:

5)

6)

7)

46) The cost of the panel for Johnny's room is $6.95 a sheet. How much will it cost him to panel his room?

STEPS:

1) READ CAREFULLY

2) GIVEN: Cost for panel - $6.95 sheet
Number of panels needed ____

3) FIND: Cost to panel room

4) OPERATIONS:

5)

6)

7)

47) Tina went to a local hamburger stand to buy her lunch. She bought a giant burger for $1.10, fries for .35¢, and a shake for .55¢. How much change will she receive from $5.00?

STEPS:

1) READ CAREFULLY

2) GIVEN: Price for burger - $1.10
Price for fries - .35¢
Price for shake - .55¢

3) FIND: Change from $5.00

4) OPERATIONS:

5)

6)

7)

48) Bill is selling his car for $1,400.00. If he wants ¼ down, how much will the buyer have to give him for a down payment?

STEPS:

1) READ CAREFULLY

2) GIVEN: Cost of car - $1,400.00
Fraction down - ¼

3) FIND: Amount of down payment

4) OPERATIONS:

5)

6)

7)

49) Egghead Insurance Company gives a 1/5 discount to students who maintain at least a "B" average in school. Henry has a "B" average. If his insurance normally cost $500.00 a year, how much will he save using the discount?

STEPS:

1) READ CAREFULLY

2) GIVEN Cost of insurance - $500.00 a year
Discount - 1/5

3) FIND: Amount of discount

4) OPERATIONS:

5)

6)

7)

50) The high jump record at Dudley High School was 5' 6½". Roscoe jumped 5' 7-3/4". By how far did he break the record?

STEPS:

1) READ CAREFULLY

2) GIVEN: Record jump - 5' 6½"
Roscoe's jump - 5' 7-3/4"

3) FIND: How far did he break the record?

4) OPERATIONS:

5)

6)

7)

51) There are 184 ays in the school year. If you were absent for 19 days, how many days were you present?

STEPS:

1) READ CAREFULLY

2) GIVEN: Number of days in school year - 184
Number of days absent - 19

3) FIND: Number of days present

4) OPERATIONS:

5)

6)

7)

52) In a basketball season, Don scored 402 points and Lou scored 346 points. How many more points did Don score?

STEPS:

1) READ CAREFULLY

2) GIVEN: Points Don scored - 402
Points Lou scored - 46

3) FIND: How many more points Don scored

4) OPERATIONS:

5)

6)

7)

53) Read the following ad. How much does this job pay per week: Wanted: Cook's helper. $3.20 per hour. Eight hours a day, 5 days a week. Swing shift. Apply at Grease Trap.

STEPS:

1) READ CAREFULLY

2) GIVEN: Hourly pay - $3.20
Hours per day - 8
Days a week - 5

3) FIND: Salary per week

4) OPERATIONS:

5)

6)

7)

54) Frankie earned $2,400.00 on her part-time job last year. If she paid 20% for income tax, how much tax did she pay?

STEPS:

1) READ CAREFULLY

2) GIVEN: Amount earned - $2.400.00
Percent paid for tax - 20%

3) FIND: Taxes paid

4) OPERATIONS:

5)

6)

7)

55) Susie works as a waitress. She makes $146.80 a week. Each week, she pays the following: $9.50 for Social Security; $5.25 for union dues; $5.00 a week for uniforms; and $23.60 for income tax. How much is her take-home pay?

STEPS:

1) READ CAREFULLY

2) GIVEN: 1)
2)
3)
4)
5)

3) FIND:

4) OPERATIONS: 1)
2)

5) ESTIMATE:

6) COMPUTE:

7) CHECK

56) Lee's dad sold 65 used cars last month. If he makes $35.00 for each car he sells, how much did he make?

STEPS:

1) READ CAREFULLY

2) GIVEN: 1)
2)

3) FIND:

4) OPERATIONS:

5) ESTIMATE:

6) COMPUTE

7) CHECK

57) Jo and Lynn together scored 32 points in a basketball game. If the team scored 51 points, how many did the other players score?

STEPS:

1) READ CAREFULLY

2) GIVEN: Points Jo and Lynn scored - 32
Total team points - 51

3) FIND:

4)

5)

6)

7)

58) Joan bought a pair of shoes for $21.95, a blouse for $14.95, and a pair of pants for $19.50. Sales tax was $1.86. How much change will she receive from $60.00?

STEPS:

1) READ CAREFULLY

2) GIVEN: Cost of shoes - $21.95
Cost of blouse - $14.95
Cost of pants - $19.50
Sales tax - $1.86

3) FIND:

4)

5)

6)

7)

59) Randy, Candy and Mandy are triplets. Randy dropped out of school at age 16 and got a job as a dishwasher. He earns $2.90 an hour. Candy completed high school and became a secretary. She earns $3.85 an hour. Mandy completed Community College and became a bookkeeper. She earns $4.65 an hour. They work 8 hours a day and 5 days a week. How much does each one make a week?

