

AN EXPERIMENTAL INVESTIGATION OF WORD SOLVING PROBLEMS
IN SEVENTH AND EIGHTH GRADES WITH DIFFERENT
MATHEMATICAL BACKGROUNDS

by 45

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CHAPTER I

INTRODUCTION

During recent years, many schools have changed from either a traditional, or transitional, to a "modern" mathematics program, as did the West Allis-West Milwaukee Joint School District Number One. In 1963-64, grades three and four were still using a traditional arithmetic text, Making Sure of Arithmetic, published by Silver Burdett. In the 1964-65 schoolyear, the fifth grade continued to use the traditional text while the fourth grade changed to the Greater Cleveland Mathematics Program of the Science Research Associates. The mathematical series used included texts one-twelve for intermediate grades.¹

The Greater Cleveland Mathematics Program was completely modern and different from previously-used texts.

This modern math program, the most widely used in the nation, is designed with the philosophy in mind that it is necessary to understand the concepts underlying mathematical operations before learning the computational skills for doing the operations.²

This program also includes all mathematical elements

¹Robert Johnson, Assistant Superintendent of Schools, West Allis-West Milwaukee Joint City School District Number One.

²General Catalog, Science Research Associates, Inc., 1967, p. 55.

taught in the intermediate grades and provides students with a better understanding and working knowledge of mathematical relationships.

In the 1964-65 schoolyear, the fourth grade class started with the Greater Cleveland Mathematics Program of Science Research Associates, Incorporated. This class has continued to use this series. The twelve books were designed principally for grades four, five, and six. When many of the instructors realized they would not complete the full series of twelve books during the 1966-67 schoolyear, they decided to use books eleven and twelve with the present Laidlaw texts in the seventh grade.³

The fifth grade class in the 1964-65 schoolyear used the traditional book, Making Sure of Arithmetic, published by Silver Burdett. This class has continued with a traditional program and is the eighth grade the researcher used in this study.

I. STATEMENT OF THE PROBLEM

In 1964-65, the fourth grade departed from the traditional mathematics program of the school system; they had studied the Greater Cleveland Mathematics Program from 1964-65

³Robert Johnson, Assistant Superintendent of Schools, West Allis-West Milwaukee Joint City School District Number One.

through the 1967-68 schoolyear. This class was the seventh grade tested by the researcher in this investigation.

The eighth grade tested by the researcher has studied only the traditional mathematics program through the grades.

Therefore, this investigation was undertaken to see whether the modern mathematics program of the seventh grade was giving the students a better foundation for techniques in problem solving than the traditional mathematics program of the eighth grade. Because of the difference in the mathematical backgrounds, a difference in the approach, techniques, and understanding should be evident.

II. WHAT IS "MODERN" MATHEMATICS?

In order to be able to define the term "modern" mathematics, the following explanation is necessary. Mathematical programs have changed in both content and structure in certain areas to form a program referred to as "modern" arithmetic or "modern" mathematics. When using the term "modern", it usually refers to a modern program in arithmetic. Such a program differs from a traditional program both in content and spirit, having new emphases and points of view. Therefore, modern mathematics is not newly-discovered mathematics, but mathematics new to the curriculum of the elementary and

secondary levels of our schools.⁴

The modern spirit referred to in modern mathematics is a spirit of inquiring and discovery that is instilled in the pupils. This spirit helps the students use ideas already acquired as a means of discovery of new ideas.⁵

Modern mathematics introduces some mathematical concepts earlier than was previously considered possible. This does not mean, however, that an arithmetic program that merely accelerates the content is necessarily a modern program.⁶ The content must be such that the student gains insight into number relationships, principles of operations, and patterns among numbers. Another important aspect of "modern arithmetic" or "modern mathematics" is the precise use of the vocabulary. An example of this would be the use of the words numeral and number. A number is a quantitative concept, and a numeral is a name for a number.⁷

The new arithmetic or mathematics defines certain basic principles carefully and systematically. Today more

⁴Silver Burdett Company, What is Modern Mathematics? (The Resourceful Teacher No. VII. Park Ridge, Illinois, 1966,) p. 1.

⁵Ibid.

⁶Ibid.

⁷Ibid., p. 2.

emphasis is placed on principles for two basic reasons:

(1) to give the student tools for building upon new facts and concepts from what he already has acquired and (2) to give the student an appreciation, no matter how elementary, of the basic structure of mathematics.⁸

The content of the modern mathematics program may include some geometric concepts as early as grades one and two. The geometric ideas are developed further in subsequent years. The pupil in the elementary grades learns not only to identify geometric shapes but to discover many of their properties. The child usually enjoys geometry if the discovery approach is used. Another source of enjoyment for him is seeing these different geometric shapes in everyday happenings.⁹

Other characteristics of a modern mathematics program are unification and integration of mathematical ideas and procedures. In more modern mathematics, separate treatment of various branches of mathematics becomes more difficult and even inadvisable in a modern approach to the subject. Also, increased emphasis must be given to basic principles and patterns of our number system, and to the properties of

⁸Ibid., p. 3.

⁹Ibid., p. 4.

operations from which we abstract generalizations.¹⁰

Other characteristics of modern mathematics are more precise definitions, terminology, and notations. Many familiar definitions of traditional mathematics have been replaced by new definitions that are more precise. Considerably much more time is being taken in the classrooms to get acquainted with the "language of mathematics".¹¹

Previous traditional mathematical programs emphasized the use of rules instead of the formation and foundation of mathematical concepts. In modern mathematics, if a "line segment" is meant, it is not spoken of as a "line". In discussing a length of a line, mathematicians say "the measure of the line segment is ... inches", and not "the line segment is ... inches".¹²

III. DEFINITION OF TERMS

The seventh and eighth grades used in this study refer to the students enrolled in seventh and eighth grades respectively during the 1967-68 schoolyear in the West Allis-West Milwaukee Joint City School District Number One. Only those

¹⁰A. B. Evenson, Modern Mathematics: Introductory Concepts and Their Implications (Chicago: Scott, Foresman and Company, 1962), p. 4-5.

¹¹Ibid., p. 5.

¹²Ibid.

who attended the school system since the 1963-64 schoolyear, when the modern mathematics program was inaugurated, were used.

Word solving problems, often referred to as story problems, are those in the form of sentences or paragraphs, from which the student must choose only that information necessary to solve them.

In the chapter entitled RESULTS, the researcher will refer to a careless error as a careless computational mistake rather than an error due to lack of knowledge or procedure. For example, a student might have used a correct approach in solving a word problem, but during his computation he may have added or subtracted incorrectly, thus committing a careless error.

Problem solving abilities are those which rely on (1) translating to mathematical symbols, (2) complete and clear understanding of mathematical symbols, (3) skills in computational processes, and (4) knowledge of the basic principles of mathematics and of problem solving so the students may apply them correctly in varying situations.¹³

Techniques are those mathematical methods and skills used to solve a problem.

¹³A. B. Evenson, Modern Mathematics: Introductory Concepts and Their Implications (Chicago: Scott, Foresman and Company, 1962), page 4, 5.

Approach consists of the initial techniques or steps used to formulate the equation to be solved.

IV. IMPORTANCE OF THE STUDY

In this age of rapid change, more attention must be given to careful problem solving techniques. Modern mathematics had been changed to cope with a better understanding of the basic principles and foundations of mathematics. Therefore, modern mathematics should help in problem solving techniques. All of the modern mathematical implications mentioned previously, should have a large impact on problem solving at all levels. Before any word problem can be solved, a student must be able to translate the words of the problem to mathematical symbols. Therefore, in order to be able to translate, a student needs a clear understanding of all mathematical symbols he needs to use. A student must also be skilled in all computational processes to be able to solve the mathematical symbols used in his mathematical statement.¹⁴

Since modern mathematics cannot possibly foresee every type of problem a student may encounter in life, it can only hope to teach the basic principles of mathematics and problem solving necessary to be able to apply these principles

¹⁴A. B. Evenson, Modern Mathematics: Introductory Concepts and Their Implications (Chicago: Scott, Foresman and Company, 1962), page 7.

correctly in the various types of situations.¹⁵

According to the Houghton Mifflin Company, the following question appears to be unresolved: Compared to traditional mathematics, has modern mathematics improved a student's ability to solve word problems? The teacher's manual states:

In some of the more "modern" of the experimental programs, instruction in problem solving has been de-emphasized. Whether the amount of instructional attention given in the past to problem solving was defensible is still a matter for experimentation and debate. But if the newer instructional procedures are, in fact, superior, they should result in improved performance in problem solving ability.¹⁶

V. ASSUMPTIONS AND LIMITATIONS OF THE STUDY

The researcher had to make several assumptions when matching the students for the testing. First, he had to assume that the result from the Iowa Tests of Basic Skills for each student was the best possible score the student could achieve and that no student had copied or otherwise cheated in the test.

In matching the students, the researcher had two scores from which to choose from the Arithmetic Problem Solving section of the Iowa Tests of Basic Skills. The grade

¹⁵Ibid.

¹⁶E. F. Lindquist, and A. N. Hieronymus, Teacher's Manual: Iowa Tests of Basic Skills (Boston: Houghton Mifflin Company, 1964), p. 50.

equivalent score or the percentile score could have been used in the matching. However, the percentile scores had large gaps. The percentiles near the mean differed by as much as five percentile points for each tenth of a grade in grade equivalent scores.¹⁷ Therefore, percentiles were not used as a matching tool.

Grade equivalent scores could have been used, but these results also were not accurate when differing from the mean of the group. In addition, not all scores were reported to the nearest tenth in each grade. The pupils in grade eight could have had grade equivalent scores of 8.1, 8.4, 8.5, 8.7, and 8.9, but had no scores between these listed scores. The pupils in grade seven could have had grade equivalent scores of 7.0, 7.3, 7.6, and 7.8, but had no scores between these listed scores. Therefore, it was impossible in most cases to have exactly one year's difference in grade equivalent scores. The researcher then converted all grade equivalent scores to standard scores for purposes of matching, using the formula:

$$\text{Standard Score} = \frac{\text{Student Score (G. E.)} - \text{Mean for Group (G. P.)}}{\text{Standard Deviation for this grade on this test as reported in the manual}}$$

Thus all grade equivalent scores were changed to standard

¹⁷E. F. Lindquist, and A. N. Hieronymus, Manual for Administrators, Supervisors, and Counselors: Iowa Tests of Basic Skills (Boston: Houghton Mifflin Company, 1964), p. 63-64.

scores. Again, since not all scores were reported to the nearest tenth of grade equivalent, the matching was only as close as the scores permitted the researcher to determine in the matching of standard scores. The actual results may be found in the appendix.

Because the West Allis-West Milwaukee Joint School District Number One changed to the modern mathematics program so abruptly, many of the faculty may not have adjusted their forms of teaching, terminology, methods, and approaches. However, this study was begun on the basic assumption that all faculty members did make this adjustment completely and immediately when the modern program was adopted.

Problem solving skills cannot be determined only on the ability to do certain word problems, knowledge of certain concepts, and ability to translate word solving problems to mathematical symbols. Thus, it can only be assumed the questions that were used would show certain differences based on the two previous mathematical backgrounds.

As many as possible of the students must be questioned individually to determine if a difference exists; however, because of the time element, the researcher was unable to question all the students extensively and to test all the questions on a large population. If the researcher had had time, he could have checked all the questions with a larger population and tried to establish some norms for the group.

Time was also a factor in attempting to have the students solve enough problems of each type that correspond to a per cent of each type in each grade.

The types of problems were given in eight categories. The same eight categories that Houghton Mifflin Company uses in their tests of arithmetic in the Iowa Tests of Basic Skills were employed by the researcher in this study: currency, decimals, fractions, geometry, measurement, per cents, ratio and proportion, and whole numbers.¹⁸ Since the content of most texts can be categorized into these eight types, the researcher decided to use these eight categories in this study also.¹⁹

The differences stated in the conclusion were found to be true for this specific group tested at West Allis-West Milwaukee Joint City School District Number One. These differences may not necessarily be prevalent in other school districts with similar backgrounds. There also may be other differences the investigator was unable to discover because of either the sampling group or the questions posed to the students by the investigator. He can only assume he has

¹⁸E. F. Lindquist, and A. N. Hieronymus, Teacher's Manual: Iowa Tests of Basic Skills (Boston: Houghton Mifflin Company, 1964), p. 50

¹⁹Edward Drahozal, Ph. D., Test Consultant, Houghton Mifflin Company, Geneva, Illinois.

found most differences of major importance to make the study a valid and complete report.

VI. REVIEW OF RELATED RESEARCH AND LITERATURE

The view many mathematicians have regarding problem solving has been restricted to so-called word problems or story problems. Many mathematicians fail to perceive that much of mathematical learning itself is problem solving. The more students develop their mathematical learning itself as problem solving, the better able the students are to cope effectively with new problems that may arise in both mathematics and social contexts.²⁰

The use of number sentences is important in finding solutions to verbal problems. To write number sentences for problems, the student must be able to translate verbal sentences and phrases into the language of mathematics, which consists of numbers and symbols.²¹ Solutions to verbal problems are important, but there are other important concepts other than the solutions to the problems.

The highly symbolic language of mathematics makes it useful as an aid in solving problems. This language contains

²⁰J. Fred Weaver, "Applications and Problem Solving," The Arithmetic Teacher, XII (October, 1965), p. 413.

