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A comparison of the responses given to three different forms of verbal arithmetic problems at the fourth grade level.

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A COMPARISON OF THE RESPONSES GIVEN TO THREE DIFFERENT FORMS OF VERBAL ARITHMETIC PROBLEMS AT THE FOURTH GRADE LEVEL

Submitted by

Edward C. Helland

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First Reader: J. Fred Weaver

Assistant Professor of Education

Second Reader: Mark Murfin

Associate Professor of Education

TABLE OF CONTENTS

LIST OF TABLES

Table		Page

CHAPTER I

PURPOSE OF THE STUDY

The purpose of this study is to try to discover whether or not the way in which a verbal arithmetic problem is stated has any bearing on the response.

Source of the study.-- It has been the feeling of the writer that some word problems in arithmetic are stated in such a manner as to make them more difficult to the pupils. He has found in his teaching that the pupil will have more success when the original problem is reworded.

The writer has also noticed that instructional materials differ in the use of word problem statements. That is, verbal problems are worded in different forms. The facts are presented in the same manner, but the pupil is directed to find the answer in different ways. The most commonly used way is through a question.

> Mary has 2 dolls, and Jane has 3 dolls.
> How many dolls do they have together?

Another method of directing the pupil to find the answer is through a command.

> Mary has 2 dolls, and Jane has 3 dolls.
> Find how many dolls they have together.

A third method of directing the pupil to find the answer is through an incomplete statement.

Mary has 2 dolls, and Jane has 3 dolls.
Together they have __________ dolls.

If these three forms of word problems could be incorporated in a testing instrument, and if a significant difference could be demonstrated by objective data, there might well be implications for instructional materials and practices in arithmetic.

Justification of the study.-- Although this research can be regarded as only a pilot study due to its limited samples, it is hoped that it will supply material for further studies.

Tenney [1] conducted a preliminary investigation along these same lines in which she used two forms of word problems; however, it was not inclusive enough to constitute an answer to the problem of this thesis. Perhaps with the data obtained from her study, and that from this study, more adequate investigations can be made in the future.

Travers [2] has stated in connection with verbal arithmetic problems of the completion type that the "... form of the response is the same regardless of the method of presentation used. Each question could be converted into an incomplete statement." This statement not only was the cue for the form of the instrument used in this study, but also aids to justify the study itself.

1/Rosemond H. Tenney, The Relative Merits of Two Ways of Stating Verbal Arithmetic Problems at the Third-Grade Level, (Boston University, School of Education, 1950). Unpublished Master's Thesis.

2/Robert M. W. Travers, How to Make Achievement Tests, New York, The Odyssey Press, 1950, p. 37.

Scope of the study.-- This test is constructed in such a way that it will measure the child's response to equated verbal arithmetic problems in three different forms. Thirty-six problems have been used. Each process -- addition, subtraction, multiplication, and division -- is represented in nine word problems. Each of the three forms of the test has twelve examples with three each of the four processes.

Techniques employed in this study included construction of test items, the administration of the test to all the fourth-grade pupils (193) in Hingham, Massachusetts in May, and finally, an analysis of the test in relation to intelligence and the three forms of the testing instrument.

CHAPTER II

REVIEW OF THE LITERATURE AND RESEARCH

Investigators have attempted with varying degrees of success to find some relationship between an isolated factor or group of related factors and problem difficulty. This report of some of the research gives an idea of the variety of relationships studied.

The research is reported under the following headings: method of solution and reasoning; related factors of intelligence, reading and vocabulary, and computational skill in arithmetic; familiarity of setting; and miscellaneous factors.

Method of solution and reasoning.-- Some investigators have been interested in trying to tie up success in word problems with specific methods of approach to a problem.

Three methods of teaching arithmetic problems in the fourth and seventh grades were compared by Hanna.[1] The "Dependencies" method taught the children to see that each factor in the problem depended upon other factors, and through the analysis of these dependent factors, the pupil could discover what is to be found and how to solve the problem. The "Conventional-Formula"

1/Paul R. Hanna, "Methods of Arithmetic Problem Solving," Mathematics Teacher, (volume 23:pp. 442-450,) November, 1930.

method was the analysis of (1) what is asked for, (2) what is given, (3) how should these facts be used to secure the answer, and (4) what is the answer. The "Individual" method allowed the pupils whatever method of solution they wanted to use to solve the problem. He found that the fourth grade showed best results in this order: (1) Dependencies, (2) Individual, and (3) Conventional. The seventh grade order was: (1) Individual, (2) Dependencies, and (3) Conventional. Hanna concluded that the "Conventional-Formula" method produced the least mean gain, and that the other two methods produced little difference.

A later study by Burch [1/] indicated that children are not helped by the use of an adult pattern of logic made up of five or six steps, and that some children are actually hindered by it.

Another comparison of three instructional methods was studied by Thiele.[2/] (1) "Association Method" -- when a child got into difficulty, he was to consult "type" or "model" solutions and correct his own problem with the least amount of assistance. (2) "Analysis Method" -- the child was to ask the questions, "What is given?", "What is to be found?", and "What is the correct solution?" (3) "Vocabulary Method" -- the child was to select the words needed to make sensible problems out of the

1/Robert L. Burch, An Evaluation of Analytic Testing in Arithmetic Problem Solving. Doctor's Dissertation, Durham, N. C., Duke University, 1949.

2/C. Louis Thiele, Comparison of Three Instructional Methods in Problem-Solving, (In American educational research association. Research on the foundations of American education; Official report, 1939. pp. 11-15.)

facts stated. The results of the study revealed that the "Association Method" was the superior method by "reliable differences". Thiele concludes that when left to their own devices, and when given plenty of experience with arithmetic problems, children will have more success.

Problem-solving was investigated in a different way by Bramhall,[1] who was interested in the comparative merits of "conventional" as compared with "imaginative" problems. Seven classes (213 children) spent three class periods a week on imaginative problems, solving them in any way they wished, while the same number of classes (214 children) spent their time entirely on conventional problems. Bramhall could find no difference in the results of exclusive training with either kind, his measurements being made after ten weeks with several different standard tests.

Monroe [2] concocted four sets of tests which could compare the "responses of pupils to certain types of statements of the same problem." The purpose of these tests was to find whether or not children would follow any actual procedure in solving arithmetic problems. His accounting shows that a large percentage of seventh grade pupils do not reason in the process of

1/Edwin W. Bramhall, "Experimental Study of Two Types of Arithmetic Problems," _Journal of Experimental Education_, volume 8, pp. 36-38, September 1939.

2/Walter S. Monroe, "How Pupils Solve Problems in Arithmetic", _Elementary School Journal_, volume 29, pp. 644-645; May 1929.

solving verbal problems in arithmetic. Many of the children resorted to almost random calculation, rather than follow any plan. The responses indicated by those who had success with the problems seem to be determined largely by habit.

John [1] observed intermediate grade pupils of two different schools while they solved two-step arithmetic problems to discover the types of errors they make and then tabulated them. The analysis showed that errors in the fundamentals, reading, and miscellaneous occurred in that descending order. The use of the wrong process was the most prevalent error in reasoning recorded.

Related factors: intelligence, reading, vocabulary, and computational skill in arithmetic.-- Johnson [2] tried to name some of the "intellectual factors" which were more closely related to the ability to solve verbal arithmetic problems. At the eighth-grade level he discovered that the greatest correlation existed between general vocabulary and problem solving. Second in line was reasoning. Johnson also discovered that when problem scales without numbers were used in place of the regular problem scales, the sequence was reversed -- reasoning was higher than general vocabulary.

Engelhart [3] reported his study of the relative factors of

1/Lenore John, "Difficulties in Solving Problems in Arithmetic," Elementary School Journal, volume 31: pp. 202-215, Nov. 1930.

2/Harry C. Johnson, "The Effect of Instruction in Mathematical Vocabulary Upon Problem Solving in Arithmetic," Journal of Educational Research, volume 38: 97-110, October 1944.

3/Max D. Engelhart, "Relative Contribution of Certain Factors to Individual Differences in Arithmetical Problem Solving Ability," Journal of Experimental Education, volume 1: pp. 19-27, September 1932.

intelligence, computation ability, and reading ability to the difficulty of solving arithmetic word problems. His evidence indicated that both intelligence and computation ability were contributing factors, and suggests that more instruction and drill in computation be provided.