STEPS:

1) READ CAREFULLY

2) GIVEN: Randy's salary - $2.90/hour
Candy's salary - $3.85/hour
Mandy's salary - $4.65/hour
Hours worked per day - 8
Days worked per week - 5

3) FIND:

4)

5)

6)

7)

60) Using the answers from problem 59, find the monthly salary for each. (Use four weeks for a month)

STEPS:

1) READ CAREFULLY

2) GIVEN: Randy's weekly salary _____
Candy's weekly salary _____
Mandy's weekly salary _____
One month equals four weeks

3) FIND:

4)

5)

6)

7)

61) Using the answers from problem 60, find the yearly salary for each. (Use 12 months for a year)

STEPS:

1) READ CAREFULLY

2) GIVEN: Randy's monthly salary
Candy's monthly salary
Mandy's monthly salary
One year equals 12 months

3) FIND:

4)

5)

6)

7)

62) Using the answers from problem 61, how much more does Mandy make than a) Randy and b) Candy?

STEPS:

1) READ CAREFULLY

2) GIVEN: Randy's yearly salary
Candy's yearly salary
Mandy's yearly salary

3) FIND:

4)

5)

6)

7)

63) Last year, the following were deducted from Randy's check: $104.00 for union dues; $322.50 for Social Security; and $940.88 for income tax. What was his take-home pay last year? (Use the yearly salary computed in problem 61)

STEPS:

1) READ CAREFULLY

2) GIVEN: Union dues - $104.00
Social Security - $322.50
Income tax - $940.88
Yearly salary -

3) FIND:

4)

5)

6)

7)

64) Last year, the following were deducted from Mandy's check: $521.28 for Social Security and $1,303.20 for income tax. What was her take-home pay last year? (Use the yearly salary computed in problem 61)

STEPS:

1) READ CAREFULLY

2) GIVEN: Social Security - $521.28
Income tax - $1,303.20
Yearly salary -

3) FIND:

4)

5)

6)

7)

65) It took Ron 5 hours to drive from Las Vegas to Los Angeles. The distance is 290 miles. How fast did he drive?

STEPS:

1) READ CAREFULLY

2) GIVEN: Time - 5 hours
Distance - 290 miles

3) FIND:

4)

5)

6)

7)

66) If Ron's car gets 15 miles to a gallon of gas, how many gallons of gas did he use?

STEPS:

1) READ CAREFULLY

2) GIVEN: Miles driven - 290
Miles to a gallon of gas - 15

3) FIND:

4)

5)

6)

7)

67) If Ron paid 68.9¢ per gallon for gas, how much was the gas for the trip?

STEPS:

1) READ CAREFULLY

2) GIVEN: Cost per gallon of gas - 68.9¢
Number of gallons used - (see problem 66)

3) FIND:

4)

5)

6)

7)

68) If Ron would have bought gas at a self-service station, it would have cost him 62.9¢ per gallon. How much would he have saved?

STEPS:

1) READ CAREFULLY

2) GIVEN: Cost at self-service - 62.9¢
Number of gallons used - (see problem 66)
Amount paid at .62.9¢ per gallon (see problem 67)

3) FIND:

4)

5)

6)

7)

69-70) Remember Zeke and Josie? They are having problems trying to balance their checkbook. Can you help them?

Date	Entry	Amount	Balance
8/1/78	Deposit	$625.00	$625.00
8/1/78	Check to Mac's Furniture	35.00	
8/3/78	Chech to Quick Auto	58.00	
8/5/78	Check to food store	24.00	
8/8/78	Deposit	150.00	
8/10/78	Check to clothing store	38.52	
8/15/78	Check to rent	125.00	
8/16/78	Check to food store	70.35	
8/23/78	Check to insurance company	45.75	

STEPS:

1) READ CAREFULLY

2) GIVEN: See above

3) FIND: Balance

4)

5)

6)

7)

73) Tony bought the following for his car: Spark plugs - $8.50; points - $3.75; oil - $5.80; and filter - $2.39. How much change will he receive from a fifty-dollar bill?

STEPS:

1) READ CAREFULLY

2) GIVEN:

3)

4)

5)

6)

7)

74) There are 112 school in Clark County and 54 schools in Washoe County. How many more schools are in Clark County?

STEPS:

1) READ CAREFULLY

2) GIVEN:

3)

4)

5)

6)

7)

75) On Saturday, 625 people visited Old Vegas. On Sunday, 713 visited Old Vegas. If they expected 1,500 people, how did they do?

STEPS:

1) READ CAREFULLY

2)

3)

4)

5)

6)

7)

76) For the holiday tournament, 510 people saw the first game, 613 saw the second game, 678 saw the third game, and 829 saw the fourth game. What was the average attendance for the four games?

STEPS:

1) READ CAREFULLY

2)

3)

4)

5)

6)

7)

77) Paul is driving from Las Vegas to New Orleans, Louisiana. He drove 486 miles on Friday, 424 miles on Saturday, and 525 miles on Sunday. If New Orleans is 2,150 miles from Las Vegas, how many more miles does he have to drive?