²¹National Council of Teachers of Mathematics, Topics in Mathematics for Elementary School Teachers (Number Sentences Booklet Number 8. Washington, D. C., 1964), p. 30.

symbols comparable to parts of the English language, such as, nouns, verbs, phrases, and punctuation marks. These punctuation marks are used to clarify the meaning of either a mathematical phrase or sentence.²²

In chapter three, EXPECTED OUTCOMES, the researcher stated that modern mathematics programs placed increased emphasis on the concepts, approaches to concepts, and terminology. However, the number of word problems, by actual count, decreased when the modern mathematics programs were first inaugurated.²³

Some critics of the new mathematics programs state that many of the large experimental programs have ignored applications and relations to science instruction. Mathematics reform during the past few years has been for the greater part in the hands of pure mathematicians. Many agree that this has been important as the first step in making a mathematics program truly contemporary in concept and spirit. If this program is to be complete, then applications of this pure mathematics program are necessary as the second step.²⁴

²²National Council of Teachers of Mathematics, Topics in Mathematics for Elementary School Teachers (Number Sentences Booklet Number 8. Washington, D. C., 1964), p. 1.

²³Edward Drahozal, Ph. D., Test Consultant, Houghton Mifflin Company, Geneva, Illinois.

²⁴Howard F. Fehr, "Sense and Nonsense in a Modern School Mathematics Program," The Education Digest, XXXI (April, 1966), pp. 16, 17.

Even though pure mathematicians were involved in setting up some programs, high school and college teachers together with psychologists and others have set up other mathematics programs, e.g., School Mathematics Study Group.²⁵

Howard F. Fehr made the following statement which might truly clarify one point in the philosophy of any mathematics instructor:

It is essential for the student of mathematics to acquire the faculty of being able, by his own wit, to learn more mathematics, to solve new problems, to adapt his past knowledge to new knowledge and new points of view, . . .²⁶

While some mathematicians have stated we do not give enough emphasis to problem solving, others hold the opposite opinion. These mathematicians believe our view basically consists of the so-called social applications. Consequently, the term usefulness has been restricted.²⁷

As mentioned previously, the number of word problems or story problems had decreased with the new modern mathematics programs. If story problems have decreased, then the emphasis on these problems may not necessarily be evident.

²⁵Floyd J. Coppedge, Ph. D., Assistant Professor of Education, Kansas State University, Manhattan, Kansas.

²⁶Howard F. Fehr, "Sense and Nonsense in a Modern School Mathematics Program," The Education Digest, XXXI (April, 1966), pp. 16, 17.

²⁷J. Fred Weaver, "Applications and Problem Solving," The Arithmetic Teacher, XII (October, 1965), p. 412.

N. Wesley Earp once stated that when special emphasis was placed on problem solving, improved achievement resulted. This was proven true when students were given a good many well-chosen problems to solve. He then concluded that achievement of an acceptable level of problem solving skills was possible if the teacher emphasized the development of these skills and applied the suggestions given for improving these skills.²⁸

Problem solving skills can be improved, but not by simply assigning word problems. Solving problems is a complex process. Research has told us there seems to be no one best procedure for problem solving. Research also has told us, though, that some systematic approach is better than none at all.²⁹

Many authors of textbooks state the procedure necessary in solving a problem. The last step in most cases is labeling the answer. An article by Herbert Hannon states that labeling is very important and definitely should be taken into consideration. His summary points out this important aspect:

²⁸N. Wesley Earp, "Problem Solving--Arithmetic's Persistent Dilemma," School Science and Mathematics, LXVII (February, 1967), p. 188.

²⁹G. W. Brown, "Improving Instruction in Problem Solving in Ninth Grade Mathematics," School Science and Mathematics, LXIV (May, 1964), p. 344.

Three examples have been used to explore the desirability of using labels in problem solving. The point of view presented was that whenever measurement units were involved, these units might be defined as a numeral for 1. Number operations in the usual sense could then be used with the labels used as numerals, i.e., names for numbers.

First, $3a + 2a = (3 + 2)a$, where a is an arbitrary unit of measurement defined as 1.

Also, $3a \times 4a = (3 \times 4) \times (a \times a)$, where a^2 is defined as 1, and finally as " a " squared.

Finally, $3 \times 4a = (3 \times 4)a$, where " a " again is defined as 1--the arbitrary unit of measurement.

Certainly the above point of view permits the separation of the units of measurement (labels) from the number operations used in the usual sense and as such merits some consideration in problem solving--the practical aspects of mathematics.³⁰

³⁰Herbert Hannon, "Label $\times$ Label = Label²--A Point of View," School Science and Mathematics, LXVIII (June, 1968), p. 510

CHAPTER II

DESIGN OF THE STUDY

The study consisted of matching and testing pairs of students in the seventh and eighth grades of one junior high school in the West Allis-West Milwaukee Joint City School District Number One. The researcher questioned the students to determine if their abilities to solve word problems were different. The questions used were from eight areas: currency, decimals, fractions, geometry, measurement, per cents, ratio and proportion, and whole numbers.

I.. AREAS OF TESTING

Based upon several "modern" textbooks in use today and upon the guide of Houghton Mifflin Company publications, the researcher found the areas of problem solving to be categorized into eight types. The eight areas, as listed above in the introductory paragraph, might be represented in both concept and problem solving techniques. Since the researcher was interested primarily in the latter, he used verbal ideas containing some or all of these techniques. The techniques of each area are as follows:

1. Currency: reading and writing amounts; counting; relating value of coins and making change.
2. Decimals: reading and writing; fraction, decimal,

per cent equivalents; fundamental operations using decimals.

3. Fractions: part of a whole or group; relative sizes; reducing; fundamental operations using fractions.
4. Geometry: recognizing geometric figures; dimensions, perimeters, areas of polygons.
5. Measurement: quantity; time; temperature; weight; areas and volume; fundamental operations with denominate numbers.
6. Per cent: meaning and use.
7. Ratio and proportion: meaning and use.
8. Whole numbers: reading and writing; rounding; measurement; averaging; fundamental operations.

These were the basic areas used to determine if a difference in problem solving was apparent.³¹

The modern mathematics series may differ slightly in techniques, vocabulary, or approach, but all series spend approximately the same amount of time on each area and cover each area at about the same time during the year. This is especially true in the lower grades.³²

³¹E. F. Lindquist, and A. N. Hieronymus, Manual for Administrators, Supervisors, and Counselors: Iowa Tests of Basic Skills (Boston: Houghton Mifflin Company, 1964), p. 37.

³²Ibid., p. 36

The per cent of problems in use in each area in modern texts today is approximately as follows:

1. Currency: thirty-five to forty per cent.
2. Decimals: two to four per cent.
3. Fractions: thirty to thirty-five per cent for grade seven; fourteen to seventeen per cent for grade eight.
4. Geometry: six to nine per cent.
5. Measurement: six to eight per cent in grade seven; three to five per cent in grade eight.
6. Per cent: three to five per cent in grade seven; fifteen to twenty per cent in grade eight.
7. Ratio and proportion: two to five per cent.
8. Whole numbers: three to five per cent in grade seven; eight to twelve per cent in grade eight.³³

These per cents will vary in future texts and future forms of the Iowa Tests of Basic Skills. There are trends at present to reduce the number of currency problems even though this area is one of the best common denominators of all students at all levels in society. The amount will be reduced to an average of twenty-five per cent. The area of geometry will be increased to an average of fifteen per cent. In the lower levels there is an increase in the amount of

³³Edward Drahozal, Ph. D., Test Consultant, Houghton Mifflin Company, Geneva, Illinois.

geometry included among leading publishers of modern arithmetic texts. The amount of material on measurement will vary from publisher to publisher. Many publishers will use this area as the common denominator among students of all areas of society compared to the present area of currency.³⁴

II.. INSTRUMENTATION

The word problems used to determine the approaches of the students were chosen from several sources. Some problems, worded slightly different, were chosen from forms one, two, three, and four of the Iowa Tests of Basic Skills. Other problems were chosen from current textbooks in use by the West Allis-West Milwaukee Joint City School District Number One. The problems are stated in the appendix.

There are several questions which test the student's ability to translate words to symbols and symbols to words. This is one area of problem solving that must be mastered if a problem is to be solved.³⁵

The time needed by each student to complete each problem was recorded and analysis was made later to determine if time was an essential factor in this comparative study.

³⁴Edward Drahozal, Ph. D., Test Consultant, Houghton Mifflin Company, Geneva, Illinois.

³⁵A. B. Evenson, Modern Mathematics: Introductory Concepts and Their Implications (Chicago: Scott, Foresman and Company, 1962), p. 7.

The time was recorded to the nearest second. After the student had worked it to his best ability, the researcher asked questions on the approach to the problem and how he determined the result. If the result the student had was incorrect, the researcher asked questions to see if the student could see the mistake and correct it.

III. PROCEDURES

The Horace Mann Junior High School, one of the largest in the school system, was selected for the study because of its closeness to the investigator. According to Mr. Robert Johnson, assistant superintendent, all of the junior high schools in the system are the same in terms of average intelligence quotient, levels of aptitude skills, and the social and economical level of the community. After the selection of the junior high had been made, information concerning each student in the seventh and eighth grades was entered on a four by six card. Based upon this information, five points of matching were chosen: (1) sex, (2) intelligence quotient, (3) grade equivalent from the word solving section of the Iowa Tests of Basic Skills, (4) year in school, and (5) date of birth. Other information recorded included the parent's name, student's name, address, and telephone number.

Since grade equivalents are very deceiving in value when they depart very far from the mean for that age, grade

equivalent scores were changed to standard scores for the purpose of matching, using the following formula to change the scores:

$$\text{Standard Score} = \frac{\text{Grade Equivalent} - \text{Group Placement}}{\text{Standard Deviation}}$$

These then took the place of the grade equivalent on the cards.

The standard deviation for the above formula was as follows: Grade seven used form three; the standard deviation was 15.90.³⁶ Grade eight used form four; the standard deviation was 18.08.³⁷

When all the scores had been recorded, the researcher placed the cards in order of the standard scores and within each of these score groupings, the cards were arranged according to the intelligence quotient.

The investigator was able to match the students as closely as possible, using the following as a guide: The students in each pair were of exactly one year's separation in grade level. One student was from grade eight and the other student from grade seven.

Second, the two students in each pair were of the same sex. The investigator attempted to have the same number of

³⁶E. F. Lindquist, and A. N. Hieronymus, Manual for Administrators, Supervisors, and Counselors: Iowa Tests of Basic Skills (Boston: Houghton Mifflin Company, 1964), p. 41.

³⁷Ibid., p. 45.

matched pairs of each sex in the study.

Third, the students were matched in accordance with their intelligence quotients. This was done to within one intelligence quotient point on each matched pair.

Fourth, the students were matched on the basis of the standard scores of the Iowa Tests of Basic Skills' arithmetic problem solving section, Test A-2. This was done to within .0082 standard score units on each matched pair.

Last, the students were matched according to age. Since the study encompassed two grades exactly one year apart, their age should have been as close as possible to a year apart also. After the students were matched on the previously mentioned points, the researcher tried to have this difference in age be as close to twelve months as possible. Therefore, 91.5 per cent of all cases are within an age difference range of ten to fourteen months. The remaining 8.5 per cent are nine or fifteen months apart in age. The raw data on all matching of the groups can be found in the appendix.

When the pairs were selected, a letter with a return post card enclosed was sent to the parents of each of the students who were part of the study. A copy of the letter may be found in the appendix. This letter asked permission for the researcher to test their child at their home for a period of one hour. When the post card was returned with

their signed permission, the researcher contacted them for an appointment to test their child. Only two families refused to grant the researcher permission to test their children. The number assigned to each matched pair and a set of random numbers contained in a text determined the order of testing to avoid a preference to either side of the mean.

The student and the researcher usually worked on a table at the student's home, because it was impossible to test the students at the school. The researcher gave the student a clean sheet of typing paper and one card at a time, each having one problem to be solved. The researcher timed each individual. When each student had solved the problem correctly or incorrectly, the researcher asked for methods of approach each student had used, and information concerning the solution. If the solution was incorrect, the researcher, through oral questions only, attempted to discover if the student could explain his own error, so that the researcher could further understand the reason for the incorrect result.

IV. ANALYSIS OF DATA

The analysis consisted of several steps to determine if a difference in problem solving was apparent. The first step of the analysis was to total the number of correct responses of each student. The second step was to find the average

number of correct responses of each grade and then determine if the difference in the averages was statistically significant.

Many of the students who had the problem incorrect at first examination, would have had the problem correct if they had not made simple careless errors. Therefore, the researcher evaluated the number of correct and incorrect results, taking into consideration this concept of careless errors. After finding the number of correct responses of each student, the average number of correct responses of each grade was found to determine if the difference in the averages was statistically significant.

The amount of time required by each student to work each problem correctly was recorded. In the analysis of each problem, an average time for each grade was calculated and compared to determine if the difference was statistically significant. This difference was based on two factors. First, the times were compared considering careless errors. Second, the times were compared not considering careless errors. The researcher wanted to determine if a consideration of the careless errors made a statistical difference in the times.

Since some of the problems are similar to those administered by the Iowa Tests of Basic Skills, forms one, two, three, and four, the end of the year norms for this study

group were compared to the national midyear norms for each specific problem. This was done only on those problems where the end of the year per cent of the group was equal to or below the national midyear per cent. If the end of the year per cent was greater than the national midyear per cent, the results were not stated because no inference could be drawn from that data. If the norms for a specific problem differed considerably, the investigator did try to determine why.