Hansen [1/] worked with sixth-grade pupils to find whether or not certain abilities could be linked with success in arithmetic word problems. He found that the group which had superior achievement in solving verbal arithmetic problems had also excelled in certain arithmetical factors, mental factors, and reading factors. The arithmetical factors were: fundamental operations, estimating answers to examples, ability to solve problems, thinking abstractly with numbers, estimating answers to problems, problem analysis, number series, quantitative relationships (social), finding key to a problem, and arithmetic vocabulary. The mental factors were: general reasoning ability, noting differences, noting likenesses, non-language factors, analogies, delayed memory span, immediate memory span, memory, spacial imagery, spacial relationships, and inference. The reading factors were: general language ability, reading graphs, charts and tables, and general vocabulary.

Once again reference must be made to John's [2/] observations pointing out that, of the categories listed in the study, read-

1/Carl W. Hansen, "Factors Associated with Successful Achievement in Problem Solving in Sixth Grade Arithmetic", Journal of Educational Research, volume 38: pp. 111-118, October 1944.

2/John, loc. cit.

ing ranked third highest in number of errors. The reading errors in order of their incidence were (1) re-reading the problem, (2) vocabulary difficulties, (3) not comprehending the situation, (4) word, or phrase errors, or omissions, (5) mistakes in reading the answers, and (6) errors because of the use of the parenthesis.

Treacy 1/ carried out this idea further and found that general reading level does not significantly relate to success in arithmetic problem solving. He did, however, find that certain specific reading skills do act as factors on the success. The list included: quantitative relationships, vocabulary in context, vocabulary -- isolated words, arithmetic vocabulary, perception of relationships, integration of dispersed ideas, drawing inferences from content, and retention of clearly stated details.

Stevens 2/ has stated that general reading ability has less correlation with the ability to solve arithmetic word problems than the ability in fundamental operations. He notes that there is a higher correlation between tests of analyzing problems and problem solution than between problem solution and general reading or of fundamental operations. His statement indicates that in order to solve a problem the child needs to have the skill

1/John P. Treacy, "The Relationship of Reading Skills to the Ability to Solve Arithmetic Problems", Journal of Educational Research, volume 38, pp. 86-96; October 1944.

2/B. A. Stevens, "Problem Solving In Arithmetic", Journal of Educational Research, volume 25; pp. 253-260, April 1932.

to be able to analyze it, rather than reading skills or skills in the fundamental operations.

When Fay 1/ studied the relationship between reading skills and the area of arithmetic on the sixth-grade level, he found no definite tie-up between the skills in reading and the achievement in arithmetic.

The Hansen 2/ study tried to identify some factors that are associated with sixth-graders' success in word problems. He found that such reading factors as general language ability, reading graphs, charts and tables, and general vocabulary were associated with greater achievement in word problems.

He also pointed out that the superior group did not excel in these reading factors: speed -- reading to predict outcomes, conprehension -- reading to predict outcomes, speed -- reading to note details, and comprehension -- reading to note details.

Again reference must be made to Engelhart. 3/ His analysis indicates that general training in reading is likely to have a negligible effect on individual differences in problem solving achievement.

Brueckner and Grossnickle 4/ present a list of ten causes of difficulty in solving problems in their book and it is inter-

1/Leo C. Fay, "Relationship Between Specific Reading Skill and Selected Areas of Sixth Grade Achievement", Journal of Educational Research, volume 43, pp. 541-547, March 1950.

2/Hansen, loc. cit.

3/Engelhart, loc. cit.

4/Brueckner and Grossnickle, How to Make Arithmetic Meaningful, (Philadelphia, The John C. Winston Co., 1947), p. 452.

esting to note the first three in the list. (1) Inability to understand the problem in whole or in part, due to insufficient experience and lacking the ability to visualize the situation. (2) Reading failings such as inability to locate information, not being able to remember material read, or organize what was read, and inability to read for details. (3) Computational failings due to forgetting procedure, or lack of knowing procedure.

Johnson 1/ observed the effect the teaching of "mathematical vocabulary" had on the solving of arithmetic problems. The findings of the study were that the teaching of a specific vocabulary produces a definite knowledge of the terms themselves, and an improvement in the solution of the verbal problems using those terms. However, it did not bring about general improvement in verbal problems, nor a transfer of training from the learning of words taught to other words not taught.

Osburn and Drennan 2/ conducted a study on the third-grade level in which they emphasized a certain set of clues for a period of six weeks. The before and after tests showed a "certain amount of transfer." The children of superior ability gave evidence of transferring more than those of less ability.

1/Harry C. Johnson, "The Effect of Instruction in Mathematical Vocabulary Upon Problem Solving in Arithmetic", Journal of Educational Research, volume 38, pp. 97-110, October 1944.

2/W. J. Osburn and L. J. Drennan, "Problem Solving in Arithmetic", Educational Research Bulletin (Ohio State University) volume 10, pp. 123-28, March 4, 1931.

Familiarity of setting.-- The Brownell and Stretch [1] study points out that unfamiliar situations have little effect on 65% to 80% of the children, but that unfamiliar settings do bring into being a new source of difficulty for 20% to 35% of the children. They also report that unfamiliar settings mostly affect the children who are usually inaccurate in problem solving.

Monroe [2] found that when the problem was an unfamiliar situation or the terminology was unfamiliar, the pupil either gave an incorrect solution or did not even try to solve it.

Making reference to John's [3] work it will be noted that among the reading errors, she discovered that children have difficulty with verbal problems when the situation is not comprehended.

At the head of the list of ten causes of difficulty in solving problems cited by Brueckner and Grossnickle [4] is "failure to comprehend the problem in whole or in part because of lack of experience and inability to visualize the situation."

Miscellaneous.-- Among the miscellaneous factors involved in arithmetic verbal problems are those occurring in two-step problems.

1/William A. Brownell and Lorena B. Stretch, The Effect of Unfamiliar Settings on Problem Solving, Duke University Research Studies in Education, No. 1, Durham, N. C., Duke University Press, 1931.

2/Monroe, loc. cit.

3/John, loc. cit.

4/Brueckner and Grossnickle, loc. cit.

Berglund and Young [1/] performed a study to discover if the order of appearance of the processes affected the difficulty of arithmetic problems. The analysis of their data was in terms of comparing the opposite appearances of the two steps as follows:

1. Subtraction - addition more difficult than addition-subtraction
2. Addition - Multiplication slightly more difficult than multiplication-addition
3. Division - addition more difficult than addition-division
4. Division - subtraction more difficult than subtraction-division
5. Subtraction - multiplication more difficult than multiplication-subtraction
6. Division - multiplication more difficult than multiplication-division

Mitchell [2/] conducted a study to find the value of making problems specific. He had two lists of problems: one that was specific because there were numerical values involved, and one that was general in nature because it had no numbers. Mitchell found that the pupils who solved the specific problems had not

1/G. G. Berglund and R. V. Young, "The Effect of Process Sequence on the Interpretation of Two-step Problems in Arithmetic", Journal of Educational Research, volume 34, pp. 21-29, September 1940.

2/Claude Mitchell, "The Specific Type of Problem in Arithmetic Versus the General Type of Problem", Elementary School Journal, volume 29, pp. 594-596, April 1929.

formulated any general concepts that they could use in solving the general problems. He found a very low correlation between the two lists of problems even though the problems in both lists involve the same principals for solving the problems.

Tenney 1/ conducted an experiment to discover if the way in which a problem was worded would have any bearing on the solution. She reasoned that the conventional method of stating word problems (declarative sentence followed by an interrogative sentence) was not in keeping with the psychological concept that the problem must be first presented to capture the thinking of the pupil, then the facts can be given. Therefore, her experimental form took the reverse order of appearance (interrogative sentence followed by the declarative sentence). She concluded that the conventional form appeared to have a slight advantage over the experimental form. She contends that there is psychological merit in placing the goal to be achieved in the beginning of a problem situation, and that perhaps a study should be made with controlled and experimentally taught groups.

For further study of the research on arithmetic verbal problems, the reader is referred to Miss Tenney's unpublished Master's thesis. Her research chapter is organized in this manner: familiar and unfamiliar situations, vocabulary in problem solving, visualization in problem solving, the form of the verbal arithmetic problem, and summary.

1/Rosamond Holmes Tenney, The Relative Merits of Two Ways of Stating Verbal Arithmetic Problems at the Third-Grade Level, (Boston University, School of Education, 1950).