STEPS:

1) READ CAREFULLY
2)
3)
4)
5)
6)
7)

78) If Paul's car averages 18 miles per gallon of gas and if the cost of gas averages .72¢ a gallon, how much will he have to pay for gas?

STEPS:

1) READ CAREFULLY
2)
3)
4)
5)
6)
7)

79) For last year's Walk-A-Thon, Madge had a total pledge of $5.50 for each mile she walked. If she walked 13 miles, how much should she collect?

STEPS:

1) READ CAREFULLY
2)
3)
4)
5)
6)
7)

80) Pete walked the entire 20 miles. If he collected a total of $84.00, how much was pledged to him for each mile he walked?

STEPS:

1) READ CAREFULLY
2)
3)
4)
5)
6)
7)

81) Several of Pete's sponsors paid him by check. He received checks for $5.00, $8.00, $5.50, $2.00, $2.00, $10.00, $1.40, $6.00, $12.00, and $15.00. How much was the total in checks?

STEPS:

1) READ CAREFULLY

2)

3)

4)

5)

6)

7)

82) If Pete collected the remainder in cash, how much cash did he collect?

STEPS:

1) READ CAREFULLY

2)

3)

4)

5)

6)

7)

83) John was given $2.50 a mile for the 20-mile walk and a bonus of $15.00 if he completed the walk, how much should he collect?

STEPS:

1) READ CAREFULLY

2)

3)

4)

5)

6)

7)

84) The total pledges for the Walk-A-Thon were $125,850.00. Students collected $88,255.00. How much was not collected?

STEPS:

1) READ CAREFULLY

2)

3)

4)

5)

6)

7)

APPENDIX B

Summary of the Mathematical Operation Required in the Experimental Mathematics Curriculum Materials

	Add	Subtract	Multiply	Divide		Add	Subtract	Multiply	Divide
1			x		26				x
2		x			27		x		
3	x				28	x	x		
4	x	x			29		x		
5			x		30	x			x
6				x	31			x	x
7	x	x			32	x	x	x	
8	x	x	x		33	x		x	
9			x		34	x	x		
10			x		35		x	x	
11	x		x		36		x	x	
12			x		37		x	x	
13	x	x			38				x
14	x			x	39			x	
15		x			40				x
16			x		41		x		
17			x		42		x		
18	x		x		43	x			
19	x				44			x	
20	x	x			45	x			
21	x	x			46			x	
22	x	x			47	x	x		
23				x	48			x	
24	x		x		49			x	
25			x		50		x		

	Add	Subtract	Multiply	Divide		Add	Subtract	Multiply	Divide
51		x			68		x	x	
52		x			69		x		
53			x		70		x		
54			x		71				x
55	x	x			72			x	
56			x		73	x	x		
57		x			74		x		
58	x	x			75	x	x		
59			x		76	x			x
60			x		77	x	x		
61			x		78			x	x
62		x			79			x	
63	x	x			80				x
64	x	x			81	x			
65				x	82		x		
66				x	83	x		x	
67			x		84		x		

APPENDIX C

Results of the First Readability Trial of the Experimental Mathematics Curriculum Material

Rewriting the material, the following words were substituted for the deleted.

ability	estimation	separate
arithmetic	headaches	situation
assistance	important	solution
challenge	incorrect	success
combination	information	surprise
completion	intended	verbal
computation	naturally	
deciding	opportunity	
demonstrate	performing	
different	procedures	
difficult	realize	
discover	recommended	
doubts	reread	

APPENDIX D

Response of the Teachers Who Tested the Experimental Mathematics Curriculum Materials for Useability and for Student Ability to Do the the Necessary Computation

	Strongly Agree	Agree	No Opinion	Disagree	Stongly Disagree
1. Students were able to read the material.	B	A			
2. Students were able to perform the required computation.		A, B			
3. Students understand the steps involved.	B	A			
4. The step-by-step procedure outlined in the packet was helpful.	A,B				
5. The format of this instructional material was different from other material.		B	A		
6. The length of the suggested daily activities was appropriate.		B	A		
7. The length of the instructional unit was appropriate.		A,B			
8. Students could see a need for learning computation.		B	A		
9. Students could see a need for learning to solve verbal problems		B	A		
10. This instructional material was interesting to the students.	B	A			
11. The problems used in this unit were appropriate for this age group	A	B			
12. Students were motivated to do better on this unit than they have been on other problem-solving units.		A	B		
13. As a teacher, I could see students making progress as they worked on the unit.	B	A			
14. As a teacher, I prefer this approach to others I have used.	B	A			

Teachers: A & B

APPENDIX E

Complete Listing of the Prestudy Data for All Subjects Participating in the Study