After considering careless errors, the approaches of those students whose results were yet incorrect were shown and evaluated to determine if their errors were due to careless reading, misunderstanding, or poor conception of arithmetic concepts. The number of students in each grade who used the same incorrect approach is also listed.

Another step in the analysis was to determine the total number of correctly labeled problems of each student. The second step was to find the average number of correctly labeled problems of each grade and then determine if the difference in the averages was statistically significant.

The researcher evaluated the teachers' backgrounds to determine if they were knowledgeable in the field of modern mathematics at the onset of the program at their grade levels. If they were not so trained, this might be a factor in the results.

CHAPTER III

EXPECTED OUTCOMES

The modern mathematics programs place a greater emphasis on deductive proof and reasoning. Since the deductive system is based on undefined terms, postulates, and laws of logic, a student might be better able to cope with word solving problems than previously with traditional texts.³⁸

Modern mathematics texts have spent more time on precise definitions, terminology, and notation. The traditional texts emphasized the use of rules instead of the formation of certain mathematical concepts. In modern mathematics programs of today, more attention is given to the precision of concepts which will definitely affect the students' problem solving ability. The exponents of the new mathematics believe that the student's progress in this subject is often retarded because he is not able to verbalize accurately. Since being able to translate words into mathematical symbols is a key to solving word problems, the student's ability to know the words more precisely will help

³⁸A. B. Evenson, Modern Mathematics: Introductory Concepts and Their Implications (Chicago: Scott, Foresman and Company, 1962), p. 2.

in word solving problems.³⁹

Therefore, even though the seventh grade is a year behind the eighth grade in school, the researcher may find the seventh grade to be equal to the eighth grade students in word solving abilities.

As pointed out earlier in the report, many mathematics programs have not emphasized word solving abilities.⁴⁰ Based on actual count of word solving problems, many texts have decreased the number of problems considerably. Since the modern mathematics program puts more emphasis on concepts, approaches to concepts, and terminology, the publishers had to eliminate something in the text to keep the work within a schoolyear. Therefore, the number of word solving problems was decreased in favor of concepts. Since many publishers realized their mistake in this move, the publishers have increased their word solving problems.⁴¹

The modern mathematics program in use by the West Allis-West Milwaukee Joint City School District Number One was the first series Science Research Associates published on

³⁹A. B. Evenson, Modern Mathematics: Introductory Concepts and Their Implications (Chicago: Scott, Foresman and Company, 1962), p. 5.

⁴⁰E. F. Lindquist, and A. N. Hieronymus, Teacher's Manual: Iowa Tests of Basic Skills (Boston: Houghton Mifflin Company, 1964), p. 50.

⁴¹Edward Drahozal, Ph. D., Test Consultant, Houghton Mifflin Company, Geneva, Illinois.

modern mathematics. These consist of the twelve paperback books of the Greater Cleveland Mathematics Program for intermediate grades. Hence, possibly fewer problems were given the seventh grade class with the modern mathematics than the eighth grade class with traditional texts. If this was the case, the results from the testing may show the seventh grade students to be poor in word solving problems compared to the eighth grade students.

Because there are sound points of discussion on both sides of the issue, no clear-cut prediction can be made.

CHAPTER IV

RESULTS

Careless errors made a large difference in the results of some of the problems. Therefore, the researcher had to divide each problem into two aspects, not considering careless errors and considering careless errors. The seventh grade students committed a total of forty careless errors while the eighth grade students had twenty-seven careless errors. This affected the total number correct by each grade as follows: Seventh grade students had 275 correct considering careless errors and 235 not considering careless errors. Eighth grade students had 305 correct considering careless errors and 278 not considering these careless errors.

Based on the number of correct answers, not considering careless errors, there is no statistical significant difference between the means of the seventh and eighth grade classes at the .05 level. Using the t-formula gave a value of 1.8937 with thirty-six degrees of freedom.

Based on the number of correct answers, considering careless errors, there is no statistical significant difference between the means of the seventh and eighth grade classes at the .05 level. Using the t-formula gave a value of 1.231 with thirty-six degrees of freedom.

The concept of labeling may be important since it might mean that the student who labels has a better knowledge of what he is doing than a student who does not label his work. An average of both grades was established, based on the total number of correctly labeled problems of each student in each grade. The value calculated using the t -formula was 1.1813, which indicates the difference in the means of the seventh and eighth grade classes was of no statistical significance at the .05 level.

The results discussed thus far in this chapter were tabulated in TABLE I, page thirty-three, and TABLE II, page thirty-four.

In reading each question, the researcher found the difference between the seventh and eighth grade classes to vary from question to question. Therefore, to determine if one class had a better knowledge of story problems than the other class, each problem was analyzed.

This analysis was conducted according to the following steps:

1. The problem as presented to the student.
2. The achievement status, not considering careless errors, followed by achievement status, considering careless errors.
3. Common errors of students.
4. Average time in seconds.

TABLE I
TOTAL RESULTS OF ALL QUESTIONS

Results	Grade 7	Grade 8
Total number of correct answers, considering careless errors	275	305
Total number of incorrect answers	197	161
Total number of students who did not attempt to solve the problem	83	89
Percentage of total correct responses considering careless errors	49.55%	54.95%
Percentage of total incorrect responses considering careless errors	35.50%	29.01%
Percentage of total number of students who did not attempt to solve the problem	14.95%	16.04%
Total number of careless errors	40	27
Percentage of careless errors of those students who attempted to solve the problem	8.47%	5.79%
Percentage of students who correctly labeled the solutions to the problem	73.73%	80.47%

TABLE II
COMPARISON OF SEVENTH AND EIGHTH GRADERS ON
TOTAL ACHIEVEMENT RESULTS

Variable	Grade 7		Grade 8		
	Mean raw score	σ	Mean raw score	σ	
Number of correct answers, not considering care- less errors	6.351	2.506	7.514	2.697	1.8937
Number of correct answers, consid- ering careless errors	7.432	2.509	8.243	3.052	1.2310
Number of answers correctly labeled	9.378	2.294	10.11	2.911	1.1813

5. Labeling.
6. Percentage of achievement, where applicable.

I.. QUESTION NUMBER ONE

A grocery store published an ad of these specials:

Turkey: 27¢ per pound

Ground Beef: 3 pounds for \$1.44

Ham: 49¢ per pound

Beef Roast: 59¢ per pound

Oranges: 3 dozen for \$1.00

Peas: 2 cans for 39¢

Red Salmon: 85¢ per can

Celery: 2 large stalks for 29¢

Peaches: 4 cans for 89¢

Sugar: 10 pounds for 99¢

Mrs. Davis bought the following:

4 pounds of Beef Roast

1 can of Red Salmon

2 stalks of Celery

4 cans of Peaches

How much did the groceries cost?⁴²

Not considering the possibility that anyone had made

⁴²E. F. Lindquist, and A. N. Hieronymus, Iowa Tests of Basic Skills, Form 3 (Boston; Houghton Mifflin Company, 1964), p. 93, Question 66.

a careless error, nineteen students in grade seven and twenty-one students in grade eight correctly answered question one. Next, when considering the careless errors made by some students, twenty-seven students in grade seven and twenty-four students in grade eight had the correct answer. These results are shown in TABLE III, page thirty-seven.

A great difference is noted in TABLE III because eight students in grade seven and three students in grade eight made careless errors.

Reading errors accounted for the majority of the mistakes. Listed in TABLE IV, page thirty-eight, are some of the errors students made in solving this problem, with the number of students in each grade who made that error. As the first problem was being administered, the researcher noted that most of the students were nervous.

As shown in TABLE V, page thirty-nine, the difference in the average times of seventh and eighth grades was not statistically significant in either case. When not considering careless errors, the t-distribution formula gave a result of .2994. This result shows the difference is not significant at the .05 level. When considering careless errors as a factor, the t-distribution still indicated the difference in the average of the means was not significant. The t-distribution gave a value of .3062, which also indicates the difference is not significant at the .05 level.

TABLE III
ACHIEVEMENT STATUS ON QUESTION ONE

Answer	Grade 7		Grade 8	
	No.	%	No.	%
Not considering careless errors				
Correct	19	51.35	21	56.76
Incorrect	17	45.95	15	40.54
None	1	2.70	1	2.70
Considering careless errors				
Correct	27	72.97	24	64.86
Incorrect	9	24.32	12	32.43
None	1	2.70	1	2.70

TABLE IV
COMMON ERRORS OF STUDENTS ON QUESTION ONE

Errors	Grade 7	Grade 8
Used ground beef instead of beef roast	5	7
Two cans of peaches instead of four	1	0
Used peas instead of peaches	0	1
Used ham instead of beef roast	0	1
Used one pound of beef roast instead of four pounds	1	1
Used celery at 29 cents each instead of two for 29 cents	2	2

TABLE V
AVERAGE TIME IN SECONDS ON QUESTION ONE

Answer	Grade 7	Grade 8
Not considering careless errors		
Correct	99.47 Sec.	96.62 Sec.
Incorrect	120.71	106.00
None	135.00	180.00
Considering careless errors		
Correct	100.74	98.29
Incorrect	135.78	107.00
None	135.00	180.00

Another factor to consider might be labeling, which again might mean the student who labeled had a slightly better knowledge of what he was doing than a student who did not label his work. In this particular problem the seventh grade students appeared to show a better understanding of this labeling concept, since all seventh grade students labeled the problem correctly while all eighth grade students did not.⁴³

This particular problem is similar to a problem used in the Iowa Tests of Basic Skills. Question number sixty-six of Form Three, from which this question was patterned, had a midyear per cent given for the national average as shown in TABLE VI.⁴⁴ The seventh grade had a percentage of achievement higher than the eighth grade midyear per cent.

TABLE VI
PERCENTAGE OF ACHIEVEMENT ON QUESTION ONE

Group average	Grade 7	Grade 8
National (midyear per cent)	53.00%	60.00%
Study (end of year per cent)	72.97	64.86

⁴³A more complete presentation of labeling information can be found in the appendix.

⁴⁴Iowa Tests of Basic Skills, Item Performance Analysis, (Boston: Houghton Mifflin Company, 1965), Grades 7, 8.

II.. QUESTION NUMBER TWO

The track for Joe's electric train was a 200-inch oval. Roger's train had 12 curved and 4 straight sections of track each 10 inches long. How many inches longer was Joe's track?⁴⁵

This second question, concerning measurement of track using whole numbers, had the results as shown in TABLE VII, page forty-two, not considering and considering the possibility of careless errors. Two seventh grade students committed the same careless error: They wrote the subtraction problem 200 minus 160 and had 30 as the answer.

The reasons why the students had this particular problem wrong are listed in TABLE VIII, page forty-four. The majority of the errors, especially of the eighth grade students, were poor reading errors. Also included in the table are the number of students at each grade level who committed this same error.

If time was to be a factor in this particular problem, the difference between the means of the seventh and eighth grade students was not statistically significant. The value of t in the t -distribution formula, when considering careless errors, was .3662. This indicates the difference in the average times is not significant at the .05 level. When not

⁴⁵E. F. Lindquist, and A. N. Hieronymus, Iowa Tests of Basic Skills, Form 1 (Boston: Houghton Mifflin Company, 1964), p. 92, Question 55.

TABLE VII
ACHIEVEMENT STATUS ON QUESTION TWO

Answer	Grade 7		Grade 8	
	No.	%	No.	%
Not considering careless errors				
Correct	20	54.05	24	64.86
Incorrect	15	40.54	8	21.62
None	2	5.41	5	13.51
Considering careless errors				
Correct	22	59.46	24	64.86
Incorrect	13	35.14	8	21.62
None	2	5.41	5	13.51

considering careless errors, the value derived is also not significant at the .05 level. These results are shown in TABLE IX, page forty-four.

The consideration of labeling as a factor in determining understanding definitely favored the eighth grade in this particular problem. Nearly all eighth grade students labeled the problem correctly while only about two thirds of the seventh grade students did it correctly. This was based on the number of students who attempted or did solve the problem.

III. QUESTION NUMBER THREE

The sailing schedule shows that the ship arrives at Milwaukee on Wednesday at 8:00 a.m. and leaves at 1:30 p.m. on the same day. How many hours is the ship docked in Milwaukee?⁴⁶

The third question, using the concept measurement in terms of time, had the results as listed in TABLE X, page forty-five. None of the students committed careless errors.

Nearly all of the students who solved the problem correctly, seventh or eighth graders, did little pencil work to compute the result. The majority arrived at the answer mentally. The greater percentage of those students who tried

⁴⁶E. F. Lindquist, and A. N. Hieronymus, Iowa Tests of Basic Skills, Form 2 (Boston: Houghton Mifflin Company, 1956), p. 94, Question 81.

TABLE VIII
COMMON ERRORS OF STUDENTS ON QUESTION TWO

Errors	Grade 7	Grade 8
Did not see the word "longer" in the problem	6	8
Added both lengths together instead of subtracting	3	0
10 times 12 minus 120 times 4 equals 480 inches	3	0

TABLE IX
AVERAGE TIME IN SECONDS ON QUESTION TWO

Answer	Grade 7	Grade 8
Correct	58.27 Sec.	60.71 Sec.
Incorrect	71.77	64.13
None	101.00	64.20

TABLE X
ACHIEVEMENT STATUS ON QUESTION THREE

Answer	Grade 7		Grade 8	
	No.	%	No.	%
Correct	21	56.76	20	54.05
Incorrect	15	40.54	14	37.84
None	1	2.79	3	8.12

to compute the result on paper had incorrect answers. TABLE XI, page forty-seven, shows common errors and the number of students who committed them.