Summary.-- In summary of the research reported in this chapter we seem to know the following:

1. As regards method of solution and reasoning
   a. "Dependencies", "Individual", "Association", and "Vocabulary" methods obtain better results than the "Conventional-formula" or "Analysis" methods.
   b. Some children seem to solve verbal problems through random calculations and habit, and most of their errors are due to lack of reasoning.
2. As regards intelligence
   a. Intelligence is definitely a contributing factor to the success of solving verbal problems, but not the only factor.
3. As regards reading and vocabulary
   a. General reading ability does not significantly correlate with achievement in verbal arithmetic problems.
   b. Specific reading skills do significantly correlate with achievement in verbal arithmetic problems.
      1. quantitative relationships
      2. vocabulary in context
      3. vocabulary - isolated words
      4. arithmetic vocabulary
      5. perception of relationships
      6. integration of dispersed ideas
      7. drawing inferences from content
      8. retention of clearly stated details
      9. general language ability
      10. reading graphs, charts and tables
      11. general vocabulary
      12. locate information
      13. organize material read

c. Teaching a specific "mathematical vocabulary" will produce an improvement in verbal problems using the words taught; however, not a general improvement.

d. Teaching a certain set of clues will show a certain amount of transfer, especially for the child of superior ability.

4. As regards familiarity of setting

   a. An unfamiliar setting has an adverse effect on the success of word problems in arithmetic.

5. As regards two-step problems

   a. The order of appearance of the processes seems to have an affect on the success.

6. As regards specific and general problems

   a. Children who can solve specific problems do not formulate general concepts to aid the solution of general problems.

7. As regards problem construction

   a. The conventional way of wording a problem -- a declarative sentence followed by an interrogative sentence -- appears to have a slight advantage over the experimental form which was used -- an interrogative sentence followed by a declarative.

Even though these investigations have been concerned with verbal arithmetic problems, none has experimented with the idea that a word problem may be presented in any form without changing the response of the pupil. This approach is the thesis of this study, and will be explained and evaluated in the following chapters.

CHAPTER III

ORGANIZATION OF THE TEST

Test items.-- Sixteen problems were chosen from current fourth-grade arithmetic books. Four books were selected at random, which were published between 1938 and 1951. From each book was taken one problem for each of the four processes -- addition, subtraction, multiplication and division.

This selection gave a total distribution of four problems of each process. The examples chosen were all one-step problems. Of the 16 original problems, only 12 were selected as best for the writer's purposes.

Problems reworded.-- Since the purpose of the test was to try to discover whether the form in which a problem is worded would have any effect on the response, each of these 16 problems was reworded in two other forms. The original form had a declarative sentence followed by an interrogative sentence. The second form, which is being used in instructional material also, had a declarative sentence followed by an imperative sentence. The third form was more or less an experimental form, since it is not commonly used in instructional material, and had a declarative sentence followed by an incomplete statement.

Format.-- Each form of the test had all its problems worded in the same manner. There were twelve problems in each of the three forms of the test.

Problems equated.-- As the problems were reworded, attention was given to maintaining the following items: any word which might serve as a "cue", the process, and the conditions of the problem. In each of the four matched problems the following were changed: the numbers, the names of the people or items, and the setting of the problem.

A further control was introduced as in each of the problems a one digit number and a two digit number was used. Almost all of the number combinations were such that the division process, if used, would yield an even answer.

Before the test was administered, it was examined by two fourth-grade teachers to judge the format and the level of difficulty of the test.

Administration of the tests.-- The tests were given to all the fourth-grade children in the town of Hingham, Massachusetts. This involved a total of 225 children, 98 of which were boys and 127 of which were girls.

Each teacher was given a letter to give an overview of the test, general instructions, and a set of specific instructions for each form of the test.

To insure a constant in the administration, the tests were given on Monday, Wednesday, and Friday of the same week in all the classes.

In an attempt to eliminate the effect of practice on any one form, the test forms were given in the six possible sequences: ABC, ACB, BAC, BCA, CAB, and CBA. Since there were eight classes, sequences ACB and CAB were arbitrarily chosen to be administered to the two remaining classes.

Informational forms were also sent to the teacher to obtain the time for the administration of the tests, and to obtain the intelligence quotients for the members of the class.

Collecting and organizing the data.-- All the tests were to be given to all the children in the classrooms. However, only those cases in which the child used all three forms of the test were accepted. After the cases were eliminated, a total of 193 were left.

The test items were scored separately on the selection of process, and on the answer given to the problem. Each was considered as being either right R, wrong W, or omitted O. For example, if the correct process had been selected, and the correct answer given, the item was scored with RR. If the correct process had been selected, and a wrong answer given, the item was scored RW. If the correct process had been selected, and no answer was given, the item was scored RO.

For the purpose of collecting the data onto master sheets, the papers were divided according to class and sex.

CHAPTER IV

ANALYSIS OF THE RESULTS

Purpose of this study.-- The purpose of this study is to find whether or not the way in which a verbal arithmetic problem is worded will have any affect on the response to the problem.

Stating matched problems in three different ways was the method utilized to serve the purpose of the study. In test form A, all the problems were stated with a statement of facts followed by an interrogative sentence. In test form B, all the problems were stated with a statement of the facts followed by an imperative sentence. In test form C, all the problems were stated with a statement of the facts followed by an incomplete statement.

Examination of the data.-- The data were compiled according to population, intelligence quotients, type of response to the items, sex, arithmetic process, and sequence of forms. The top fourth of the total population had a range of from 112 - 144 intelligence quotient, and the bottom fourth of the total population had a range of from 55 - 97 intelligence quotient.

Items were scored and compiled according to the type of response given. The selection of the process which would be best to use, and the answer given were scored according to whether they were right R, wrong W, or omitted O. Thus, if the selection of process was right, and the answer given was right, the item would be scored RR. If the selection of process was right, and the answer given was wrong, the item would be scored RW. If the selection of process was right, and the answer was omitted, the item would be scored RO. If the selection of process was wrong, and the answer given was right, the item would be scored WR. If the selection of process was omitted, and the answer given was wrong, the item would be scored OW, etc.

Analysis of the data.-- Table 1 shows the distribution of the total population of the fourth grades used in this study.

POPULATION

Table 1. Distribution of Boys and Girls Arranged According to Classrooms

Class	Boys	Girls
(1)	(2)	(3)
I	12	16
II	14	17
III	9	11
IV	9	11
V	11	15
VI	8	13
VII	10	13
VIII	12	12
Total	85	108

It should be noted that each classroom has a larger girl population than boy population, and that the totals indicate more than a fourth again as many girls as boys.

INTELLIGENCE

Table 2 shows the intelligence quotients distribution as obtained from the Kuhlmann-Finch Intelligence Test given to all fourth grades in Hingham, Massachusetts, in February, 1953.

Table 2. I. Q. Distribution of the Fourth Grade Pupils Used in This Study

I. Q.	Frequency
(1)	(2)
140 - 144	1
135 - 139	1
130 - 134	1
125 - 129	7
120 - 124	9
115 - 119	21
110 - 114	20
105 - 109	34
110 - 104	41
95 - 99	21
90 - 94	18
85 - 89	10
80 - 84	3
75 - 79	2
70 - 74	3
65 - 69	
60 - 64	
55 - 59	1
	N = 193

From Table 2 the top and bottom I. Q. ranges were calculated. Twenty-five per cent of the lowest scores constitute the bottom fourth, and twenty-five per cent of the highest scores make up the top fourth. Accumulating the frequencies up from the lowest score, it was found that the first quartile fell in the 95 - 99 I. Q. class. A further breakdown of this class found the 48th case to be at 97 I. Q. Accumulating the frequencies down from the highest score, it was found that the third quartile fell in the 110 - 114 I. Q. class. A further breakdown of this class found that the 48th and 49th cases were together at 112 I. Q. Hence, there were 48 children in the bottom I. Q. group, and 49 in the top I. Q. group.

Table 3 shows how the boy's and girl's mean scores differ in regard to intelligence quotients, and form of the test. It was felt that RR is the most significant response type, and would show the most important differences, if any existed.

Table 3. Means for Response Type RR Arranged According to Form, Top and Bottom I. Q. Groups, and Sex

Form	I. Q.	Boys	Girls	Difference *
(1)	(2)	(3)	(4)	(5)
	Top	10.1	10.6	.5
A	Bottom	5.9	5.9	
	Difference	4.2	4.7	
	Top	10.4	10.5	.1
B	Bottom	6.2	5.7	- .5
	Difference	4.2	4.8	
	Top	9.6	10.9	1.3
C	Bottom	6.2	5.7	- .5
	Difference	3.4	5.2	

* Positive differences indicate higher means for girls
Negative differences indicate higher means for boys

Table 3 shows that the boys in the top fourth of the class obtained a mean score of 10.1 on form A, while the girls obtained 10.6. The difference between these scores is .5 which is relatively small. Hence for all practical purposes there was no difference as regards sex for the top fourth on form A. The bottom fourth show no difference for form A. There is a practical significant difference between the boys in the top fourth and the bottom fourth on form A, and the same is true for the girls.