Stud. #	Sch. #	GP ID	Sex	I.Q. RS	I.Q. SA	I.Q. %ile	I.Q. S/9	Read RS	Read SS	Read %ile	Read S/9	Computation RS	Computation SS	Computation %ile	Computation S/9	Mathematical Concepts RS	Mathematical Concepts SS	Mathematical Concepts %ile	Mathematical Concepts S/9	Problem Solving RS	Problem Solving SS	Problem Solving %ile	Problem Solving S/9
01	1	1	1	31	89	23	4	38	78	16	3	15	87	18	3	12	76	10	2	15	39	22	3
02	1	1	1	40	93	38	4	60	93	48	5	18	92	24	4	11	74	8	2	7	71	4	2
03	2	1	1	23	80	13	3	30	70	8	2	25	100	44	5	22	92	44	5	18	94	32	4
04	1	1	2	51	104	59	5	57	91	42	5	20	95	30	4	11	74	8	2	12	83	14	3
05	1	1	1	23	85	13	3	34	74	12	3	4	60	1	1	8	67	2	1	15	89	22	3
06	1	1	1	36	93	31	4	39	79	18	3	16	89	20	3	14	81	16	3	12	83	14	3
07	1	1	1	31	88	23	4	27	67	6	2	16	89	20	3	13	79	14	3	9	75	6	2
08	2	1	1	46	100	49	5	45	83	24	4	15	87	18	3	22	92	44	5	20	98	40	5
09	1	1	2	28	89	19	3	35	75	14	3	18	92	24	4	18	87	28	4	10	79	8	2
10	1	1	2	26	86	16	3	34	74	12	3	11	79	8	2	12	76	10	2	3	73	4	2
11	2	1	1	51	102	59	5	52	88	34	4	23	98	36	4	23	93	48	5	25	104	62	6
12	2	1	2	42	100	41	5	58	92	44	5	19	94	26	4	17	86	26	4	19	96	36	4
13	2	1	1	35	92	29	4	44	83	24	4	24	99	40	5	22	92	44	5	13	85	16	3
14	1	1	1	31	92	23	4	45	83	24	4	19	94	26	4	18	87	28	4	12	83	14	3
15	2	1	2	25	85	15	3	41	81	20	3	17	90	22	3	13	79	14	3	14	87	20	3
16	2	1	2	26	83	15	3	35	75	14	3	17	90	22	3	12	76	10	2	11	81	11	3
17	1	1	1	11	64	2	1	44	83	24	4	14	85	14	3	9	70	4	2	12	83	14	3
18	2	1	1	47	105	51	5	53	88	34	4	25	101	50	5	25	96	54	5	21	99	44	5

Stud. #	Sch. #	GP ID	Sex	I.Q. RS	I.Q. SA	I.Q. %ile	I.Q. S/9	Read RS	Read SS	Read %ile	Read S/9	Computation RS	Computation SS	Computation %ile	Computation S/9	Mathematical Concepts RS	Mathematical Concepts SS	Mathematical Concepts %ile	Mathematical Concepts S/9	Problem Solving RS	Problem Solving SS	Problem Solving %ile	Problem Solving S/9
19	1	1	1	31	88	23	4	18	56	1	1	14	85	14	3	12	76	10	2	15	89	22	3
20	1	1	2	46	99	49	5	40	80	18	3	23	98	36	4	7	65	2	1	16	91	26	4
21	2	1	1	42	100	41	5	39	79	18	3	17	90	22	3	4	56	1	1	23	102	52	5
22	2	1	2	12	70	2	1	35	75	14	3	17	90	22	3	14	81	16	3	8	73	4	2
23	2	1	2	39	94	36	4	45	83	24	4	27	102	54	5	20	90	36	4	16	91	26	4
24	2	1	1	49	101	55	5	69	99	62	6	6	65	1	1	22	92	44	5	20	98	40	5
25	1	1	1	44	97	45	5	55	89	38	4	10	87	28	4	13	85	15	3	41	89	14	3
26	2	1	2	28	87	19	3	20	51	2	1	23	98	36	4	15	83	16	3	9	76	6	2
27	2	1	2	34	94	28	4	38	78	16	3	21	96	32	4	21	91	40	5	16	91	26	4
28	2	1	1	29	85	20	2	29	69	8	2	14	85	14	3	15	83	18	3	12	83	14	3
29	2	1	1	30	88	22	3	55	89	38	4	18	92	24	4	16	84	22	3	16	91	26	4
30	2	1	1	17	76	6	2	34	74	12	3	16	89	20	3	11	74	8	2	11	81	11	3
31	2	1	2	32	92	25	4	46	84	26	4	21	96	32	4	17	86	26	4	13	85	16	3
32	2	1	2	21	79	11	3	29	69	8	2	14	85	14	3	10	72	6	2	8	73	4	2
33	2	1	2	19	75	8	2	31	71	10	2	19	94	26	4	9	70	4	2	10	79	8	2
34	3	2	1	33	91	26	4	45	84	24	4	21	96	32	4	22	92	44	5	20	98	40	5
35	3	2	1	47	102	51	5	69	99	62	6	15	87	18	3	16	84	22	3	23	102	52	5
36	3	2	2	38	96	35	4	28	68	6	2	15	87	18	3	11	74	8	2	9	76	6	2