Since no careless errors were found, time had to be considered only once. Statistically, the difference in the average of the means was of no significance. The value of t in the t -test was .8139, which indicated the difference was of no significance at the .05 level.

Listed in TABLE XII are the average times of all students of each grade.

TABLE XII
AVERAGE TIME IN SECONDS ON QUESTION THREE

Answer	Grade 7	Grade 8
Correct	48.48 Sec.	43.05 Sec.
Incorrect	69.53	58.14
None	35.00	80.00

Labeling in this particular problem was not as important as it might have been in another problem. Though many of the students, both seventh and eighth graders, wrote the answer as 6:30, they included the correct label when they read the answer aloud. The results did indicate that the eighth grade did do slightly better than the seventh grade

TABLE XI
COMMON ERRORS OF STUDENTS ON QUESTION THREE

Errors	Grade 7	Grade 8
$\begin{array}{r} 8:00 \\ 1:30 \\ \hline 6:70 \end{array}$ or 7:10	11	7
8:00 plus 1:30 is equal to 9:30	1	2
Started counting from 8:00 instead of 9:00	2	1
Knew 8:00 A.M. but thought 1:30 P.M. was in the early morning	1	2
Mentally 30 minutes from 1 hour is 30 minutes and 1 hour from 8 hours equals 7 hours, therefore $7\frac{1}{2}$ hours	0	2

on labeling in this particular problem.

This problem is similar to problem eighty-one in Form Two of the Iowa Tests of Basic Skills, therefore the midyear per cents can be cited.⁴⁷

TABLE XIII compares per cents achieved by the national group to those achieved by the study group.

TABLE XIII
PERCENTAGE OF ACHIEVEMENT ON QUESTION THREE

Group average	Grade 7	Grade 8
National (midyear per cent)	41.00%	73.00%
Study (end of year per cent)	54.05	56.76

IV. QUESTION NUMBER FOUR

If a dozen ears of corn cost forty-eight cents, what would Mrs. Smith pay for a half dozen ears of corn?⁴⁸

The researcher, in running a preliminary study before testing this matched group, noticed an hundred per cent correct response by both grades. Despite this high achievement,

⁴⁷Iowa Tests of Basic Skills, Item Performance Analysis, (Boston: Houghton Mifflin Company, 1965), Grades 7, 8.

⁴⁸E. F. Lindquist, and A. N. Hieronymus, Iowa Tests of Basic Skills, Form 2 (Boston: Houghton Mifflin Company, 1956), p. 93, Question 63.

the researcher decided to leave the problem in the testing program, because it at least might have encouraged a few students for future problems when they noticed an easy one. In the actual testing of the matched pairs, none of the students committed careless errors. However, five of the nine students who had incorrect answers made careless reading errors. The remaining four students could not explain to the researcher why they did the operations they performed. They were convinced, though, that they had the correct result.

The number of students from each grade and the percentage are listed in TABLE XIV.

TABLE XIV
ACHIEVEMENT STATUS ON QUESTION FOUR

Answer	Grade 7		Grade 8	
	No.	%	No.	%
Correct	31	83.78	34	91.89
Incorrect	6	16.22	3	8.12
None	0	0	0	0

The errors committed by the nine students are listed in TABLE XV.

TABLE XV
COMMON ERRORS OF STUDENTS ON QUESTION FOUR

Errors	Grade 7	Grade 8
Thought it read six dozen	4	1
48¢ divided by 6 equals 8¢	2	2

Considering time as a possible factor in trying to determine which grade level had a better knowledge and understanding of this particular problem, the researcher found the difference between the means of grade seven and eight to be not significant. The difference in the average times of those who solved the problem correctly at both grade levels was $\frac{4}{10}$ of one second. Using the t-distribution formula, a result of .077 was produced. This indicates that the difference in the means was of no significance at the .05 level. TABLE XVI, page fifty-one, compares average times taken by the students to compute question four.

Labeling in this particular problem was not a pertinent factor in determining which grade had a better understanding of the problem, as the difference between the two grade levels was only two students.

TABLE XVI
AVERAGE TIME IN SECONDS ON QUESTION FOUR

Answer	Grade 7	Grade 8
Correct	25.97 Sec.	26.38 Sec.
Incorrect	53.50	38.33
None	0	0

V. QUESTION NUMBER FIVE

Mr. Roberts bought three life vests as safety equipment for his new boat and paid for them with a twenty dollar bill. If the vests are \$5.19 each, how much change should he receive?⁴⁹

This question is concerned with currency, one of the eight areas into which word or story problems were grouped.

Careless errors definitely had to be considered in this problem, because 17.57% of all seventy-four students tested made careless errors. Listed in TABLE XVII, page fifty-three, are the number and per cent of students who worked the problem, not considering and considering careless errors.

There was a total of thirteen careless errors. Six of the errors were committed by the seventh grade students while seven of the errors were committed by the eighth grade students. Six seventh graders and five eighth graders had the problem wrong due to errors other than careless errors.

⁴⁹E. F. Lindquist, and A. N. Hieronymus, Iowa Tests of Basic Skills, Form 4 (Boston: Houghton Mifflin Company, 1964), p. 93, Question 68.

TABLE XVII
ACHIEVEMENT STATUS ON QUESTION FIVE

Answer	Grade 7		Grade 8	
	No.	%	No.	%
Not considering careless errors				
Correct	25	67.57	24	64.86
Incorrect	12	32.43	12	32.43
None	0	0	1	2.70
Considering careless errors				
Correct	31	83.78	31	83.78
Incorrect	6	16.22	5	13.51
None	0	0	1	2.70

Nine students committed common errors, as shown in TABLE XVIII.

TABLE XVIII
COMMON ERRORS OF STUDENTS ON QUESTION FIVE

Errors	Grade 7	Grade 8
Thought he purchased only one jacket	6	3
Thought he purchased only two jackets	0	2

The average times are of such a nature that it may not be possible to use them with any degree of assurability. The average times of those who made careless errors were extremely high compared to those of the students who found the correct solution. Listed in TABLE XIX, page fifty-five, are the average times, showing how the students who committed careless errors affected the results.

The average time of the six students in the seventh grade who made careless errors was 96.5 seconds. The average time of the seven students in the eighth grade who made careless errors was 84.71 seconds. This accounts for the difference between considering and not considering careless errors.

The researcher statistically analyzed each of these considerations by use of the t-test. By not considering

TABLE XIX
AVERAGE TIME IN SECONDS ON QUESTION FIVE

Answer	Grade 7	Grade 8
Not considering careless errors		
Correct	59.72 Sec.	46.83 Sec.
Incorrect	89.33	76.50
None	0	20.00
Considering careless errors		
Correct	66.84	55.39
Incorrect	82.17	65.00
None	0	20.00

careless errors, the value of t was 3.1731. This value is greater than the .01 level of significance, thus making the difference in the average times of the seventh and eighth grade students significant. The eighth grade class had an average time significantly faster than the average time of the seventh grade class.

By considering careless errors, the value of t was 1.273, which is not significant at the .05 level.

The researcher also noted that the student who spent only twenty seconds on the problem before stating he had no idea of how to work the problem probably did not spend a sufficient amount of time to warrant that statement. If he had spent more time on the problem, the researcher feels he might have solved the problem correctly, based upon his answers to certain leading questions the researcher asked him after he stated he had no idea of how to work it.

The labeling results in this particular problem were practically the same for each grade. Those students who did not label the problem correctly had the decimal point for the cents, but did not use the dollar sign to indicate the integers preceding the decimal point were dollars.

This problem is similar to problem sixty-eight in Form Four of the Iowa Tests of Basic Skills.⁵⁰ That problem

⁵⁰Iowa Tests of Basic Skills, Item Performance Analysis, (Boston: Houghton Mifflin Company, 1965), Grades 7, 8.

had midyear per cents well below those achieved by both the seventh and eighth grade students of the study. For example, the eighth grade's midyear per cent was sixty-six per cent while the seventh grade of the study achieved nearly eighty-four per cent.

Listed in TABLE XX are the national midyear per cents and the per cents achieved by the students of this study.

TABLE XX
PERCENTAGE OF ACHIEVEMENT ON QUESTION FIVE

Group average	Grade 7	Grade 8
National (midyear per cent)	59.00%	66.00%
Study (end of year per cent)	83.78	83.78

VI.. QUESTION NUMBER SIX

Mr. Adams paid $12\frac{1}{2}\text{¢}$ each for 1800 fingerlings (young fish). How much did he pay in all for the fish?⁵¹

This problem was categorized in the area of fractions, one of the eight areas into which story problems were grouped.

⁵¹E. F. Lindquist, and A. N. Hieronymus, Iowa Tests of Basic Skills, Form 3 (Boston: Houghton Mifflin Company, 1964), p. 94, Question 72.

Since about eleven per cent of all students who were involved in the study made careless errors when working the problem, this had to be considered an important factor, even though an equal number from each grade made careless errors. Listed in TABLE XXI, page fifty-nine, are the number and per cent of students who worked and achieved that status, not considering and considering careless errors.

Listed in TABLE XXII, page sixty, are some of the reasons why a large number of students had the problem incorrect. When applied to this problem, the concepts of many of the students were poor.

TABLE XXIII, page sixty-one, shows the average timings of both seventh and eighth grade students, not considering and considering careless errors.

These average timings were statistically of no significance, even though the eighth grade students had a time which was approximately twenty per cent faster. The concept of considering careless errors or not considering careless errors did not change the results statistically. When considering the careless errors, the value of t for testing the difference of the average times was 1.3643. This result indicated that the difference in the average times was of no significance at the .05 level. When not considering careless errors, the value of t was 1.0364. This also indicated it was not significant at the .05 level.

TABLE XXI
ACHIEVEMENT STATUS ON QUESTION SIX

Answer	Grade 7		Grade 8	
	No.	%	No.	%
Not considering careless errors				
Correct	9	24.32	10	27.03
Incorrect	19	51.35	18	48.65
None	9	24.32	9	24.32
Considering careless errors				
Correct	13	35.14	14	37.84
Incorrect	15	40.54	14	37.84
None	9	24.32	9	24.32

TABLE XXII
COMMON ERRORS OF STUDENTS ON QUESTION SIX

Errors	Grade 7	Grade 8
Used 12.2 to represent twelve and one-half	5	5
Used $\frac{1}{2}$ as .02	1	0
Divided instead of multiplied	2	1
Multiplied correctly but had no concept of where to put the decimal point	0	3
Claimed there was no way to represent the fraction $\frac{1}{2}$ in decimal form	1	0
12(1800) plus $\frac{1}{2}$ (of that product) 21600 plus $\frac{1}{2}$ (of that product again) was 32,400	2	0
Used $12\frac{1}{2}$ as 25 instead of 25 divided by 2	3	0
Thought $12\frac{1}{2}$ times 1800 was 12(1800) plus $\frac{1}{2}$ (12)(1800)	0	3
Thought the decimal went after the first non-zero number	0	2
Used $12\frac{1}{2}$ as 12 divided by 24	1	0

TABLE XXIII
AVERAGE TIME IN SECONDS ON QUESTION SIX

Answer	Grade 7	Grade 8
Not considering careless errors		
Correct	95.67 Sec.	78.80 Sec.
Incorrect	101.16	87.78
None	77.44	72.00
Considering careless errors		
Correct	99.08	80.07
Incorrect	99.67	89.07
None	77.44	72.00

The consideration of labeling in the solution of the problem was of no value in determining whether one grade had a better understanding, because both grades had exactly the same number labeled correctly.

This problem, very similar to problem seventy-two of Form Three, revealed a very interesting factor in terms of the national midyear per cents.⁵² The results are found in TABLE XXIV.

TABLE XXIV
PERCENTAGE OF ACHIEVEMENT ON QUESTION SIX

Group average	Grade 7	Grade 8
National (midyear per cent)	37.00%	50.00%
Study (end of year per cent)	35.14	37.84

VII. QUESTION NUMBER SEVEN

Mr. Jones went fishing and found the average weight of his fish was 3.9 pounds. Mrs. Jones went fishing and found the average weight of her fish was 2.25 pounds. How

⁵²Iowa Tests of Basic Skills, Item Performance Analysis, (Boston: Houghton Mifflin Company, 1965), Grades 7, 8.

many pounds heavier was the average of Mr. Jones's fish?⁵³

This problem, which is in the category of decimals, had the number and per cent of achievement, first, not considering and, second, considering the possibility of careless errors, as shown in TABLE XXV, page sixty-four.

The researcher found that the lack of knowledge of concepts was the major reason for incorrect answers. The researcher asked the following question of the majority of the students who either had the problem incorrect or had no answer: "Which of these values is larger or smaller: 3.9 or 3.90? Or are the two values equal, that is, the same?" The response of nearly every student indicated 3.9 is larger, because that states nine tenths while the other states only ninety one-hundredths; nine tenths is definitely larger than ninety one-hundredths. This response was given by both seventh and eighth grade students. Considering that seventh grade had had modern mathematics, in which understanding is a fundamental feature, the researcher could not explain the reason for that response.

Listed in TABLE XXVI, page sixty-five, are some of the ways in which students attempted to solve the problem, having incorrect results.