From this table it is evident that the children in the higher intelligence group did consistantly better on all forms of the test. This table also shows that the differences in sex are practically significant only in form C for the top fourth of the population tested. This form favored the girls.

The girls in the top fourth of the population got their highest mean score on form C, and the boys in this top group made their lowest mean score on form C.

RESPONSE TYPES

Table 4 indicates the mean scores for each type of response for all the children, and is arranged according to the three forms of the test.

Table 4. Summary of the Means for All the Children Arranged According to Form and Response Type

Form (1)	RR (2)	RW (3)	RO (4)	WR (5)	WW (6)	WO (7)	OR (8)	OW (9)	OO (10)
A	8.6	.7	-	.2	1.8	-	.2	.1	.4
B	8.8	.5	-	.3	1.7	-	.3	.1	.3
C	8.6	.6	-	.4	1.4	-	.3	.1	.5

This table shows that the children obtained a mean score of 8.6 on form A for the response type RR. That is, the children, on the average, chose the right process and gave the right answer for 8.6 of the 12 problems on test form A.

The children chose the right process but gave the wrong answer on an average of .7 for the 12 problems on test form A.

The children chose the wrong process and gave the right answer on an average of .2 of the 12 problems on test form A.

This table clearly indicates that in most cases the children selected the right process and gave the right answer, since the largest mean scores are for response type RR. The wrong selection of process, and the wrong answer WW, was the second most common type of response.

To make the figures in this table more meaningful it was decided to construct the following two tables. Table 5 has combined the means for the response types RR, WR, AND OR, to show the total means of right answers regardless of the choice of process.

Table 5. Combined Means for Response Types RR, WR, and OR, Arranged According to Form

Response	Form A	Form B	Form C
(1)	(2)	(3)	(4)
RR	8.6	8.8	8.6
WR	.2	.3	.4
OR	.2	.3	.3
Total	9.0	9.4	9.3

On test form A the children made a mean score of 8.6 for the response type RR, a mean score of .2 for the response type WR, and a mean score of .2 for the response type OR. The total of these means is 9.0, which indicates that, on the average, the children gave the right answer for 9.0 of the 12 problems on the test form A. An examination of the totals shows no difference of practical significance in the forms.

Table 6 was constructed to combine the response types RW, WW, and OW, to determine which form of the test would yield the greatest mean scores for the wrong answer regardless of the choice of the process.

Table 6. Combined Means for the Responses RW, WW, and OW, Arranged According to Form

Response	Form A	Form B	Form C
(1)	(2)	(3)	(4)
RW	.7	.5	.6
WW	1.8	1.7	1.4
OW	.1	.1	.1
Total	2.6	2.3	2.1

On test form A, the children made a mean score of .7 for the response type RW, a mean score of 1.8 for the response type WW, and a mean score of .1 for response type OW. The total of these means is 2.6, which indicates that, on the average, the children gave the wrong answer for 2.6 of the 12 problems regardless of the selection of process on form A.

Form a has produced the highest total mean score for wrong answers; however the difference is too small to be of any practical significance.

Tables 5 and 6 were made to give more meaning to Table 4. These two tables showed that there was no difference of practical significance between the three forms of the test as regards the right answers given and the wrong answers given.

These last three tables indicate that there is little or no practical significance in the difference between the responses given to the three forms of wording a verbal arithmetic problem.

SEX DIFFERENCES

To determine whether or not girls achieved higher mean scores than boys, or vice versa, the following table was made according to the type of response and test form.

Table 7. Means for Boys and Girls Arranged According to Form and Type of Response

Form	Sex	RR	RW	RO	WR	WW	WO	OR	OW	OO
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
A	Boy	8.3	.8		.3	1.7		.3	.2	.4
	Girl	8.7	.6		.1	2.0		.1	.1	.4
*Difference		.4	-.2		-.2	.3		-.2	-.1	
B	Boy	8.6	.7		.3	1.6		.4	.2	.3
	Girl	8.9	.5		.2	1.8		.2		.3
*Difference		.3	-.2		-.1	.2		-.2	-.2	
C	Boy	8.1	.8		.5	1.5		.4	.1	.6
	Girl	9.0	.5		.2	1.4		.2	.1	.5
*Difference		.9	-.3		-.3	-.1		-.2		-.1

* Positive differences indicate higher means for girls
Negative differences indicate higher means for boys

This table shows that the boys got a mean score of 8.3 on form A for the response type RR, which indicates that the boys chose the right process and gave the right answer for 8.3 of the 12 problems on form A. The girls chose the right process and gave the right answer (response type RR) for 8.7 of the 12 problems on form A. The boys chose the wrong process and gave the wrong answer (response type WW) for 1.6 problems on form B. The girls chose the wrong process and gave the wrong answer (response type WW) for 1.8 of the 12 problems on form B.

The above table indicates that the girls got consistently higher scores on the response type RR on all forms of the test. The girls got higher scores on forms A and B for the response type WW, while the boys' mean score for form C was higher than the girls'. The boys' mean scores were consistently higher on response types RW, WR, and OR. Response types RO and WO did not register any mean scores for either boys or girls on forms A, B, and C.

All the differences are so small that they are of little or no practical significance, which would indicate that the way in which verbal arithmetic problems are worded has no affect on the response as regards sex.

Table 8 was constructed so that a comparison might be made of the means and the standard deviations for the boys and the girls for the three different forms of the test for the response type RR. The response type RR was chosen since it is the most significant type of response. This table shows the mean scores as well as the variability of the groups for each form of the test.

Table 8. Means and Standard Deviations for Response Type RR, Arranged According to Form and Sex

Form		Boys	Girls	Difference*
(1)		(2)	(3)	(4)
A	Mean	8.3	8.7	.4
	S.D.	3.0	2.8	- .2
B	Mean	8.6	8.9	.4
	S.D.	3.0	2.8	- .2
C	Mean	8.1	9.0	1.0
	S.D.	3.0	2.6	- .4

*Positive difference indicates higher means or standard deviations for girls
Negative difference indicates higher means or standard deviations for boys

The boys chose the right process and gave the right answer for 8.3 of the 12 problems on form A. The girls chose the right process and gave the right answer for 8.7 of the 12 problems on form A. This makes a difference of .4 between the boys and the girls and shows that the girls got the higher mean score. The boys had a standard deviation of 3.0, while the girls had a standard deviation of 2.8. This makes a difference of .2 between them which shows the boys to be more variable than the girls.

The indications in Table 8 are that the girls got higher means on all forms of the test, and the boys had larger standard deviations on all forms of the test. This information seems to point out that the girls did better as a group than the boys in the correct selection of process, and in the correct answer given. The consistently larger standard deviations for the boys shows their greater variability; therefore, as a group, the boys' RR scores were more spread out. Furthermore, the smaller mean score indicates that as a group, the boys did not do as well as the girls in the response type RR.

The differences of the mean scores are so small on forms A and B that they are of no practical significance. The mean difference for form C is probably significant for this response type RR. However, it was demonstrated that when the means for the right answer, regardless of the selection of process, were combined, the differences were not practically significant.

The differences in the variability is relatively small, and is of no practical significance.

ARITHMETIC PROCESSES

The following four tables have been constructed to show the per cent of response for each of the arithmetic processes according to the form of the test.

Table 9 shows the percentage of response given to the addition examples on the three forms of the test.

Table 9. Per Cent of Response for Addition Examples, Arranged According to Type of Response and Form

Form	RR	RW	RO	WR	WW	WO	OR	OW	OO
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
A	85.2	5.0		.4	4.8		1.0	.5	3.1
B	87.9	3.5		.7	3.8		1.4	.4	2.4
C	81.2	4.5	.2	1.2	7.1	.2	1.6	.2	4.0

This table shows the per cent of the children's response to the addition examples according to the type of response and the form of the test. The following are illustrations of how these percentages should be interpreted.

Of all the children 85.2 per cent chose the right process and gave the right answer (RR response type) for all the addition examples on form A.