Stud. #	Sch. #	GP ID	Sex	I.Q. RS	I.Q. SA	I.Q. %ile	I.Q. S/9	Read RS	Read SS	Read %ile	Read S/9	Computation RS	Computation SS	Computation %ile	Computation S/9	Mathematical Concepts RS	Mathematical Concepts SS	Mathematical Concepts %ile	Mathematical Concepts S/9	Problem Solving RS	Problem Solving SS	Problem Solving %ile	Problem Solving S/9
37	3	2	2	23	85	13	3	29	69	8	2	11	79	8	2	17	86	26	4	9	76	6	2
38	3	2	1	47	104	51	5	37	77	16	3	15	87	18	3	12	76	10	2	13	85	16	3
39	4	2	1	27	87	18	3	60	93	48	5	13	83	12	3	12	76	10	2	19	96	36	4
40	3	2	1	40	97	38	4	45	83	24	4	29	104	62	6	23	93	48	5	23	102	52	5
41	3	2	2	28	85	12	3	32	72	10	2	15	87	18	3	14	81	16	3	13	85	16	3
42	3	2	1	42	99	41	5	35	75	14	3	22	97	34	4	22	92	44	5	24	103	56	5
43	4	2	2	20	80	9	2	22	61	2	1	7	67	2	1	11	74	8	2	13	85	15	3
44	3	2	2	40	99	38	4	66	97	58	5	17	90	22	3	17	86	26	4	19	96	36	4
45	3	2	1	35	96	31	4	44	83	24	4	31	106	70	6	30	103	72	6	18	94	32	4
46	3	2	1	43	94	43	5	47	85	28	4	21	96	32	4	19	89	32	4	18	94	32	4
47	3	2	2	33	92	26	4	36	76	14	3	20	95	30	4	14	81	16	3	19	96	36	4
48	3	2	2	50	101	57	4	59	92	44	5	33	110	78	7	28	100	68	6	28	110	74	6
49	3	2	1	28	86	19	3	27	67	6	2	13	83	12	3	15	85	18	3	6	27	2	1
50	3	2	2	12	68	2	1	25	65	4	2	15	87	18	3	8	67	2	1	5	63	1	1
51	3	2	2	22	82	12	3	38	78	16	3	33	110	78	7	22	92	44	5	30	115	80	7
52	3	2	2	43	99	43	5	59	92	44	5	24	99	40	5	24	94	50	5	17	92	30	4
53	3	2	2	47	102	51	5	59	92	44	5	28	103	58	5	25	96	54	5	19	96	36	4
54	3	2	1	59	111	74	6	70	99	62	6	19	94	26	4	30	103	72	6	23	102	52	5

Stud. #	Sch. #	GP ID	Sex	I.Q. RS	I.Q. SA	I.Q. %ile	I.Q. S/9	Read RS	Read SS	Read %ile	Read S/9	Computation RS	Computation SS	Computation %ile	Computation S/9	Mathematical Concepts RS	Mathematical Concepts SS	Mathematical Concepts %ile	Mathematical Concepts S/9	Problem Solving RS	Problem Solving SS	Problem Solving %ile	Problem Solving S/9
55	3	1	1	26	83	16	3	23	63	2	1	13	83	12	3	15	83	18	3	12	83	14	3
56	3	2	2	42	99	41	5	50	87	32	1	16	89	20	3	11	74	8	2	17	92	30	4
57	3	1	1	45	99	49	5	56	97	58	5	35	114	86	7	21	91	40	5	27	108	70	6
58	3	2	2	44	98	45	5	65	96	54	5	17	90	22	3	23	93	48	5	17	92	30	4
59	3	2	2	23	82	13	3	27	67	6	2	16	89	20	2	13	79	14	3	19	96	36	4
60	3	2	2	33	88	26	4	49	86	30	4	12	81	10	4	16	84	22	3	11	81	11	3
61	3	2	2	41	95	40	5	67	97	58	5	18	92	24	4	21	91	40	5	18	94	32	4
62	3	2	1	19	78	8	2	31	71	10	2	19	94	26	3	7	65	2	1	11	81	11	3
63	3	2	2	32	93	25	4	58	92	44	5	16	89	20	3	19	89	32	4	13	85	16	3
64	4	2	1	37	93	33	4	53	88	34	4	14	85	14	4	18	87	28	4	8	73	4	2
65	3	2	2	28	87	19	3	40	80	18	3	22	97	34	3	16	84	22	3	16	91	26	4
66	3	2	2	25	86	15	3	52	88	34	4	13	83	12	4	17	86	26	4	11	81	11	3
67	3	2	1	42	96	41	5	46	84	26	4	18	92	24	3	19	89	32	4	21	99	44	5
68	3	2	1	27	88	18	3	29	69	8	2	14	85	14	4	18	87	28	4	13	85	16	3
69	4	2	1	19	78	8	2	25	66	6	2	21	96	32	4	9	70	4	2	12	83	14	3
70	3	2	1	39	91	36	4	31	71	10	2	19	94	26	4	13	79	14	3	8	73	4	2
71	3	2	2	37	96	33	4	46	84	26	4	22	97	34	4	21	91	40	5	25	104	62	6
72	3	2	1	29	88	20	3	51	87	32	4	20	95	30	4	18	87	28	4	12	94	32	4