⁵³E. F. Lindquist, and A. N. Hieronymus, Iowa Tests of Basic Skills, Form 3 (Boston: Houghton Mifflin Company, 1964), p. 94, Question 73.

TABLE XXV
ACHIEVEMENT STATUS ON QUESTION SEVEN

Answer	Grade 7		Grade 8	
	No.	%	No.	%
Not considering careless errors				
Correct	16	43.24	23	62.16
Incorrect	16	43.24	11	29.73
None	5	13.51	3	8.12
Considering careless errors				
Correct	18	48.65	27	72.97
Incorrect	14	37.84	7	18.92
None	5	13.51	3	8.12

TABLE XXVI
COMMON ERRORS OF STUDENTS ON QUESTION SEVEN

Errors	Grade 7	Grade 8
$\begin{array}{r} 2.25 \\ - 3.9 \\ \hline .186 \end{array}$	8	4
Had 1.16 because .9 from .25 is .16 and 2 from 3 is 1	1	1
$\begin{array}{r} 3.90 \\ 2.25 \\ \hline .0565 \end{array}$ Subtracted the decimal part and added the whole numbers	1	0
Took $\frac{1}{2}$ of the result (1.65) because it said average	0	1
$\begin{array}{r} 2.25 \\ - 3.9 \\ \hline 17.6 \end{array}$ because 9 from 15 is 6 and 3 from 21 is 17	2	0

The researcher, in studying the reasons for the errors, noticed that most of the reasons were similar to the one discussed earlier concerning 3.9 and 3.90. By further study of the errors, the researcher noticed poor concepts on the part of both grades.

The time required to solve the problem either correctly or incorrectly is listed in TABLE XXVII, page sixty-seven. It can be noticed that those students who had the problem correct in either grade did so at a faster rate of time than those of the seventh grade. Despite the faster time, however, statistically it was of no significance at the .05 level, when either considering careless errors or not considering careless errors. The values of t when considering and not considering careless errors were 1.612 and 1.8881, respectively.

If labeling was to be a possible factor in determining which grade had the better understanding, the results would favor the eighth grade. The eighth grade students correctly labeled nearly twice as high a percentage of the problems as did the seventh grade students.

Since this problem is similar to question seventy-three of Form Three, the researcher was able to use national midyear per cents for comparison.⁵⁴

⁵⁴Iowa Tests of Basic Skills, Item Performance Analysis, (Boston: Houghton Mifflin Company, 1965), Grades 7, 8.

TABLE XXVII
AVERAGE TIME IN SECONDS ON QUESTION SEVEN

Answer	Grade 7	Grade 8
Not considering careless errors		
Correct	65.38 Sec.	43.61 Sec.
Incorrect	69.44	60.18
None	76.60	63.00
Considering careless errors		
Correct	61.00	43.81
Incorrect	75.64	68.86
None	76.60	63.00

Listed in TABLE XXVIII are the per cents, considering careless errors.

TABLE XXVIII
PERCENTAGE OF ACHIEVEMENT ON QUESTION SEVEN
CONSIDERING CARELESS ERRORS

Group average	Grade 7	Grade 8
National (midyear per cent)	48.00%	64.00%
Study (end of year per cent)	48.65	72.97

If the researcher would not have given the students credit for careless arithmetic errors, the per cents would be changed noticeably, as shown in TABLE XXIX

TABLE XXIX
PERCENTAGE OF ACHIEVEMENT ON QUESTION SEVEN
NOT CONSIDERING CARELESS ERRORS

Group average	Grade 7	Grade 8
National (midyear per cent)	48.00%	64.00%
Study (end of year per cent)	43.24	62.16

VIII. QUESTION NUMBER EIGHT

A honeybee colony that contains 60,000 bees in late fall may have only 12,000 at the end of the winter. What per cent of the bees live through the winter season?⁵⁵

This question is from the area of per cent. The values listed in TABLE XXX, page seventy, are based upon answers, not considering and considering careless arithmetic errors.

Common errors, other than careless errors, made by the students are listed in TABLE XXXI, page seventy-one. Also listed in this table are the number of students in each grade who committed the same error.

The researcher discovered that the students had committed computational errors rather than reading errors.

The average time required by students who had the problem correct was in favor of the eighth grade students, as shown in TABLE XXXII, page seventy-two.

The average eighth grade student worked the problem in approximately sixty per cent of the time it took the average seventh grade student to achieve the correct result. Statistically, it also was shown that the difference in the average times of seventh and eighth grade students was

⁵⁵E. F. Lindquist, and A. N. Hieronymus, Iowa Tests of Basic Skills, Form 3 (Boston: Houghton Mifflin Company, 1964), p. 94, Question 86.

TABLE XXX
ACHIEVEMENT STATUS ON QUESTION EIGHT

Answer	Grade 7		Grade 8	
	No.	%	No.	%
Not considering careless errors				
Correct	7	21.62	10	27.03
Incorrect	19	51.35	18	48.64
None	11	29.73	9	24.32
Considering careless errors				
Correct	9	24.32	11	29.73
Incorrect	17	45.95	17	45.95
None	11	29.73	9	24.32

TABLE XXXI
COMMON ERRORS OF STUDENTS ON QUESTION EIGHT

Errors	Grade 7	Grade 8
1200 divided by 60000 is equal to 1/5 per cent	3	0
Since 5 times the 12000 equals 60,000 the answer is 5%	0	11
60,000 less 12,000 is 48,000. Therefore the answer is 48%	5	5
Since 60 divided by 12 is 5, the answer is 50%	1	0
12,000 times 60,000 divided by 100 is equal to the answer	4	0
Since 60,000 minus 12,000 is 58,000 and 60,000 is 100% and 58,000 is 2,000 less than 60,000, then the answer is 2% less than 100% or 98%	0	1
(P)(12,000) divided by 100 is equal to 60,000 then P is equal to 5,000%	4	0

TABLE XXXII
AVERAGE TIME IN SECONDS ON QUESTION EIGHT

Answer	Grade 7	Grade 8
Not considering careless errors		
Correct	107.43 Sec.	64.00 Sec.
Incorrect	94.84	57.67
None	95.27	70.44
Considering careless errors		
Correct	111.78	62.82
Incorrect	91.06	58.06
None	95.27	70.44

significant, whether considering or not considering careless errors. Using the t statistic, the values for t when considering and not considering careless errors were 2.6991 and 2.7175, respectively. The values, whether considering or not considering careless errors, are both significant at the .05 level, and thus prove the eighth grade students to be superior in the aspect of time.

Labeling of this particular type of problem is very important in terms of understanding, because per cent can be represented in several ways. After they had completed the problem, the researcher asked the students how they interpreted their answers. Eighth grade students did an exceptionally fine job in terms of explaining their labels and did a considerably better job of labeling than did the seventh grade students.

When compared to a national norm, the researcher found the eighth grade to be below while the seventh grade appeared to be about average. Since this question is similar to number eighty-six in Form Three, national midyear per cents were available to the researcher.⁵⁶

⁵⁶Iowa Tests of Basic Skills, Item Performance Analysis, (Boston: Houghton Mifflin Company, 1965), Grades 7, 8.

Listed in TABLE XXXIII are the comparisons.

TABLE XXXIII
PERCENTAGE OF ACHIEVEMENT ON QUESTION EIGHT

Group average	Grade 7	Grade 8
National (midyear per cent)	22.00 %	43.00%
Study (end of year per cent)	24.32	29.73

During the several weeks in which the testing was conducted, both grades began the study of per cent. Because the students had varying degrees of knowledge, the researcher feels the above results do not give a fair picture.

IX.. QUESTION NUMBER NINE

Alice started a 4H laying flock project in September with eighty small pullets. (Pullets are small chickens.) The laying house for the flock was twelve feet by sixteen feet. How many square feet of floor area, to the nearest tenth, did this allow each bird?⁵⁷

⁵⁷E. F. Lindquist, and A. N. Hieronymus, Iowa Tests of Basic Skills, Form 4 (Boston: Houghton Mifflin Company, 1964), p. 94, Question 83.

This particular question is from the area of geometry, using only multiplication and division to achieve the correct result. Listed in TABLE XXXIV, page seventy-six, are the results, not considering and considering careless arithmetic errors.

Four seventh grade students and three eighth grade students accounted for the change noted in considering careless errors. Though using the correct procedure, these students made careless arithmetic mistakes: subtraction errors when they divided and addition errors when they multiplied.

Listed in TABLE XXXV, page seventy-seven, are some of the incorrect approaches and procedures the students used.

The majority of the students had this problem incorrect because of their poor understanding of concepts.

Since the average timings of those who made careless errors affected the results to some degree, both average times are shown in TABLE XXXVI, page seventy-eight.

Of the group who made careless errors, the average time taken by the seventh grade student was 138.50 seconds while the average time taken by the eighth grade student was only 94.00 seconds. This explains the increase in the average time of the seventh grade and the decrease in the average time of the eighth grade.

Despite the difference in average times and the

TABLE XXXIV
ACHIEVEMENT STATUS ON QUESTION NINE

Answer	Grade 7		Grade 8	
	No.	%	No.	%
Not considering careless errors				
Correct	9	24.32	9	24.32
Incorrect	19	51.35	17	45.95
None	9	24.32	11	29.73
Considering careless errors				
Correct	13	35.14	12	32.43
Incorrect	15	40.54	14	37.84
None	9	24.32	11	29.73

TABLE XXXV
COMMON ERRORS OF STUDENTS ON QUESTION NINE

Errors	Grade 7	Grade 8
Divided 192 by 80 and had 2 with a remainder of 32 and could not divide further because 32 could not be divided by 80	4	1
Had 2 and $\frac{2}{5}$ for the answer and was not sure what was meant by tenths	1	1
Had a remainder of 32 and called it the decimal portion of the result	5	6
Area of 192 square feet was divided by 10 because the question asked for the answer to the nearest tenth	2	1
Forgot to divide by 80, did not see the word <u>each</u>	2	4
Area was 2 lengths and 2 widths, 2 x 12 is equal to 24 2 x 16 is equal to 32 56 sq. ft. is the total area	1	0
Total area was 2 x 12 equals 24 2 x 16 equals 32 768 sq. ft. is the area	0	1
Read tens instead of tenths	0	1

TABLE XXXVI
AVERAGE TIME IN SECONDS ON QUESTION NINE

Answer	Grade 7	Grade 8
Not considering careless errors		
Correct	108.00 Sec.	103.78 Sec.
Incorrect	122.21	89.65
None	74.22	73.91
Considering careless errors		
Correct	117.38	101.33
Incorrect	117.87	88.71
None	74.22	73.91

difference the careless errors made in the results, statistically the results were of no significance at the .05 level. The values of t , considering and not considering careless errors, were .9807 and .1470, respectively.

In a problem of area, such as question nine, it is important for the student to differentiate between feet and square feet, labeling the solution correctly. A greater number of eighth grade students than seventh grade students labeled this problem correctly.

Since this problem is similar to question eighty-three of Form Four, national midyear per cents were available to the researcher for comparisons.⁵⁸ These results are stated in TABLE XXXVII, showing the eighth grade students below their national midyear per cent.

TABLE XXXVII
PERCENTAGE OF ACHIEVEMENT ON QUESTION NINE

Group average	Grade 7	Grade 8
National (midyear per cent)	26.00%	39.00%
Study (end of year per cent)	35.14	32.43

⁵⁸Iowa Tests of Basic Skills, Item Performance Analysis, (Boston: Houghton Mifflin Company, 1965), Grades 7, 8.

X. QUESTION NUMBER TEN

To make a base for a desk, a board $7 \frac{5}{8}$ inches wide was sawed into two pieces, one of which was $4 \frac{3}{4}$ inches wide. If no allowance is made for sawing, how wide in inches was the other piece?⁵⁹

This problem, which is from the area of fractions, had the results as listed in TABLE XXXVIII, page eighty-one. The concept of considering careless errors changed the results only slightly, since only one eighth grade student made a careless arithmetic mistake.

The majority of the errors were due to poor understanding of concepts rather than poor reading. The most common error was one of incorrect borrowing. When the students had a quantity of eighths, and needed to borrow one from the whole number, they borrowed ten-eighths rather than eight-eighths. Listed in TABLE XXXIX, page eighty-two, are the errors made by students.

The average times necessary for each student to complete the problem are shown in TABLE XL, page eighty-three.

The difference in the average times is not statistically significant, considering or not considering careless errors. The value of t in considering careless errors was

⁵⁹E. F. Lindquist, and A. N. Hieronymus, Iowa Tests of Basic Skills, Form 3 (Boston: Houghton Mifflin Company, 1964), p. 92, Question 56.