Of all the children 3.8 per cent chose the wrong process and gave the wrong answer (WW response type) for all the addition examples on form B.

Of all the children 4.5 per cent chose the right process but gave the wrong answer (RW response type) for all the addition examples on form C.

The response type RR is the most significant and Table 9 shows that form B resulted in the highest percentage of this response in the addition examples.

Table 10 shows the percentage of response given to the subtraction examples on the three forms of the test.

Table 10. Per Cent of Response for Subtraction Examples, Arranged According to Type of Response and Form

Form	RR	RW	RO	WR	WW	WO	OR	OW	OO
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
A	75.5	6.2		1.7	9.5		1.6	1.0	4.5
B	75.0	5.2		3.8	11.7		1.4	1.0	1.9
C	76.0	4.7		4.3	7.8		2.9	.4	4.0

This table shows the per cent of the children's response to the subtraction examples according to the type of response and the form of the test. The following are illustrations of how these percentages should be interpreted.

Of all the children, 75.5 per cent chose the right process and gave the right answer (RR response type) for all the subtraction examples on form A.

Of all the children, 75.0 per cent chose the right process and gave the right answer (RR response type) for all the subtraction examples on form B.

Of all the children, 76.0 per cent chose the right process and gave the right answer (RR response type) for all the subtraction examples on form C.

Response type RR is the most significant and Table 10 shows that form C resulted in the highest per cent of this response in the subtraction examples.

Table 11 shows the per cent of response given to the multiplication examples on the three forms of the test.

Table 11. Per Cent of Response for Multiplication Examples, Arranged According to Type of Response and Form

Form	RR	RW	RO	WR	WW	WO	OR	OW	OO
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
A	62.9	9.0		1.7	22.5		1.4	1.0	1.6
B	65.8	5.5		1.7	21.6		2.4	.4	2.6
C	64.4	9.2	.2	2.4	17.8		1.6	1.0	3.5

This table shows the per cent of the children's response to the multiplication examples according to the type of response and the form of the test. The following are illustrations of how these percentages should be interpreted.

Of all the children, 62.9 per cent chose the right process and gave the right answer (RR response type) for all the multiplication examples on form A.

Of all the children, 5.5 per cent chose the right process but gave the wrong answer (RW response type) for all the multiplication examples on form B.

Of all the children .2 per cent chose the right process but omitted the answer (RO response type) for all the multiplication examples on form C.

Response type RR, is the most significant and Table 11 shows that form B resulted in the highest per cent of this response in the multiplication examples.

Table 12 shows the per cent of response given to the division examples on the three forms of the test.

Table 12. Per Cent of Response for Division Examples, Arranged According to Form and Type of Response

Form	RR	RW	RO	WR	WW	WO	OR	OW	OO
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
A	61.7	2.6	.2	2.8	24.7		2.4	1.4	4.3
B	63.6	5.2	.2	3.1	19.3		4.2	1.4	3.1
C	64.8	3.1		4.2	15.5		4.2	1.6	6.7

This table shows the per cent of the children's response to the division examples according to the type of response and the form of the test. The following are illustrations of how these percentages should be interpreted.

Of all the children, 61.7 per cent chose the right process and gave the right answer (RR response type) for all the division examples on form A.

Of all the children 63.6 per cent chose the right process and gave the right answer (RR response type) for all the division examples on form B.

Of all the children 64.8 per cent chose the right process and gave the right answer (RR response type) for all the division examples on form C.

Response type RR is the most significant and Table 12 shows that form C resulted in the highest per cent of this response in the division examples.

In summary of the last four tables (9 - 12) dealing with the arithmetic processes, it is apparent that for the addition and multiplication examples, form B (the statement of facts followed by an imperative sentence) resulted in the highest per cent of RR responses. For the subtraction and division examples, form C (the statement of facts followed by an incomplete statement) resulted in the highest per cent of RR responses.

To more clearly see the results of Tables 9 - 12, the following two tables have been constructed. They combine certain response types in connection with the forms and the arithmetic process.

First consider Table 13, in which response types have correct answers in common.

Table 13. Combined Per Cents for Response Types RR, WR, and OR, Arranged According to Form and Arithmetic Process

Form	Addition	Subtraction	Multiplication	Division
(1)	(2)	(3)	(4)	(5)
A	86.5	78.8	66.0	66.8
B	90.0	80.1	70.0	70.8
C	83.9	81.3	68.4	73.1

Making observations vertically, the reader will notice that in the processes of addition and multiplication, form B resulted in the highest per cent of correct answers, regardless of choice of process. In the processes of subtraction and division, form C resulted in the highest per cent of correct answers, regardless of choice of process. In the process of addition, form C obtained the lowest per cent, and in the other three processes, form A obtained the lowest per cent.

This seems of interest since the form A type of problem, which is the most commonly used in instructional material, really obtained the lowest per cent of correct answers, regardless of process selection.

Now, observing the figures horizontally, the reader's attention is directed to the fact that in all three forms of the test, the process of multiplication obtained the lowest per cents, and the process of addition obtained the highest per cents.

Now consider Table 14, in which response types have wrong answers in common.

Table 14. Combined Per Cents for Response Types RW, WW, and OW, Arranged According to Form and Arithmetic Process

Form	Addition	Subtraction	Multiplication	Division
(1)	(2)	(3)	(4)	(5)
A	10.4	16.8	32.5	28.7
B	7.6	18.0	27.5	26.0
C	11.7	12.8	28.0	20.2

Viewing the figures of this table vertically, the reader will notice that in the process of addition, form C resulted in the highest per cent of wrong answers regardless of choice of process. This means that more incorrect answers were given on form C addition examples. Form B resulted in the least incorrect answers regardless of choice of process for the addition examples.

This situation was reversed on the subtraction process. Form C resulted in the fewest incorrect answers regardless of

Table 15. Test Forms Arranged According to Classes and Sequence

Class	First	Second	Third
(1)	(2)	(3)	(4)
I	C	A	B
II	A	B	C
III	C	B	A
IV	B	A	C
V	C	A	B
VI	A	C	B
VII	A	C	B
VIII	B	C	A

Since there were eight classes and only six possible different sequences (ABC, ACB, BAC, BCA, CAB, and CBA), two of the six were arbitrarily chosen (ACB and CAB) for the two remaining classes.

Table 16 shows the mean scores obtained by all the children for each response type according to the position in the sequence in which they were administered.

Table 16. Means for All the Children for Each Response Type, Arranged According to Test Sequence

Sequence	RR	RW	RO	WR	WW	WO	OR	OW	OO
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
First	8.1	.8		.3	1.8		.3	.1	.5
Second	8.8	.6		.3	1.6		.2	.1	.3
Third	9.0	.6		.2	1.6		.3	.1	.4

The above table was constructed to demonstrate the effect of practice. This assumes that the pupil's achievement will increase with experience. This table bears out that assumption, at least to a degree. However, to more readily see this, the two following tables have been made to summarize the figures of Table 16.

Table 17. Combined Means for the Responses RR, WR, and OR, Arranged According to Sequence and Sex

Sequence	Boys	Girls	Difference*
(1)	(2)	(3)	(4)
First	8.6	9.0	.4
Second	9.3	9.5	.2
Third	9.5	9.4	- .1

* Positive difference indicates higher means for girls
Negative difference indicates higher means for boys

Combining the response types which have in common the correct answers, the reader will quickly see the effect of practice in the boys' column of means. There is a jump of seven tenths of a problem between the first and second tests taken, and an increase of two tenths between the second and third. The means for the girls' efforts demonstrates a rise of five tenths between the first and second tests taken, while there is a drop of one tenth between the second and third tests taken.

The effect of practice, as such, for both boys and girls has its greatest demonstration between the first and second tests taken.

The difference between boys' and girls' responses brings out the interesting effect of the difference favoring the girls on the first test given. Following the differences down, it will be noticed that the girls lose the favor in the difference to the boys in the third test.

Table 18. Combined Means for the Response Types RW, WW, and OW, Arranged According to Sequence and Sex

Sequence	Boys	Girls	Difference*
(1)	(2)	(3)	(4)
First	2.9	2.5	- .4
Second	2.2	2.3	.1
Third	2.3	2.2	- .1

*Positive difference indicates higher means for girls
Negative difference indicates higher means for boys

These responses have in common the wrong answers given.

Much as in Table 17, the greatest drop in the means for both boys and girls appears between the first and second tests taken, then the differences taper off to one tenth of a problem.