Stud. #	Sch. #	GP ID	Sex	RS	SA	%ile	S/9	RS	SS	% ile	S/9	RS	SS	%ile	S/9	RS	SS	%ile	S/9	RS	SS	%ile	S/9
73	3	2	1	51	103	59	5	52	88	34	4	21	96	32	4	20	90	35	4	23	102	52	5
74	3	2	1	46	99	49	5	50	87	32	4	24	99	40	5	26	98	58	5	20	98	40	5
75	3	2	2	38	93	35	4	60	93	48	5	20	95	30	4	21	91	40	5	18	94	32	4
76	3	2	1	24	56	14	3	32	72	10	2	17	90	22	3	17	86	26	4	16	91	26	4
77	3	2	1	41	98	40	5	46	84	26	4	24	99	40	5	25	96	54	5	21	99	44	5
78	4	2	1	63	111	82	7	70	99	62	6	20	95	30	4	29	102	70	6	20	98	40	5
79	3	2	1	41	99	40	5	43	82	22	3	9	74	4	2	18	87	23	4	9	76	6	2
80	3	2	2	18	74	7	2	23	63	2	1	12	31	10	2	9	70	4	2	10	79	6	2
81	3	2	2	30	85	22	3	27	67	6	2	15	87	18	3	16	84	22	3	13	85	16	3
82	3	2	2	33	90	26	4	61	93	48	5	13	83	12	3	26	98	58	5	22	101	48	5
83	3	2	1	40	97	38	4	35	75	14	3	18	92	24	4	17	86	26	4	12	83	14	3
84	3	2	1	53	105	63	6	65	96	54	5	24	99	40	5	30	103	72	6	17	92	30	4
85	3	2	2	36	95	31	4	68	98	60	6	21	96	32	4	23	93	48	5	19	96	36	4
86	3	2	2	20	77	9	2	36	76	14	3	12	81	10	2	15	83	18	3	15	89	22	3
87	3	2	1	32	91	25	4	31	71	10	2	14	85	14	3	16	84	22	3	11	81	11	3
88	3	2	2	47	98	51	5	60	93	48	5	13	83	12	3	18	87	23	4	13	85	16	3
89	3	2	1	23	85	13	3	46	84	26	4	23	98	36	4	20	90	36	4	16	91	26	4
90	3	2	1	37	93	33	7	30	79	3	3	9	74	4	2	14	81	16	3	15	89	22	3

APPENDIX F

Posttest Scores for the Subjects
Participating in the Study

Stu. #	Sch.#	GP . ID	PS	Stu. #	Sch.#	GP . ID	PS
1	1	1	13	43	4	2	14
2	1	1	13	44	3	2	20*
3	2		27*	45	3	2	25*
4	1	1	19	46	3	2	22*
5	1	1	9	47	3	2	19
6	1	1	10	48	3	2	31*
7	1	1	14	49	3	2	16
8	2	1	24*	50	3	2	9
9	1	1	18	51	3	2	14
10	1	1	11	52	3	2	14
11	2	1	27*	53	3	2	24*
12	2	1	21*	54	3	2	21*
13	2	1	25*	55	3	2	10
14	1	1	11	56	3	2	16
15	2	1	18	57	3	2	23*
16	2	1	15	58	3	2	20*
17	1	1	17	59	3	2	12
18	2	1	25*	60	3	2	12
19	1	1	15	61	3	2	21*
20	1	1	15	62	3	2	15
21	2	1	28*	63	3	2	15
22	2	1	12	64	4	2	13
23	2	1	20*	65	3	2	18
24	2	1	20*	66	3	2	14
25	1	1	15	67	3	2	23*
26	2	1	16	68	3	2	12
27	2	1	18	69	4	2	28*
28	2	1	18	70	3	2	22*
29	2	1	16	71	3	2	24*
30	2	1	11	72	3	2	26*
31	2	1	18	73	3	2	24*
32	2	1	11	74	3	2	24*
33	2	1	11	75	3	2	18
34	3	2	22*	76	3	2	20*
35	3	2	15*	77	3	2	22*
36	3	2	14	78	4	2	25*
37	3	2	19	79	3	2	20*
38	3	2	17	80	3	2	11
39	4	2	29*	81	3	2	13
40	3	2	28*	82	3	2	16
41	3	2	12	83	3	2	21*
42	3	2	25*	84	3	2	29*

*Passing score

Stu. #	Sch. #	GP . ID	PS
85	3	2	24*
86	3	2	14
87	3	2	12
88	3	2	18
89	3	2	17
90	3	2	16

APPENDIX G

Summary of Teacher Qualifications for the Teachers Participating in the Study

Certification of Teachers Who
Participated in Study

	Teacher I	Teacher II	Teacher III	Teacher IV
Major	Math	Math	Music Voice	Math
Minor	History	Music	None	None
Years of Teaching	3	4	16	4
Years of Teaching Math	3	4	5	4
Years of Teaching in CCSD	1	4	16	4

Notes: 1. Teacher numbers correspond to school numbers

2. Teacher number 3 holds a general certificate for grades K-9. This teacher does not qualify for a mathematics teacher certificate.