TABLE XXXVIII
ACHIEVEMENT STATUS ON QUESTION TEN

Answer	Grade 7		Grade 8	
	No.	%	No.	%
Not considering careless errors				
Correct	5	13.51	16	43.24
Incorrect	24	64.86	16	43.24
None	8	21.62	5	13.51
Considering careless errors				
Correct	5	13.51	17	45.95
Incorrect	24	64.86	15	40.54
None	8	21.62	5	13.51

TABLE XXXIX
COMMON ERRORS OF STUDENTS ON QUESTION TEN

Errors	Grade 7	Grade 8
Changed the fraction 7 and $\frac{5}{8}$ to 6 and $\frac{15}{8}$ so they were able to subtract 4 and $\frac{6}{8}$	13	10
Subtracted the numerators and denominators as seperate parts ($\frac{5}{8}$ minus $\frac{3}{4}$ equals $\frac{2}{4}$ or $\frac{1}{2}$)	5	1
Changed 7 and $\frac{5}{8}$ to $\frac{61}{8}$ and also changed 4 and $\frac{6}{8}$ to $\frac{30}{8}$ which then resulted in the incorrect answer by subtracting	2	0
Added instead of subtracted	1	3
Multiplied instead of subtracted	0	1
Thought $\frac{5}{8}$ was equal to $\frac{3}{4}$	3	0

TABLE XL
AVERAGE TIME IN SECONDS ON QUESTION TEN

Answer	Grade 7	Grade 8
Not considering careless errors		
Correct	85.60 Sec.	73.25 Sec.
Incorrect	105.83	79.67
None	110.63	92.20
Considering careless errors		
Correct	85.60	74.06
Incorrect	105.83	79.67
None	110.63	92.20

found to be .8061. This value, and the value of t when not considering careless errors, were not significant at the .05 level.

Labeling the answer in inches, though not extremely important to the understanding of the problem, was considered. The results indicated that the eighth graders had a slightly better performance than did the seventh graders.

This question, similar to problem fifty-six of Form Three, gave a national midyear per cent for seventh grade only.⁶⁰

TABLE XLI
PERCENTAGE OF ACHIEVEMENT ON QUESTION TEN

Group average	Grade 7	Grade 8
National (midyear per cent)	42.00%	0 %
Study (end of year per cent)	13.51	45.95

When comparing the national average of 42% to the study average of 13.51%, it would appear to the researcher that the seventh grade apparently had not studied this in school. However, in reviewing the texts of seventh grade, the researcher found that they had had problems similar to

⁶⁰Iowa Tests of Basic Skills, Item Performance Analysis, (Boston: Houghton Mifflin Company, 1965), Grade 7.

this the first semester of the 1967-68 schoolyear. Thus the researcher cannot explain why they did so poorly.

XI. QUESTION NUMBER ELEVEN

How much would nine oranges cost at 36¢ a dozen?⁶¹

In this particular problem there were no careless errors. The results of achievement are stated in TABLE XLII.

TABLE XLII
ACHIEVEMENT STATUS ON QUESTION ELEVEN

Answer	Grade 7		Grade 8	
	No.	%	No.	%
Correct	20	54.05	21	56.76
Incorrect	9	24.32	10	27.03
None	8	21.62	6	16.22

The reasons for arriving at incorrect answers were varied, the majority being careless reading errors. The specific reasons are stated in TABLE XLIII, page eighty-six.

⁶¹E. F. Lindquist, and A. N. Hieronymus, Iowa Tests of Basic Skills, Form 2 (Boston: Houghton Mifflin Company, 1956), p. 93, Question 70.

TABLE XLIII
COMMON ERRORS OF STUDENTS ON QUESTION ELEVEN

Errors	Grade 7	Grade 8
36 divided by 9/12 equals \$3.33	1	0
Used it as 36¢ apiece	3	5
36 divided by 9 is 4 and 4 subtracted from 36 is 32	2	3
36 divided by 9 is 4 and 4 is the answer	3	2

The consideration of the concept of time being a factor in evaluating which grade had a better knowledge of procedure, statistically showed that neither grade had an advantage. The value of t , in testing the average times, was 1.3975. This value is not significant at the .05 level. TABLE XLIV, page eighty-eight, shows the comparative average times.

A high percentage of students in each grade labeled this problem correctly; however, the seventh grade class performed slightly better.

This problem was similar to question seventy in Form Two; thus the researcher was able to use a national midyear percentage for comparison.⁶² Listed in TABLE XLV, page eighty-eight, are the results, showing the eighth grade below average.

XII. QUESTION NUMBER TWELVE

Mr. Jones' gas and electric bill for November was \$9.60. If he paid it by December tenth, he would receive a $7\frac{1}{2}\%$ discount. How much would Mr. Jones save by paying the bill by December tenth?⁶³

⁶²Iowa Tests of Basic Skills, Item Performance Analysis, (Boston: Houghton Mifflin Company, 1965), Grades 7, 8.

⁶³E. F. Lindquist, and A. N. Hieronymus, Iowa Tests of Basic Skills, Form 4 (Boston: Houghton Mifflin Company, 1964), p. 94, Question 78.

TABLE XLIV
AVERAGE TIME IN SECONDS ON QUESTION ELEVEN

Answer	Grade 7	Grade 8
Correct	67.45 Sec.	47.71 Sec.
Incorrect	49.78	56.10
None	102.38	80.83

TABLE XLV
PERCENTAGE OF ACHIEVEMENT OF QUESTION ELEVEN

Group average	Grade 7	Grade 8
National (midyear per cent)	49.00%	64.00%
Study (end of year per cent)	54.05	56.76

Of the fifteen problems included in the test, this one gave the students the most difficulty. As the researcher previously mentioned, the students were beginning the study of per cent problems the last few weeks of school. Thus many of the students tested early in the testing period may have gained an understanding of per cent problems by the end of the testing period.

To understand their inability to write $7\frac{1}{2}\%$, the researcher asked the students how they would write 7% and 70%. The response was 7% as .7, and 70% as .70, which again brought out the concept the researcher discussed in question seven, concerning the similar difficulty writing 3.9 and 3.90. The researcher, by further questioning, tried to determine why the students had this misapprehension. The students' typical answer was similar to the response given in the questioning with problem seven: 7% is .7, because this is seven tenths while 70% is .70 or seventy-hundredths.

In this question the researcher had to consider some careless errors by both the seventh and eighth grade students. A total of two seventh graders and one eighth grader made careless errors to change the results, as shown in TABLE XLVI, page ninety. Listed in this table are the comparative results, considering and not considering careless errors.

Listed in TABLE XLVII, page ninety-one, are some of

TABLE XLVI
ACHIEVEMENT STATUS ON QUESTION TWELVE

Answer	Grade 7		Grade 8	
	No.	%	No.	%
Not considering careless errors				
Correct	0	0	2	5.41
Incorrect	15	40.54	16	43.24
None	22	59.46	19	51.35
Considering careless errors				
Correct	2	5.41	3	8.12
Incorrect	13	35.14	15	40.54
None	22	59.46	19	51.35

TABLE XLVII
COMMON ERRORS OF STUDENTS ON QUESTION TWELVE

	Grade 7	Grade 8
\$9.60 - 7.50 equals \$2.10 ($7\frac{1}{2}$ equals 7.50)	8	4
\$9.60 - 7.5 equals \$8.85 and \$9.60 - \$8.85 equals 95¢	2	2
$7\frac{1}{2}$ equals 7 x 2 plus 1 or 15 therefore 15¢ is the answer	1	0
Divided instead of multiplied	0	8
No idea of where to place the decimal	2	0
$7\frac{1}{2}$ equals the fraction $\frac{1}{14}$, therefore \$9.60 divided by 14 is the result	0	1

the errors made by students, in addition to those mentioned before.

The timings may not be of any value because of the extremely poor showing by both grades. Statistically, the difference in the average times of both grades could not be determined when not considering careless errors. In the t-formula, using the raw scores, the researcher would have had to divide by zero which is mathematically impossible. The t-formula, when considering careless errors, had a value of .6026. This indicates that the difference in the average times of both grades was not significant at the .05 level.

The average times, not considering and considering the careless errors, are listed in TABLE XLVIII, page ninety-three.

Labeling of this problem may not be of any real significance since only half of the students in each grade attempted to solve the problem. The eighth grade class showed a slightly higher performance.

Since this question is similar to problem seventy-eight of Form Four, the national midyear percentages were available for comparison.⁶⁴

⁶⁴Iowa Tests of Basic Skills, Item Performance Analysis, (Boston: Houghton Mifflin Company, 1965), Grades 7, 8.

TABLE XLVIII
AVERAGE TIME IN SECONDS ON QUESTION TWELVE

Answer	Grade 7	Grade 8
Not considering careless errors		
Correct	0	Sec. 119.00 Sec.
Incorrect	97.93	101.06
None	77.32	69.00
Considering careless errors		
Correct	153.50	117.00
Incorrect	89.38	100.27
None	77.32	69.00

These results may be found in TABLE XLIX.

TABLE XLIX
PERCENTAGE OF ACHIEVEMENT ON QUESTION TWELVE

Group average	Grade 7	Grade 8
National (midyear per cent)	23.00%	31.00%
Study (end of year per cent)	5.41	8.12

XIII.. QUESTION NUMBER THIRTEEN

A 3" by 4" photograph was projected on a wall so that the width of the shorter dimension of the projection was 6'. What was the length of the projection?⁶⁵

This question is from the area of ratio and proportion. Since this problem was similar to a problem in the eighth grade text, the researcher expected the eighth graders to achieve better than the seventh graders.

⁶⁵E. T. McSwain, and others, Mathematics 8 (River Forest, Illinois: Laidlaw Brothers, 1963), p. 237, Example 2.

The results are listed in TABLE I. No careless errors were made, thus the consideration was not tabulated.

TABLE I
ACHIEVEMENT STATUS ON QUESTION THIRTEEN

Answer	Grade 7		Grade 8	
	No.	%	No.	%
Correct	10	27.03	11	29.73
Incorrect	21	56.76	12	32.43
None	6	16.22	14	37.84

Since many of the seventh graders had not been exposed to proportions or ratios to a great degree, many of their approaches were different from the approaches of the eighth graders. Listed in TABLE LI, page ninety-six, are the common errors of both grades. Those listed are the errors of the majority. The approaches of the remaining students were much more complex than those listed.

Statistically the timings were of no significance; using the t-formula, the investigator found the difference in the average times of both grades was not significant at the .05 level of significance. The value of t was .3055.

TABLE LI
COMMON ERRORS OF STUDENTS ON QUESTION THIRTEEN

Errors	Grade 7	Grade 8
Since 3" x 4" equals 12", the answer is 12	3	0
Since 3" x 4" equals 12 and 6' x 2 equals 12, the answer is 2 feet	5	0
Since 4" is 1" more than 3" then 1' more than 6' is 7'	3	0
3 x 4 equals 12" and 12" divided by 6' is 2'	0	2
If 3 added to 3 is 6' then 3 added to the 4 is 7'	0	3
3" x 4" is 12" or 1 foot, and 6 feet divided by 1 foot is 6 feet	0	4

The average times are stated in TABLE LII.

TABLE LII
AVERAGE TIME IN SECONDS ON QUESTION THIRTEEN

Answer	Grade 7	Grade 8
Correct	71.30 Sec.	63.27 Sec.
Incorrect	84.33	74.58
None	72.67	67.36

Labeling of this problem was reasonably high by both grades; the seventh grade class performed slightly better.

This question was not similar to any problem in any national testing program, so no comparisons with national per cents could be made.

XIV. QUESTION NUMBER FOURTEEN

Joan paid \$102.50 for the pullets (small chickens), \$223.06 for feed, and \$19.75 for use of the laying house and equipment. She received \$362.43 for eggs and \$85.10 for the hens. How much money did Joan make on the project?⁶⁶

This problem, from the area of currency, had a great

⁶⁶E. F. Lindquist, and A. N. Hieronymus, Iowa Tests of Basic Skills, Form 4 (Boston: Houghton Mifflin Company, 1964), p. 94, Question 86.

deal of adding and subtracting; therefore, a total of eight students from both grades, six from grade seven and two from grade eight, made careless arithmetic errors. Thus, the achievement status had to be considered from both points of view, as is shown in TABLE LIII, page ninety-nine.

The majority of incorrect answers were due to reading errors, as is shown in TABLE LIV, page one hundred.

Statistically, the difference in the average times of the seventh and eighth grade students was not significant. The values of t when considering and not considering careless errors were .837 and .855, respectively, indicating the average times were of no statistical difference at the .05 level. Listed in TABLE LV, page one hundred and one, are the average times. The one student in grade seven who had no answer spent a sufficiently long time on the problem to be able to state that he had no conception of how to approach it.

The tabulation of labeling appeared to be approximately the same for both grades, though the eighth grade performed slightly better.

This problem is similar to question eighty-six of Form Four; thus the national midyear per cents were available for comparisons.⁶⁷ Both grades are well above the national

⁶⁷Iowa Tests of Basic Skills, Item Performance Analysis, (Boston: Houghton Mifflin Company, 1965), Grades 7, 8.

TABLE LIII
ACHIEVEMENT STATUS ON QUESTION FOURTEEN

Answer	Grade 7		Grade 8	
	No.	%	No.	%
Not considering careless errors				
Correct	21	56.76	24	64.86
Incorrect	15	40.54	13	35.14
None	1	2.70	0	0
Considering careless errors				
Correct	27	72.97	26	70.27
Incorrect	9	24.32	11	29.73
None	1	2.70	0	0

TABLE LIV
COMMON ERRORS OF STUDENTS ON QUESTION FOURTEEN

Errors	Grade 7	Grade 8
Subtracted the hen money from the egg money	3	3
Gave the total income and forgot the expenses	3	5
Added everything together, expenses plus income	3	3

TABLE LV
AVERAGE TIME IN SECONDS ON QUESTION FOURTEEN

Answer	Grade 7	Grade 8
Not considering careless errors		
Correct	119.48 Sec.	111.21 Sec.
Incorrect	104.87	97.54
None	127.00	0
Considering careless errors		
Correct	116.93	109.69
Incorrect	102.78	98.64
None	127.00	0

midyear per cents. The researcher noticed especially that grade seven was above the eighth grade midyear per cent. The researcher cannot explain the great difference between the national average and the study group average.