Table 19. Number of Times Test Forms Were Given, Arranged According to Test Form and Sequence

Form	First	Second	Third
(1)	(2)	(3)	(4)
A	3	3	2
B	2	2	4
C	3	3	2

This table indicates that test form B was given to more children as the last in the series than either of the other two forms. Referring to Table 16 to note the effect of practice, the writer recalls the fact that with each succeeding test the children did better. This was anticipated, and for that reason, the different teachers were instructed to administer the three forms of the test in various orders, or sequences. Table 19 shows how many times the different forms were given in each position of the sequence.

Form B was administered in the third position of the sequence just twice as often as the other two forms. Forms A and C were given in the three sequence positions exactly the same number of times. It would be, therefore, more correct for the writer to compare forms A and C.

Form A, the most commonly used form of writing arithmetic verbal problems, has a statement of the facts followed by an interrogative sentence. Form C, the least commonly used form of writing arithmetic verbal problems has a statement of the facts followed by an incomplete statement.

Referring back to Tables 13 and 14, the writer recalls that form C showed higher percentages than form A on all processes except addition. This would indicate that when the forms of the test are equated in regards to sequence, form C showed higher percentages than form A.

Table 20 shows the amounts of time required to complete the test forms, and is arranged according to the positions in the sequence of the administration of the tests to each class.

Table 20. Testing Times, Arranged According to Class and Sequence of Forms

Class	Sequence	1st Test Given	2nd Test Given	3rd Test Given
(1)	(2)	(3)	(4)	(5)
I	CAB	13	16	15
*II	ABC	34	25	13
III	CBA	19	19	11
IV	BAC	20	15	12
V	CAB	19	14	12
VI	ACB	20	18	17
VII	ACB	13	13	12
VIII	BCA	20	15	18
*Average Time		17.7	15.7	13.9

*Class II figures were not used

Table 20 gives the results of the timing for the tests in each class on each form of the test. Referring to the Appendix, the reader will find in the GENERAL DIRECTIONS, item number 8, that the test was not to be considered a "timed" test, but rather, the average time for all the tests would give any future investigator an estimate of the time required to perform this test. These figures were given by the individual classroom teachers as indicating the lapse of time between the moment the children started on their own with problem one, until 90 per cent of the children had finished. It is conceivable that the teacher of class II did not follow the directions as given, or that the class was an exceptionally slow one, or that there were more than 10 per cent in the class who were exceptionally slow. Regardless of the reason, class II times were too far away from the normal running times, and were not used in the computation of the average time for the test.

The effect of practice is seen here because the average times show a decrease in the time required of two minutes between tests. The average time for all the tests in all the classrooms regardless of the sequence was 15.3 minutes.

CHAPTER V

SUMMARY AND CONCLUSIONS

Statement of the problem and procedure.-- The purpose of this study was to try to discover whether or not the way in which a verbal arithmetic problem is stated has any bearing on the response. Three test forms were used. The traditional style, identified as form A, had a statement of the facts followed by an interrogative sentence. Form B, which is also used in instructional material, had a statement of the facts followed by an imperative sentence. The experimental style, which is rarely used in instructional material, had a statement of the facts followed by an incomplete sentence. These three forms of the test were given to 193 fourth grade children in Hingham, Massachusetts. This number includes the entire fourth grade population of that town. Five schools involving eight classes were participants in this study. The intelligence quotients considered in the analysis were the top quarter and the bottom quarter. The test results were based on correct selection of process and correct answers given to the problems.

Summary of the findings.--

1. The population of the group showed that there were more than a quarter as many more girls than boys.
2. The children in the top I. Q. group got consistently better scores than the bottom I. Q. group.

3. Only on form C, and in the top I. Q. group did the girls do better than the boys. All other sex and I. Q. comparisons showed little or no difference of practical significance.
4. The analysis of the means for the various types of responses showed that there was little or no difference of practical significance demonstrated between the three forms of the test.
5. There was little or no difference of practical significance demonstrated between the responses of boys and girls on forms A and B. Form C did show a difference of practical significance favoring the girls.
6. The boys had more variability than the girls, as shown by the larger standard deviations for the boys.
7. Differences in the responses to the four arithmetic processes was demonstrated; however, these differences were so small that their practical significance is doubtful.

Conclusions.--

1. The data of this study concludes that the way in which a verbal arithmetic problem is stated does not significantly affect the response to any practical significance.
2. It would seem evident that there are implications here for the writers of instructional material, as well as for classroom practices. Since a large part of child-

ren's learning takes place by means of varied activity in problem situations, it would seem advisable to include more problems in the styles of forms B and C. The children would experience more variety in their learning activities, if instructional materials were to use the three forms of stating word problems. This could be done without causing differences of practical significance.

Suggestions for further study.--

1. A continuation of this study on a larger scale with more problems in the test and a larger population.
2. A study might conceivably produce some valuable data if an experimental group was given experience with all three forms of the problems, while a control group was given experience only with the traditional style of the problems.

APPENDIX

Dear Teacher,

By way of introduction, I am Edward C. Helland a sixth-grade teacher in Hingham, Massachusetts. I am studying for a masters degree in education at Boston University. My thesis problem is to test the hypothesis that the form of response to verbal arithmetic problems is the same regardless fo the method of presentation used. This problem has been a matter of interest and speculation with many teachers I have contacted. To this end, I am askking for your kind cooperation.

There are three tests to be administered. The three forms of the test differ only in the way in which the word problems are stated.

FORM A Mary has 2 dolls, and Jane has 3 dolls.
How many dolls have they together?

FORM B Mary has 2 dolls, and Jane has 3 dolls.
Find how many dolls they have together.

FORM C Mary has 2 dolls, and Jane has 3 dolls.
Together they have __________ dolls.

You will note that FORM A has the problems worded in the usual manner: a declarative sentence which states the facts, and an interrogative sentence which asks for an answer. FORM B problems have a declarative sentence followed by an imperative sentence directing pupils to solve the problem. FORM C problems have a declarative sentence followed by an incomplete statement.

All children will take all forms of the test; however the effects of "order" and"practice" must be considered, therefore, the groups of tests have been arranged in varying sequences. The order you will use has been noted on your "General Instructions" sheet.

In an effortto maintain consistancy, I should like all teachers to give these tests on a Monday-Wednesday-Friday basis. In this way, the time lapse between the tests will be controlled, and the day of the week will also be constant.

The effect of "practice" may, or may not, be a factor in these tests; however, the possibility must be considered. I must ask you to cooperate on another point in this regard. Please do not teach arithmetic word problems in any systematic way during the testing period. Do not go over test forms once they have been given during the testing period. Any teaching along these lines will tend to invalidate the results.

Two types of information are being asked for, for which forms have been made, and are enclosed. One form has been supplied upon which to record the time of beginning and termination of the tests. These tests are not timed; however, since these tests may be used on a larger scale in the future, I am interested in the average time of all the tests in all the classrooms using them.

Another form has been enclosed for the recording of names and Intelligence Quotients (I.Q.) of all the pupils taking the tests. This is very important, since some of the analysis will be made according to I.Q. groupings.

Finally, I should like you to read the GENERAL INSTRUCTIONS and the DIRECTIONS of the three forms as nearly verbatim as is naturally possible. The reason again is so that I may assume consistancy.

Gratefully yours,

Edward C. Helland

Edward C. Helland

GENERAL INSTRUCTIONS

1. Place on the board:

1 -- January	5 -- May	9 -- September
2 -- February	6 -- June	10 -- October
3 -- March	7 -- July	11 -- November
4 -- April	8 -- August	12 -- December

2. Make sure every child has a pencil and an eraser.

3. Read to class:

I know a person who is interested in the arithmetic that boys and girls your age can do. He has asked you and me to help him. Today we will do a set of examples for him, Wednesday we will do another set, and Friday we will do the last set. There are three tests in all.

Fourth-grade boys and girls in several places are being asked to help by doing these same examples.

He would like us to work as fast as we can, but would not want us to go so fast that we make a lot of mistakes. He wants us to do our very best.

4. Pass out the tests. Make sure you have the correct form. You are to administer the tests in this order: FORM B on Monday, FORM C on Wednesday, and FORM A on Friday.

5. Help the children fill out the cover page.
   NAME --please print--note that last name is first
   SCHOOL
   CITY OR TOWN
   BOY OR GIRL
   TODAY'S DATE--please put this on the board to illustrate the use of the numbers for the month.
   DATE OF LAST BIRTHDAY--same as above
   YOUR AGE--age on LAST birthday

6. Erase the numbers and months from the board, add place the following on the board.

   A--Add
   S--Subtract
   M--Multiply
   D--Divide

   This should remain on the board throughout the testing period.