APPENDIX H

Pearson Product Moment Correlation Matrix for All Pre-study Data and the Posttest

Pearson Correltion Coefficients
Raw Scores

	SUBIQ	MATREAD	MATCOMP	MATCPTS	MATPS	MATPSOL
SUBIQ	1.000	.6439	.2950	.5704	.5170	.5357
MATREAD	.6439	1.000	.2458	.5736	.5065	.4531
MATCOMP	.2950	.2458	1.000	.5103	.5347	.5260
MATCPTS	.5704	.5736	.5103	1.000	.5715	.5350
MATPS	.5170	.5065	.5347	.5715	1.000	.6307
MATPSOL	.5357	.4531	.5260	.5350	.6307	1.000

APPENDIX I

Subject Membership in the Pass/Fail Groups of the Discriminant Analysis for the Control Group

Stu.#	GP ID	Sch.#	P/F	MATPSOL	SUBIQ	MATREAD	MATCOMP	MATCPTS	MATPS
21	1	2	Pass	28	100	39	17	4	23
3	1	2	Pass	27	80	30	25	22	18
11	1	2	Pass	27	102	52	23	23	25
18	1	2	Pass	25	92	44	24	22	13
13	1	2	Pass	25	105	53	26	25	21
8	1	2	Pass	24	100	45	15	22	20
12	1	2	Pass	21	100	58	19	17	19
23	1	2	Pass	20	94	46	27	20	16
24	1	2	Pass	20	101	69	6	22	20
4	1	1	Fail	19	104	57	20	11	12
9	1	1	Fail	18	89	35	18	18	10
15	1	2	Fail	18	86	41	17	13	14
27	1	2	Fail	18	94	38	21	21	16
28	1	2	Fail	18	85	29	14	15	12
31	1	2	Fail	18	92	46	21	17	13
17	1	1	Fail	17	64	44	14	9	12
26	1	2	Fail	16	87	22	23	15	9
29	1	2	Fail	16	88	55	18	16	16
16	1	2	Fail	15	83	35	17	12	11
19	1	1	Fail	15	88	18	14	12	15
20	1	1	Fail	15	99	40	23	7	15
25	1	1	Fail	15	97	55	10	18	13
7	1	1	Fail	14	88	27	16	13	9
1	1	1	Fail	13	89	38	15	12	15
2	1	1	Fail	13	93	60	18	11	7
22	1	2	Fail	12	70	35	17	14	8
10	1	1	Fail	11	86	34	11	12	8
14	1	1	Fail	11	92	45	19	18	12
30	1	2	Fail	11	76	34	16	11	11
32	1	2	Fail	11	79	29	14	10	8
33	1	2	Fail	11	75	31	19	9	10
6	1	1	Fail	10	93	39	16	14	12
5	2	1	Fail	9	85	24	4	8	15

APPENDIX J

Subject Membership in the Pass/Fail
Groups of the Discriminant Analysis
for the Experimental Group

Stu. #	CP ID	Sch. #	P/F	MATPSOL	SUBIQ	MATREAD	MATCOMP	MATCPTS	MATPS
48	2	3	Pass	31	101	59	33	28	28
39	2	4	Pass	29	87	60	13	12	19
84	2	3	Pass	29	105	65	24	30	17
40	2	3	Pass	28	97	45	29	23	23
69	2	4	Pass	28	78	26	21	9	12
72	2	3	Pass	26	98	51	20	18	18
35	2	3	Pass	25	102	69	15	16	23
42	2	3	Pass	25	99	35	22	22	24
45	2	3	Pass	25	96	44	31	30	18
78	2	4	Pass	25	111	70	20	29	30
53	2	3	Pass	24	102	59	28	25	19
71	2	3	Pass	24	96	46	22	21	25
73	2	3	Pass	24	103	52	21	20	23
74	2	3	Pass	24	99	50	24	26	20
85	2	3	Pass	24	95	68	21	23	19
57	2	3	Pass	23	99	56	35	21	27
67	2	3	Pass	23	96	45	18	19	21
34	2	3	Pass	22	91	45	21	22	20
46	2	3	Pass	22	94	47	21	19	18
70	2	3	Pass	22	91	31	19	13	8
77	2	3	Pass	22	98	46	24	25	21
54	2	3	Pass	21	111	70	19	30	23
61	2	3	Pass	21	95	67	18	21	18
83	2	3	Pass	21	97	35	18	17	12
44	2	3	Pass	20	99	56	17	17	19
58	2	3	Pass	20	98	65	17	23	17
76	2	3	Pass	20	86	32	17	17	26
79	2	3	Pass	20	99	43	9	18	9
37	2	3	Fail	19	85	29	11	17	9
47	2	3	Fail	19	92	36	20	14	19
65	2	3	Fail	18	87	40	22	16	15
75	2	3	Fail	18	93	60	20	21	18
88	2	3	Fail	18	98	60	13	18	13
38	2	3	Fail	17	104	37	15	12	13
89	2	3	Fail	17	85	46	23	20	16
49	2	3	Fail	16	86	27	13	15	4
56	2	3	Fail	16	99	50	16	11	17
82	2	3	Fail	16	90	61	13	26	22
90	2	3	Fail	16	93	39	9	14	15
62	2	3	Fail	15	78	31	19	7	11
63	2	3	Fail	15	93	58	16	19	13
36	2	3	Fail	14	96	28	15	11	9
43	2	4	Fail	14	80	22	7	11	13
51	2	3	Fail	14	82	38	33	22	30
52	2	3	Fail	14	19	59	24	24	17
66	2	3	Fail	14	86	52	13	17	11
85	2	3	Fail	14	77	36	12	15	15