TABLE LVI shows the comparative results.

TABLE LVI
PERCENTAGE OF ACHIEVEMENT ON QUESTION FOURTEEN

Group average	Grade 7	Grade 8
National (midyear per cent)	15.00%	29.00%
Study (end of year per cent)	72.97	70.27

XV. QUESTION NUMBER FIFTEEN

If three tennis balls cost \$1.76, and Frank bought a dozen tennis balls, how much did they cost?⁶⁸

This problem is also from the area of currency, as are problems one, four, five, and fourteen.

Because five students made careless errors, four from grade seven and one from grade eight, the researcher had to evaluate the achievement status, considering both aspects.

⁶⁸E. F. Lindquist, and A. N. Hieronymus, Iowa Tests of Basic Skills, Form 1 (Boston: Houghton Mifflin Company, 1955), p. 93, Question 63.

Listed in TABLE LVII, page one hundred and four, are the comparisons.

Thoughtless errors caused eleven seventh graders and four eighth graders to compute the wrong answer. Listed in TABLE LVIII, page one hundred and five, are the common errors.

The researcher believes many of those listed in TABLE LVIII would have had the problem correct if they had taken their time. It appeared that because it was the last question of the test and many of the students rushed the problem, carelessness was prevalent.

When not considering careless errors, the average times of the seventh and eighth graders who achieved the correct results were 46.73 and 48.90, respectively. Using the t-test to test the difference in the means, the researcher found the value of t to be .2652, which was not significant at the .05 level.

When considering careless errors, the difference in the average times was significant at the .001 level. The value of t was 6.67013. Thus the eighth grade had a significantly faster performance time.

TABLE LIX, page one hundred and six, shows the comparative results.

The results from the tabulation of labeling of this problem were extremely high, the performance of the seventh

TABLE LVII
ACHIEVEMENT STATUS ON QUESTION FIFTEEN

Answer	Grade 7		Grade 8	
	No.	%	No.	%
Not considering careless errors				
Correct	22	59.46	29	78.38
Incorrect	15	40.54	5	13.51
None	0	0	3	8.12
Considering careless errors				
Correct	26	70.27	30	81.08
Incorrect	11	29.73	4	10.81
None	0	0	3	8.12

TABLE LVIII
COMMON ERRORS OF STUDENTS ON QUESTION FIFTEEN

Errors	Grade 7	Grade 8
Thought he purchased twelve of those packets of three	5	2
Thought twelve was divisible by three only three times, therefore multiplied three times \$1.76	3	0
Estimated the price of each incorrectly, then multiplied by twelve	3	2

TABLE LIX
AVERAGE TIME IN SECONDS ON QUESTION FIFTEEN

Answer	Grade 7	Grade 8
Not considering careless errors		
Correct	46.73 Sec.	48.90 Sec.
Incorrect	88.07	63.80
None	0	71.33
Considering careless errors		
Correct	48.46	48.47
Incorrect	99.00	70.75
None	0	71.33

grade being slightly better.

This question is similar to problem sixty-three of Form One, which allowed the researcher to use midyear per cents for comparisons.⁶⁹ Listed in TABLE LX are the percentages, which indicate the seventh grade is approximately seven per cent above the eighth grade midyear per cent.

TABLE LX
PERCENTAGE OF ACHIEVEMENT ON QUESTION FIFTEEN

Group average	Grade 7	Grade 8
National (midyear per cent)	55.00%	64.00%
Study (end of year per cent)	70.77	81.08

XVI.. INTRODUCTORY QUESTION

When you work a word solving problem, are there any specific steps you use to solve the problem? What should you do first, second, etc.?

Actually administered first in the series of questions, this question was given to determine if the students had a procedure or a series of steps to follow in solving a verbal or story problem. The researcher was expecting the responses

⁶⁹Iowa Tests of Basic Skills, Item Performance Analysis, (Boston: Houghton Mifflin Company, 1965), Grades 7, 8.

to be similar to those in a Houghton Mifflin Company text for sixth graders.⁷⁰ The steps listed are as follows:

1. Ask, "What are the sets in the problem?"
2. Ask, "What is happening to the sets?"
3. Write the equation.
4. Solve the equation.
5. Use the solution to answer the question in the problem.

The actual responses the researcher received from the question were null. A few students in the seventh grade stated they should look for key words which indicated if they should add, subtract, multiply, or divide. Several eighth graders stated that they should try to write an equation, which they would then proceed to solve. However, not one of these students used those steps when attempting to solve the test questions.

The responses to this question gave the researcher no significant pattern that one grade level may have learned compared to the other.

XVII.. TERMINOLOGY

The researcher had difficulty with this section of

⁷⁰Ernest R. Duncan and others, Modern School Mathematics, Structure and Use, (Boston: Houghton Mifflin Co., 1967), p. 40.

the testing program administered to the students. Had terms from the modern mathematics program been chosen, the seventh grade would have been favored. Selecting terminology from the traditional program would have shown favoritism to the eighth grade. Through much experimentation and contemplation, the researcher decided upon ten common terms:

(1) sum, (2) difference, (3) product, (4) quotient, (5) reciprocal, (6) ratio, (7) remainder, (8) numerator, (9) denominator, and (10) decimal equivalent.

These terms were incorporated in twelve phrases to be completed by the students. They had to know the meaning of each term in order to complete the phrase. The phrases and tabulation of the responses are shown in TABLE LXI, page one hundred and ten.

The total results showed that seventh grade had 215 correct responses while the eighth grade had 301 correct responses.

XVIII. TEACHER SURVEY

During the period of testing, the researcher noticed that the study group used both the older standard method of division and the new modern method. This also was true with multiplication. Upon asking the seventh graders if they knew both methods, the researcher discovered that many of the seventh graders had been taught both methods together.

TABLE LXI
TERMINOLOGY

Questions	Grade 7		Grade 8	
	Correct response	Incorrect or no response	Correct response	Incorrect or no response
The sum of 12 and 5 is:	33	4	36	1
The difference of 12 & 6 is:	34	3	33	4
The product of 8 and 4 is:	15	22	26	11
The quotient of 8 and 4 is:	16	21	27	10
Reciprocal of 4:	16	21	12	25
Ratio of 4 to 8:	8	29	18	19
Remainder of 11 divided by 3 is:	19	18	26	11
Numerator of the fraction $7/3$ is:	22	15	29	8
Denominator of fraction $8/5$ is:	21	16	31	6
Decimal equivalent of $\frac{1}{4}$ is:	11	26	26	11
Decimal equivalent of $1/5$ is:	11	26	24	13
Difference of 3 and $\frac{1}{2}$ of 4 is:	9	28	13	24

The researcher decided to survey all the teachers in the school system who had taught the students in the study from the third grade through the seventh grade. As mentioned earlier, the seventh grade class began the modern mathematics program in the fourth grade. The researcher, working with the administration, was able to achieve one hundred per cent response.

The questions on the survey sheet included the following items:

1. The year the teacher entered this school system.
2. A listing of all modern mathematics courses taken prior to 1963, allowing the teacher to rate the courses as highly modern, average, or below average.
3. A year by year progression from the year 1963 to the present year, asking for the grade taught and the courses taken during that year, again rating the courses as previously mentioned.
4. Asking the teachers if they had seen the films at the administration building during the 1961-62 schoolyear on S. M. S. G. material. The films and study were patterned after the book, Studies in Mathematics.⁷¹

⁷¹Max S. Bell and others, Studies in Mathematics (Leland Stanford Junior University, 1963).

The results of the survey were as follows:

1. Only five of the thirty-two teachers surveyed had taken two courses or more of any modern mathematics courses, even those classified by the teacher as below average. These two courses were usually methods courses or were college mathematics.
2. Of the remaining twenty-seven of the thirty-two teachers surveyed, thirteen teachers had taken no modern mathematics courses. This is about forty-one per cent of all teachers surveyed.
3. The other fourteen of the twenty-seven teachers mentioned above, had taken only one course and this was a methods course. Some of the titles were as follows: Modern Mathematics Methods, Modern Mathematics, Modern Arithmetic, and Teaching of Modern Mathematics.
4. Twenty-two of the thirty-two, or approximately sixty-six per cent, of the survey sheets indicated they had seen the films at the administration building.

CHAPTER V

CONCLUSION

The final conclusion cannot be formulated into a concise statement until all the aspects of the study are reviewed and evaluated. These points will include such aspects as achievement status, time, labeling, percentage of achievement, terminology, teacher survey, and other points that may have affected the results.

As was noted in STATEMENT OF THE PROBLEM, because of the difference in mathematical backgrounds, a difference in approach, techniques, and understanding should be evident. The researcher noted that the approach and techniques of the two grades were similar in all but one problem. In problem thirteen, as seen in TABLE LI, page ninety-six, the approaches were different. However, the seventh graders had not been exposed to proportions yet in their modern mathematics program. Therefore, the researcher believes a fair judgment cannot be made.

Since the seventh graders committed forty careless errors while the eighth graders had seven, several observations can be made. In two problems, numbers one and fourteen, the eighth graders had more correct results when not considering careless errors than did the seventh graders. After considering the careless errors, the seventh grade

scored higher. Also, in problem nine, where an equal number of students had the correct response when not considering careless errors, the seventh grade scored higher after careless errors were considered. Therefore, the careless errors were numerous and especially evident on the part of the seventh graders. A possible reason for this might be the fact that the seventh grade class had had one year less of practice. Also, maturity might be a consideration.

The achievement status, not considering careless errors, allowed the eighth grade to achieve more correct responses in twelve of the fifteen problems. Of the remaining three problems, the seventh grade performed better in two and the seventh and eighth grades had an equal number correct in one. Therefore, based upon this information, when not considering careless errors, the eighth grade had a higher achievement. However, the difference in the average means of seventh and eighth grade students was not statistically significant. The t-test resulted in a value of 1.8937, which was not significant at the .05 level.

The achievement status, considering the careless errors, allowed the eighth grade to achieve more correct responses in ten of the fifteen problems. Of the remaining five problems, the seventh grade had the higher achievement in four. In one problem the seventh and eighth grades had an equal number of correct responses. Therefore, based upon

this information, the eighth grade class again had a higher achievement, though not as high as when careless errors were not considered. After considering careless errors, the difference in the means of seventh and eighth grade students again was not statistically significant. The value of t in the t -test was 1.231. Therefore, in summary, the difference in the means of the seventh and eighth grade students, whether considering or not considering careless errors, was not statistically significant.

As stated previously, time could have been a factor in solving word story problems, because it might show which grade had a better knowledge. In chapter four, RESULTS, the timings for each problem were tested by the t -test to determine if there was a statistical difference in the average times taken by the seventh and eighth grade students to work the problem. When not considering careless errors, the timings were significant in problems five and eight, showing the eighth grade class to have achieved faster. In all of the other problems, except problem number twelve, the timings were not significant. In problem twelve, the t -test could not be used, because division by zero would have resulted in two places in the formula. Therefore, in the majority of the questions, the researcher believes the timings were of no great significance, when not considering careless errors.

When considering the careless errors, the timings

were significant in problems eight and fifteen, showing the eighth grade to have achieved faster. In all of the other thirteen problems, the timings were not significant. Therefore, the researcher believes the timings were of no great significance when considering the careless errors.

The difference in the average number of correctly labeled problems by seventh and eighth grades was not significant. When tested by the t-test, the value calculated was 1.1813, which is not significant at the .05 level. Thus, the total concept of labeling was of no significance.

Comparing the study group's percentage of achievement to national norms, where applicable, revealed no significant findings, when reviewing the total results.

The terms incorporated in the terminology section are terms used in all mathematics programs, either traditional or modern. Therefore, the terms gave neither class an advantage. An evaluation of the results of the terminology testing revealed that the eighth grade had a better understanding of the terms, scoring higher in ten of the twelve answers.

After all of the results were completed, the researcher noted that eighth grade students might have been taught some modern mathematics. After checking with the eighth grade mathematics instructors, the researcher found they were teaching, when appropriate, some concepts of the modern

mathematics program. The researcher also discovered that, on occasion, the seventh grade instructors used the traditional approach in their teaching. This could be observed from the results listed in chapter four, concerning the teacher survey. It appears the teachers should have had more modern mathematics courses in order to properly teach the modern mathematics program.

However, it must be mentioned that perhaps these teachers are more qualified than this survey indicates, because of individual reading and study. The researcher is hoping that the administration soon will offer a workshop for all mathematics teachers.

Based upon the preceding information and the facts as reported in chapter four, RESULTS, the researcher believes the variation in the two grades is of little difference. Thus, it seems that the modern mathematics program, as used in this school district, has not improved problem solving skills. It would also appear that neither has it met all of the objectives set forth in the modern mathematics program, as stated in chapter one.

However, the one year's difference in age and grade should be noted. Also, without further study, the researcher does not feel it fair to place a clear-cut judgment on the West Allis-West Milwaukee Joint School District Number One. Therefore, the researcher would recommend that similar studies

be made on a larger population of students in this school system. Perhaps a like investigation should be made on a national level, if possible, in order to fully evaluate the modern mathematics program, not only in the area of problem solving skills, but also in other areas important to the mathematical background of today's student.