7. Read the directions for the form which is to be given. You are to administer the tests in this order: FORM B on Monday, FORM C on Wednesday, and FORM A on Friday. DO NOT DEVIATE FROM THIS ORDER.

8. Record the times for beginning and terminating each test on the form provided, and in the proper space. "Test terminated at" refers to the time when approximately 90% of the class has finished. When 90% of the class has finished, please collect all the papers. This is not a timed test, but I would like to compute the average time for the tests from all the tests given in all the classrooms.

9. I will correct all the papers, so when the three tests have been administered, will you please place them along with the completed timing and class list forms in the self-addressed stamped envelope and mail it to me.

DIRECTIONS FOR <u>FORM "B"</u>

The test we are going to do today has the kind of problems that we have as samples on this page. We will do these examples together, so while I read the first sample problem "A", will you please follow along on your paper.

Jack's boots are 9 inches high. His father's boots are 18 inches high. Find how many inches higher his father's boots are.

(PAUSE FOR A MOMENT)

Now, boys and girls, what would be the best way to solve this problem--add, subtract, multiply, or divide? (PAUSE FOR ANSWER)

That is correct, it is best to SUBTRACT.

Notice on your paper that the letter "S" has a circle drawn around it. Now let us do the work to get the answer. We will do our work in the space at the right side of the paper. (POINT TO IT)

Go ahead now and do the work. (WAIT FOR THE CLASS)

What did you get for an answer? (~~12 INCHES~~) (9 INCHES)

Yes, his father's boots are ~~12~~ 9 inches higher. Now place that answer on the line under the problem where it says "answer".

Now you read the next sample problem "B", and raise your hand as soon as you know the best way to solve the problem.

(CALL ON SOMEONE) (MULTIPLY)

MULTIPLY is correct. First we will place a circle around the letter "M". Next we will work out the problem by ourselves. When you know the answer raise your hand. (CALL ON SOMEONE FOR THE ANSWER)

Right! There are 36 cans of soup on the shelf.

Be sure now to place your answer on the line beside the word "answer".

The next problem you will do by yourself. When you have finished, put down your pencils and wait for me to check your work.

(AT THIS POINT, WILL YOU PLEASE WALK AROUND THE ROOM TO MAKE SURE THE CHILDREN HAVE CIRCLED A LETTER--"D" IN THIS EXAMPLE--AND THAT THEY HAVE PLACED THE ANSWER IN THE SPACE PROVIDED.)

What did you do to solve the problem? (DIVIDE IS CORRECT)

What letter did you circle? (D)

What answer dod you get? (12 FRIENDS)

Make sure you have written the answer in the space for it beside the word "answer".

If you have any questions about how to do the test, ask them now. I will not be able to help you once we start.

(ANSWER ONLY THOSE QUESTIONS WHICH HAVE TO DO WITH THE METHOD OF MARKING THE LETTER, WHERE TO DO THE WORK, AND WHERE TO PUT THE ANSWER. YOU WILL BE UNABLE TO HELP THE CHILDREN SELECT THE PROCESS, OR DO THE ARITHMETIC WORK FOR THE INDIVIDUAL PROBLEMS IN THE TEST.)

If there are no further questions, you may turn the page and begin the test now.

(PLEASE NOTE THE TIME ON THE FORM PROVIDED.)

DIRECTIONS FOR FORM "C"

The test we are going to do today has the kind of problems that we have as samples on this page. We will do these examples together, so while I read the first sample problem "A" will you please follow along on your paper.

There are 3 rows of soup cans on the shelf, and there are 12 cans in each row. There are __________ cans of soup on the shelf.

(PAUSE FOR A MOMENT)

Now, boys and girls, what would be the best way to solve this problem--add, subtract, multiply, or divide? (PAUSE FOR ANSWER)

That is correct, it is best to MULTIPLY.

Notice on your paper that the letter "H" has a circle drawn around it. Now let us do the work to get the answer. We will do our work in the space at the right side of the paper. (POINT TO IT)

Go ahead now, and do the work. (WAIT FOR THE CLASS)

What did you get for an answer? (36)

Yes, there are 36 cans of soup on the shelf. Now, place that answer on the line under the problem where it says "answer". Do not place the answer in the blank space in the problem.

Now read the next problem "B", and raise your hand as soon as you know what would be the best way to solve the problem.

(CALL ON SOMEONE) (DIVIDE)

DIVIDE is correct. First we place a circle around the letter "D". Next we will work out the problem by ourselves. When you know the answer raise your hand. (CALL ON SOMEONE FOR THE ANSWER) (12)

Right! Each friend will get 12 pieces of candy.

Be sure to place your answer on the line beside the word "answer", and not in the blank space in the problem.

The next problem you will do by yourself. When you have finished, put down your pencils and wait for me to check your work.

(AT THIS POINT, WILL YOU PLEASE WALK AROUND THE ROOM TO MAKE SURE THE CHILDREN HAVE CIRCLED A LETTER--"A" IN THIS EXAMPLE--AND THAT THEY HAVE PLACED THE ANSWER IN THE SPACE BESIDE THE WORD "ANSWER" AND NOT IN THE BLANK SPACE IN THE PROBLEM.)

What did you do to solve the problem? (ADD)

What letter did you circle? (A)

What answer did you get? (16 DOLLS)

Make sure you have written the answer in the space beside the word "answer", and not in the blank space in the problem.

If you have any questions about how to do the test, ask them now. I will not be able to help you once we start.

(ANSWER ONLY THOSE QUESTIONS WHICH HAVE TO DO WITH THE METHOD OF MARKING THE LETTER, WHERE TO DO THE WORK, AND WHERE TO PUT THE ANSWER. YOU WILL BE UNABLE TO HELP THE CHILDREN SELECT THE PROCESS, OR DO THE ARITHMETIC WORK FOR THE INDIVIDUAL PROBLEMS IN THE TEST.)

If there are no further questions, you may turn the page, and begin the test now.

(PLEASE NOTE THE TIME ON THE FORM PROVIDED.)

DIRECTIONS FOR FORM "A"

The test we are going to do today has the kind of problems that we have as samples on this page. We will do these examples together, so while I read the first sample problem "A", will you please follow along on your paper.

Mary has 12 dolls, Jane has 4 dolls. How many do they have in all? (PAUSE FOR A MOMENT)

Now, boys and girls, what would be the best way to solve this problem--add, subtract, multiply, or divide? (PAUSE FOR ANSWER)

That is correct, it is best to ADD.

Notice on your paper that the letter "A" has a circle drawn around it. Now let us do the work to get the answer. We will do our work in the space at the right side of the paper. (POINT TO IT)

Go ahead now and do the work. (WAIT FOR THE CLASS)

What did you get for an answer? ~~12~~ (16 DOLLS)

Yes, Mary and Jane have 16 dolls in all. Now place that answer on the line under the problem where it says "answer".

Now you read the next sample problem "B", and raise your hand as soon as you know the best way to solve the problem.

(CALL ON SOMEONE) (SUBRRACT)

SUBTRACT is correct. First we will place a circle around the letter "S". Next we will work out the problem by ourselves. When you know the answer raise your hand. (CALL ON SOMEONE FOR ANSWER)

Right! His father's boots are 9 inches higher.

Be sure now to place your answer on the line beside the word "answer".

The next problem you will do by yourself. When you have finished put down your pencils and wait for me to check your work.

(AT THIS POINT, WILL YOU PLEASE WALK AROUND THE ROOM TO MAKE SURE THE CHILDREN HVAE CIRCLED A LETTER--"M" IN THIS EXAMPLE--AND THAT THEY HAVE PLACED THE ANSWER IN THE SPACE PROVIDED.)

What did you do to solve the problem? (MULTIPLY)

What letter did you circle? (M)

What answer did you get? (36 CANS OF SOUP)

Make sure you have written the answer in the space for it beside the word "answer".

If you have any questions about how to do the test, ask them now. I will not be able to help you once we start.

(ANSWER ONLY THOSE QUESTIONS WHICH HAVE TO DO WITH THE METHOD OF MARKING THE LETTER, WHERE TO DO THE WORK, AND WHERE TO PUT THE ANSWER. YOU WILL BE UNABLE TO HELP THE CHILDREN SELECT THE PROCESS OR DO THE ARITHMETIC WORK FOR THE INDIVIDUAL PROBLEMS IN THE TEST.)