Stu.#	GP ID	Sch.#	P/F	MATPSOL	SUBIO	MATREAD	MATCOMP	MATCOPT	MATPS
64	2	3	Fail	13	93	53	14	18	8
81	2	3	Fail	13	85	27	14	16	13
41	2	3	Fail	12	85	32	15	14	13
59	2	3	Fail	12	82	27	16	13	19
60	2	3	Fail	12	86	47	12	16	11
68	2	3	Fail	12	88	29	14	18	13
87	2	3	Fail	12	91	31	14	16	11
47	2	3	Fail	11	74	23	12	9	10
55	2	3	Fail	10	83	23	13	15	12
50	2	3	Fail	9	68	25	15	8	5

ABSTRACT

The Statement of the Problem. What is the effect of the type of instructional materials on the acquisition of verbal problem-solving skills of general mathematics students?

The Assumptions of the Study. The necessary assumptions for the study were:

1. Verbal problem-solving skills can be learned by the general mathematics students;
2. all students need to learn to solve verbal problems;
3. students in general mathematics classes have not been provided with adequate instruction and thus, have not been acquiring verbal problem-solving skills;
4. the experimental mathematics curriculum materials used to teach verbal problem-solving skills for this study will improve the students' acquisition of these skills; and
5. although the unit of analysis for the analysis of covariance was the individual student and the independent variable (the experimental mathematics curriculum material) was randomly assigned to intact classes, there was no effect on the results of this study, and thus its outcome.

Purpose of the Study. Even though there have been studies which have examined the relationship of such characteristics as: reading and verbal problem-solving skills; mathematics computation

and verbal problem-solving skills; mathematics concepts and verbal problem-solving skills; and scholastic ability and verbal problem-solving skills, the researcher was unable to locate any evidence in the literature of a study which examined the effects of a specially designed mathematics curriculum unit on a student's ability to solve verbal problems. Thus, the researcher designed this study, not only to fill the void, but hopefully, to provide information that will enable teachers of general mathematics to improve their students' skills in verbal problem-solving and thus their ability to cope with the demands of today's society.

Procedures. Experimental mathematics curriculum materials were developed for use in this study. One hundred thirty-eight ninth grade general mathematics students in four junior high schools were selected to participate in the study. Of these 138 students, complete pre-study data from only 90 students were available. Therefore, only these 90 students were included as subjects in this study.

The subjects in two of the four schools were randomly assigned to the Experimental Group and the subjects in the two remaining schools were designated the Control Group. Subjects in the Experimental Group used the experimental mathematics curriculum materials and the subjects in the Control Group continued with the current traditional program.

After the completion of the experimental procedure, a posttest was administered to the 90 subjects who participated in the study. The results of the posttest were compared using Analysis of Covariance

Since intact classes were used in this study, the researcher further examined the prestudy data using discriminant analysis.

Findings. The null hypothesis was tested, using the ANCOVA, and was rejected, with the experimental results significant at more than the .05 level. However, interpretation difficulties for ANCOVA, based in the non-random assignment of subjects to groups in the study, led the author to additional data considerations using the prestudy data as discriminating variables and the posttest results as a classification criterion in a discriminant analysis.

The results of the discriminant analysis, using the prestudy data, were in agreement with the results of a study conducted by Chase (1960) to determine which factors were most effective in predicting success in solving verbal problems. The results of the descriminant analysis led this author to agree with earlier researchers that reading, intellectual factors, mathematics computation, and a knowledge of mathematics concepts are effective in predicting success in the acquistion of verbal problem-solving skills, and thus these variables may have influenced the outcome of the ANCOVA of this study.