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APPENDIX

C O P Y

Date: _____

G. R. Schumacher
West Milwaukee High School
5104 West Greenfield Avenue
Milwaukee, Wisconsin 53214

Dear parents:

Your son or daughter, _____, has been selected to be a part of a testing program that is being used to determine mathematical abilities in word solving problems. The test or questions I would like to ask would take approximately one hour. I would like to come to your home and talk to your child sometime during the next several weeks. I will contact you before I come if you allow me this opportunity.

This test is not given to all seventh and eighth graders at Horace Mann, but to a total of eighty selected students. Because I need the full number of these students to complete the program, I definitely would like your permission.

Your son or daughter will not be required to study or do any other work before or after my interview with him or her. In fact, I would prefer if they did not study or even know of my coming to question them until that day or the day prior to my questioning. Also, the results will in no way affect their grades at school. Each of them will be assigned a number, and names will not be used when correcting the problems.

I would appreciate any assistance you can give me in allowing me to question your child. Please return the post card.

Thank you very much!

Sincerely,

P. S.

Gordon R. Schumacher
Mathematics Instructor

If you have any questions, you may contact me during the day at 541-8080, ext. 231, and after 5 p. m. at 873-2131.

C. J. Payne
Principal, Horace Mann Jr. High School

TABLE LXII
SELECTED MATCHED PAIRS

Group no.	Grade	Sex	I.Q.	Standard score	Age difference in months	G.E.	Difference in standard scores
1*	7	F	135	.125786	-	9.7	.004105
	8	F	135	.121681	12	10.4	-
2*	7	M	116	.113207	-	9.0	.008190
	8	M	116	.105088	14	10.1	-
3*	7	F	120	.075471	-	8.4	.003569
	8	F	121	.071902	15	9.5	-
4*	7	F	105	.075471	-	8.4	.003569
	8	F	106	.071902	9	9.5	-
5*	7	F	107	.050314	-	8.0	.005005
	8	F	106	.055319	14	9.2	-
6*	7	F	114	.062893	-	8.2	.007574
	8	F	114	.055319	10	9.2	-
7*	7	F	105	.062893	-	8.2	.007574
	8	F	106	.055319	13	9.2	-
8*	7	F	125	.037736	-	7.8	-
	8	F	124	.038717	13	8.9	.000981
9*	7	F	123	.037736	-	7.8	-
	8	F	122	.038717	13	8.9	.000981
10*	7	F	121	.037736	-	7.8	-
	8	F	121	.038717	12	8.9	.000981
11*	7	F	120	.037736	-	7.8	-
	8	F	121	.038717	11	8.9	.000981
12*	7	F	111	.025157	-	7.6	-
	8	F	110	.027655	14	8.7	.002498

TABLE LXII (continued)

Group no.	Grade	Sex	I.Q.	Standard score	Age difference in months	G.E.	Difference in standard scores
13*	7	F	122	.025157	-	7.6	-
	8	F	122	.027655	12	8.7	.002498
14*	7	M	116	.025157	-	7.6	-
	8	M	115	.027655	12	8.7	.002498
15*	7	M	118	.025157	-	7.6	-
	8	M	118	.027655	10	8.7	.002498
16*	7	M	125	.006289	-	7.3	-
	8	M	126	.011063	12	8.4	.004774
17	7	F	121	.006289	-	7.3	-
	8	F	120	.011063	10	8.4	.004774
18	7	M	115	.006289	-	7.3	-
	8	M	114	.011063	15	8.4	.004774
19	7	F	111	.006289	-	7.3	-
	8	F	110	.011063	13	8.4	.004774
20	7	F	105	.006289	-	7.3	-
	8	F	106	.011063	13	8.4	.004774
21	7	F	102	.006289	-	7.3	-
	8	F	103	.011063	12	8.4	.004774
22*	7	F	97	.006289	-	7.3	-
	8	F	98	.011063	12	8.4	.004774
23*	7	M	94	.006289	-	7.3	-
	8	M	95	.011063	10	8.4	.004774
24*	7	F	94	.006289	-	7.3	-
	8	F	94	.011063	14	8.4	.004774
25*	7	F	109	-.012579	-	7.0	.007047
	8	F	109	-.005532	10	8.1	-

TABLE LXII (continued)

Group no.	Grade	Sex	I.Q.	Standard score	Age difference in months	G.E.	Difference in standard scores
26 *	7	M	108	-.012579	-	7.0	.007047
	8	M	108	-.005532	12	8.1	-
27 *	7	F	106	-.012579	-	7.0	.007047
	8	F	106	-.005532	13	8.1	-
28 *	7	M	105	-.012579	-	7.0	.007047
	8	M	105	-.005532	14	8.1	-
29 *	7	M	102	-.012579	-	7.0	.007047
	8	M	102	-.005532	10	8.1	-
30 *	7	F	100	-.012579	-	7.0	.007047
	8	F	100	-.005532	12	8.1	-
31	7	M	99	-.012579	-	7.0	.007047
	8	M	99	-.005532	12	8.1	-
32 *	7	F	122	-.012579	-	7.0	.007047
	8	F	121	-.005532	13	8.1	-
33 *	7	F	107	-.012579	-	7.0	.007047
	8	F	108	-.005532	11	8.1	-
34	7	F	105	-.012579	-	7.0	.007047
	8	F	106	-.005532	10	8.1	-
35 *	7	M	108	-.012579	-	7.0	.007047
	8	M	107	-.005532	12	8.1	-
36 *	7	M	119	-.031446	-	6.7	.003791
	8	M	118	-.027655	11	7.7	-
37 *	7	F	116	-.031446	-	6.7	.003791
	8	F	115	-.027655	13	7.7	-
38 *	7	M	109	-.031446	-	6.7	.003791
	8	M	108	-.027655	15	7.7	-

TABLE LXII (continued)

Group no.	Grade	Sex	I.Q.	Standard score	Age difference in months	G.E.	Difference in standard scores
39 *	7	F	105	-.031446	-	6.7	.003791
	8	F	105	-.027655	12	7.7	-
40	7	M	99	-.031446	-	6.7	.003791
	8	M	99	-.027655	14	7.7	-
41	7	F	105	-.031446	-	6.7	.003791
	8	F	104	-.027655	13	7.7	-
42 *	7	F	112	-.031446	-	6.7	.003791
	8	F	112	-.027655	12	7.7	-
43	7	M	107	-.056604	-	6.3	.001284
	8	M	106	-.055320	12	7.2	-
44 *	7	M	104	-.056604	-	6.3	.001284
	8	M	103	-.055320	12	7.2	-
45 *	7	F	99	-.056604	-	6.3	.001284
	8	F	99	-.055320	12	7.2	-
46 *	7	F	105	-.056604	-	6.3	.001284
	8	F	105	-.055320	14	7.2	-
47 *	7	F	101	-.056604	-	6.3	.001284
	8	F	101	-.055320	12	7.2	-

*Used in the study.

TABLE LXIII
LABELING RESULTS

Problem Number	Grade 7		Grade 8	
	Number	%	Number	%
One	36 of 36	100.00	30 of 36	83.33
Two	23 of 35	65.71	30 of 32	93.75
Three	22 of 36	61.11	26 of 34	76.47
Four	34 of 37	91.89	36 of 37	97.30
Five	34 of 37	91.89	31 of 36	86.11
Six	21 of 28	75.00	21 of 28	75.00
Seven	11 of 32	34.38	22 of 34	64.70
Eight	14 of 26	53.84	22 of 28	78.57
Nine	11 of 28	39.29	16 of 26	61.53
Ten	11 of 28	39.29	15 of 32	46.88
Eleven	27 of 29	93.10	27 of 31	87.09
Twelve	10 of 15	66.67	14 of 18	77.78
Thirteen	27 of 31	87.09	19 of 23	82.61
Fourteen	33 of 36	91.67	35 of 37	94.59
Fifteen	35 of 37	94.59	31 of 34	91.18

QUESTIONS ADMINISTERED TO STUDENTS

1. A grocery store published an ad of these specials:

Turkey: 27¢ per pound

Ground Beef: 3 pounds for \$1.44

Ham: 49¢ per pound

Beef Roast: 59¢ per pound

Oranges: 3 dozen for \$1.00

Peas: 2 cans for 39¢

Red Salmon: 85¢ per can

Celery: 2 large stalks for 29¢

Peaches: 4 cans for 89¢

Sugar: 10 pounds for 99¢

Mrs. Davis bought the following:

4 pounds of Beef Roast

1 can of Red Salmon

2 stalks of Celery

4 cans of Peaches

How much did the groceries cost?

2. The track for Joe's electric train was a 200-inch oval. Roger's train had 12 curved and 4 straight sections of track each 10 inches long. How many inches longer was Joe's track?
3. The sailing schedule shows that the ship arrives at Milwaukee on Wednesday at 8:00 a.m. and

QUESTIONS (continued)

leaves at 1:30 p.m. on the same day. How many hours is the ship docked in Milwaukee?

4. If a dozen ears of corn cost forty-eight cents, what would Mrs. Smith pay for a half dozen ears of corn?
5. Mr. Roberts bought three life vests as safety equipment for his new boat and paid for them with a twenty dollar bill. If the vests are \$5.19 each, how much change should he receive?
6. Mr. Adams paid $12\frac{1}{2}\text{¢}$ each for 1800 fingerlings (young fish). How much did he pay in all for the fish?
7. Mr. Jones went fishing and found the average weight of his fish was 3.9 pounds. Mrs. Jones went fishing and found the average weight of her fish was 2.25 pounds. How many pounds heavier was the average of Mr. Jones's fish?
8. A honeybee colony that contains 60,000 bees in late fall may have only 12,000 at the end of the winter. What per cent of the bees live through the winter season?
9. Alice started a 4H laying flock project in September with eighty small pullets. (Pullets are

QUESTIONS (continued)

small chickens.) The laying house for the flock was twelve feet by sixteen feet. How many square feet of floor area, to the nearest tenth, did this allow each bird?

10. To make a base for a desk, a board $7 \frac{5}{8}$ inches wide was sawed into two pieces, one of which was $4 \frac{3}{4}$ inches wide. If no allowance is made for sawing, how wide in inches was the other piece?
11. How much would nine oranges cost at 36¢ a dozen?
12. Mr. Jones' gas and electric bill for November was \$9.60. If he paid it by December tenth, he would receive a $7\frac{1}{2}\%$ discount. How much would Mr. Jones save by paying the bill by December tenth?
13. A 3" by 4" photograph was projected on a wall so that the width of the shorter dimension of the projection was 6'. What was the length of the projection?
14. Joan paid \$102.50 for the pullets (small chickens), \$223.06 for feed, and \$19.75 for use of the laying house and equipment. She received \$362.43 for eggs and \$85.10 for the hens.

QUESTIONS (continued)

How much money did Joan make on the project?

15. If three tennis balls cost \$1.76, and Frank bought a dozen balls, how much did they cost?

AN EXPERIMENTAL INVESTIGATION OF WORD SOLVING PROBLEMS
IN SEVENTH AND EIGHTH GRADES WITH DIFFERENT
MATHEMATICAL BACKGROUNDS

by

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ABSTRACT

In 1964-65, the fourth grades of the West Allis-West Milwaukee Joint School District Number One departed from a traditional mathematics program, Making Sure of Arithmetic, published by Silver Burdett; they have studied the Greater Cleveland Mathematics Program from 1964-65 through the 1967-68 schoolyear. This class was the seventh grade tested by the researcher. The eighth grade tested had studied only the traditional mathematics through the grades.

This investigation was undertaken to determine if the modern program which had been followed by the seventh grade students was giving them a better foundation for techniques in problem solving than the traditional program studied by the eighth grade students.

Seventy-four students from the seventh and eighth grades at Horace Mann Junior High School were matched in pairs, one in each pair from seventh grade and the other from eighth grade, according to five points: (1) sex, (2) intelligence quotient, (3) standard score derived from the grade equivalent of the word solving section of the Iowa Tests of Basic Skills, (4) year in school, and (5) date of birth.

A form letter was sent to the parents of each student to be tested, explaining the study. Parents granted permission by returning an enclosed post card. Upon receipt

ABSTRACT (continued)

of the card, the researcher arranged an appointment by telephone.

During May, 1968, the researcher tested each student individually in the student's home. He was first asked if he had learned a procedure to follow in solving word problems. Of those few who stated a series of steps to follow, none actually followed them when working the problems. The researcher also questioned the student's knowledge of terminology, using ten common terms.

The student was presented with fifteen word problems, each typewritten on a card, based upon eight common areas of study: currency, decimals, fractions, geometry, measurement, per cent, ratio and proportion, and whole numbers.

Comparing seventh grade to eighth grade, the results of the fifteen problems were analyzed individually and tabulated according to five areas: (1) achievement status, not considering careless errors; followed by achievement status, considering careless errors; (2) common errors of students; (3) average time in seconds taken by students to work the problems; (4) correct labeling; (5) percentage of achievement, where applicable (compared to national norms).

In these five areas, the only important finding was that the seventh grade committed more careless errors. The results indicated also that the eighth grade had a better

ABSTRACT (continued)

knowledge of terminology.

Because neither grade made an impressive showing, the researcher concluded that a background of modern mathematics had not necessarily improved word problem solving skills. However, a teacher survey revealed that the majority of the teachers had not been properly trained in the teaching of modern mathematics.

The researcher would recommend that further studies be made in this school system and in others to further determine if the modern mathematics program has been effective in developing problem solving skills.