If there are no further questions, you may turn the page and begin the test now.

(PLEASE NOTE THE TIME ON THE FORM PROVIDED.)

TEACHER ____________________

SCHOOL ____________ ____________

TOWN ____________________

TESTING SEQUENCE ___ A B C ✓ B C A ___ C A B

___ A C B ___ B A C ___ C B A

TIMING

	FORM A	FORM B	FORM C
Test terminated at	(hr)(min)	(hr)(min)	(hr)(min)
Test begun at	(hr)(min)	(hr)(min)	(hr)(min)
Total test time			

CLASS LIST

SCHOOL ______________________

TEACHER ______________________

TOWN ______________________

BOYS' NAMES	Name of Test	Date of Test	I.Q.	GIRLS' NAMES	Name of Test	Date of Test	I.Q.

FORM A

NAME ________________________ BOY ____

SCHOOL ________________________ GIRL ____

CITY or TOWN ________________________

TODAY'S DATE ________________________
(year) (month) (day)

DATE OF LAST BIRTHDAY ________________________
(year) (month) (day)

YOUR AGE __________

SAMPLES DO YOUR WORK HERE

A. Mary has 12 dolls. Jane has 4 dolls. How many do they have in all? (A) S M D

Answer __________

B. Jack's boots are 6 inches high. His father's boots are 18 inches high. How many inches higher are his father's boots? A S M D

Answer __________

C. There are 3 rows of soup cans on the shelf, and there are 12 cans in each row. How many cans of soup are there on the shelf? A S M D

Answer __________

(A-1) Bill had 18 trucks. He gave 3 to John. How many trucks does Bill have now? | A S M D

Answer ______________

(A-2) There are 21 new desks in our fourth-grade room, and 7 in the other fourth-grade room. How many new desks are there in the fourth-grade rooms? | A S M D

Answer ______________

(A-3) Lorna has 48 cards and must give 4 cards to each player. How many children can play cards? | A S M D

Answer ______________

(A-4) 12 girls were coloring with some crayons. Each girl had 4 crayons. How many crayons were there altogether? | A S M D

Answer ______________

(A-5) Joan put 12 dolls on the top shelf, and 6 on the second shelf. How many dolls had Joan put on the shelves? | A S M D

Answer ______________

(A-6) 2 boys wanted to make 24 toy cars. If each boy makes the same number, how many should each make? | A S M D

Answer ______________

DO YOUR WORK HERE

(A-7) Tim exercises 2 hours each day. A S M D

How many hours does he exercise in 24 days?

Answer ______________

(A-8) There were 12 marbles in each ring. A S M D

There were 4 rings. How many marbles were there in all?

Answer ______________

(A-9) Friday the girls picked 18 flowers A S M D

in the field. Saturday they picked 6. How many more flowers did they pick on Friday?

Answer ______________

(A-10) Eddy's father ran 15 miles in A S M D

3 hours. If he ran the same distance each hour, how many miles did he run each hour?

Answer ______________

(A-11) There were 16 sail boats on the A S M D

lake. 4 of them had white sails. The others had blue sails. How many boats had blue sails?

Answer ______________

(A-12) 12 boys were playing on the lawn. A S M D

3 more came to play. How many boys were playing together?

Answer ______________

FORM B

NAME ______________________ BOY ____

SCHOOL ______________________ GIRL ____

CITY or TOWN ______________________

~~DATE~~ TODAY'S DATE ______________________
(year) (month) (day)

DATE OF LAST BIRTHDAY ______________________
(year) (month) (day)

YOUR AGE __________

SAMPLES | DO YOUR WORK HERE

A. Jack's boots are 9 inches high. His father's boots are 18 inches high. Find how many inches higher his father's boots are.

A (S) M D

Answer __________

B. There are 3 rows of soup cans on the shelf, and there are 12 cans in each row. Find how many cans of soup there are on the ~~shelves~~ shelf.

A S M D

Answer __________

C. Gloria has 36 pieces of candy. She wants each of her 3 friends to have the same number of pieces. Find how many pieces of candy each friend will get.

A S M D

Answer __________

DO YOUR WORK HERE

(B-1) John had 16 lollipops in one package. There were 8 in the other. Find how many lollipops there were.

Answer ____________

A S M D

(B-2) Peter got 36 corn seeds, and passed out 3 each to some of his friends. Find how many of his friends got seeds.

Answer ____________

A S M D

(B-3) Ted has 21 boxes of candy. There are 3 pieces in each box. Find how many pieces of candy he has in all.

Answer ____________

A S M D

(B-4) There were 24 coats hanging in the coat room. 3 of them were raincoats. The others were overcoats. Find how many were overcoats.

Answer ____________

A S M D

(B-5) Barbara has 11 rolls of film. She can take 6 pictures with each roll. Find how many pictures she can take altogether.

Answer ____________

A S M D

(B-6) There were 16 bicycles at the big store. 8 of them were sold before Christmas day. Find how many bicycles are in the big store now.

Answer ____________

A S M D

DO YOUR WORK HERE

(B-7) Our class collected 24 shells in 2 months. If we collected the same amount each month, find out how many shells we collected each month.   A S M D

Answer ________________

(B-8) The lady had 7 turkeys and 21 chickens on her farm. Find how many birds she had.   A S M D

Answer ________________

(B-9) Mother irons 4 dresses each week. Find how many dresses she irons in 32 weeks.   A S M D

Answer ________________

(B-10) The teacher has 15 pencils in a box. She has 3 in her hand. Find how many more pencils are in the box.   A S M D

Answer ________________

(B-11) 14 girls were making a snow man. 7 more came to help. Find how many girls were making the snow man together.   A S M D

Answer ________________

(B-12) There were 39 gingerbread men made by 3 girls. Find how many each made, if each girl made the same number of gingerbread men.   A S M D

Answer ________________

FORM C

NAME ______________________ BOY ____

SCHOOL ______________________ GIRL ____

CITY or TOWN ______________________

TODAY'S DATE ______________________
(year) (month) (day)

DATE OF LAST BIRTHDAY ______________________
(year) (month) (day)

YOUR AGE __________

SAMPLES — DO YOUR WORK HERE

A. There are 3 rows of soup cans on the shelf, and there are 12 cans in each row. There are ________ cans of soup on the shelf. — A S (M) D

Answer __________

B. Gloris hs 36 pieces of candy. She wants each of her 3 friends to have the same number of pieces. Each friend will get ________ pieces of candy. — A S M D

Answer __________

C. Mary has 12 dolls. Jane Has 4 dolls. In all, they have ________ dolls. — A S M D

Answer __________

DO YOUR [illegible]

(3-1) Mother made 19 cookies. She frosted 7 with chocolate frosting, and the others with white frosting. She frosted __________ cookies with white frosting. A S M D

Answer __________________

(3-2) Mary has 12 carriages to care for. Her friends left 4 dolls in each carriage. In all she has __________ dolls to care for. A S M D

Answer __________________

(3-3) Altogether there were 25 letters to be delivered to 5 families. If each family got the same number of letters, they each received __________ letters. A S M D

AAnswer __________________

(3-4) Sandy brushes her teeth 3 times each day. She brushes her teeth __________ times in 12 days. A S M D

Answer __________________

(3-5) Bob looked fow science books. He found 21 books about animals, and 7 about plants. He had found __________ science books. A S M D

Answer __________________

(3-6) Mabel has 15 stamps in her collection. Jean has 5 in hers. Mabel has __________ more stamps than Jean. A S M D

Answer __________________

DO YOUR WORK HERE

(C-7) Carol's house had 4 trees in the front yard, and 11 trees in the backyard. There are ________ trees there.

Answer ____________

A S M D

(C-8) 9 cows were in the pasture eating grass. 12 more were let out of the barn. Together there were ________ cows in the pasture.

Answer ____________

A S M D

(C-9) The teacher had 16 milk straws, and gave 2 to each child who had milk. ________ children had milk.

Answer ____________

A S M D

(C-10) 15 women brought 3 chairs each to a lawn picnic. There were ________ chairs altogether.

Answer ____________

A S M D

(C-11) Douglas received 10 handkerchiefs for Christmas. He gave 5 to his brother. He now has ________ handkerchiefs.

Answer ____________

A S M D

(C-12) Dave grew 36 tomato plants in 3 years. If he grew the same amount of plants each year, he grew ________ tomato plants each year.

Answer ____________

A S M D

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