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A STUDY OF THE EFFECTS OF CERTAIN VARIABLES UPON 4TH AND 6TH GRADE COSTA RICAN CHILDREN'S ABILITY TO SOLVE ARITHMETIC WORD PROBLEMS

The Ohio State University

PH.D. 1983

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A STUDY OF THE EFFECTS OF CERTAIN VARIABLES
UPON 4TH AND 6TH GRADE COSTA RICAN CHILDREN'S ABILITY
TO SOLVE ARITHMETIC WORD PROBLEMS

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

by

María Angeles Jiménez, B. Ed., M. A.

********

The Ohio State University
1983

Reading Committee:
Lorren L. Stull
Alan Osborne
Donald Haefele

Approved by

Lorren L. Stull
Co-adviser

Al Osborne
Co-adviser
To my husband Víctor
ACKNOWLEDGMENTS

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Special appreciation is expressed to my husband Victor for his loving encouragement, help and understanding. To my parents Francisco and María Cristina for their continuous support, love and influences on my life. To my brother Alvaro for his invaluable support. A final word of thanks to my entire family, friends and colleagues for their help and support.
VITA

April 20, 1941 Born - San José, Costa Rica, Central América.

1960. . . . . . Primary School Teacher, University of Costa Rica, San José, Costa Rica.


1980. . . . . . Master of Arts, The Ohio State University, Columbus, Ohio.


1980 - 1981
1982 - 1983 . . . . Teaching Associate, Early and Middle Childhood Education, The Ohio State University, Columbus, Ohio.

FIELDS OF STUDY

Major Field: Early and Middle Childhood Education.

Studies in Early and Middle Childhood Education.  
Dr. Lorren L. Stull, Dr. Donald Haefele.

Studies in Primary School Mathematics.  
Dr. Alan Osborne.
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CHAPTER I

INTRODUCTION

This is a study of the relationships among variables that affect students' performance on arithmetic problem solving. For the purpose of this study the variables are: length of the arithmetic word problem, the presence or absence of extraneous information, reading ability, and computational ability. The students selected were Costa Rican primary school children of grades four and six. The study was suggested by several facts: 1) problem solving is one of the major goals of mathematics instruction across different cultural settings; 2) there are no studies about the relationships among problem solving ability and the variables mentioned above for Costa Rican primary school children (Universidad de Costa Rica, 1981); 3) the Costa Rican mathematics program for primary school does not include a structure plan for teaching problem solving (Ministerio de Educación Pública, 1977); and 4) Costa Rican educators seem not to be aware of the necessity for preparing students with good problem solving skills.

Problem solving is considered by several authorities as one of the most important types of cognitive performance for any individual. In mathematics education problem solving
is regarded as a vital part of doing mathematics. The National Council of Supervisors of Mathematics (1977) issued a position paper on "Basic Skills" that stated that "learning to solve problems is the principal reason for studying mathematics." The National Council of Teachers of Mathematics published An Agenda For Action (1980) in which the development of problem solving ability was advocated as the primary goal of mathematics education through the decade 1980-1990.

Research in problem solving has been done by several psychologists, educational researchers and expert problem solvers. Meiring (1980) reported Newell and Simon's definition of a problem as "a situation in which a person wants something and does not know immediately what series of actions he can perform to get it." Polya (1980) stated that the action of solving a problem is "human nature itself." He asserted that "to solve a problem is to find a way where no way is known offhand, to find a way out of a difficulty, to find a way around an obstacle, to attain a desired end, that is not immediately attainable, by appropriate means." Wirtz and Kahn (1980) stated that a problem solving situation in its mathematical sense involves several activities in which a person requires the use of reflective thought, trial and error, decision making and the presence of positive attitudes and behaviors toward the uncertainty.
Some authors think that the ability to read is only a necessary condition for good performance on problem solving. Barnett (1982) stated that "it seems safe to assume that the ability to read and interpret word problems with facility is a necessary, but not sufficient condition for problem-solving success." Harvin and Gilchrist (1970) pointed out the same idea stating that "the problem is stated in words that are to be read and understood before problem solving. Every problem begins with words that tell the story involved."

While some authors indicate that verbal problem solving refers to textbook problems, word problems, or story problems, this investigator's point of view is that "verbal problem solving" is a process that occurs when the problem is presented through words and that the problem solver has to read and understand words and symbols before working toward the solution. It is understood that "verbal problem solving" can provide two different situations to the students, one accurately characterized as problem solving, the other not. The typical situation is one in which the "problem" is presented in the format of a textbook problem that the student is to solve by mechanically applying one or more operations. According to De Vault (1981) if a solution of a problem is found by a strategy immediately apparent, problem solving does not take place. This statement of De Vault fits Polya's characterization of "one-rule-under-your-nose" related to textbook
word problems. The other "verbal problem solving" situation is one which provides the opportunity for the students to have an analytical type of experience in which they can apply their mathematical knowledge and their problem solving skills.

Costa Rican Educational System: Structure and Functioning.

The structure of the Costa Rican educational system was modified for the last time in 1974. Educational leaders presented a "Plan Nacional de Desarrollo Educativo" (National Plan for Educational Development) giving the country many more opportunities for the development and education of the people. Article number 78 of the Costa Rican constitution (1949) has been modified to be read as follows: "The General Basic Education is obligatory. General basic, pre-school, and diversified education are free and funded by the Nation." (Ministerio de Educación Pública, 1974). According to this law, "The General Basic Education is considered the minimal cultural basis of every Costa Rican. That is why it is obligatory." (Ministerio de Educación Pública, 1979).

The General Basic Education constitutes the core of this new educational structure. It is nine years long and is divided into three "cycles" of three years. The first cycle consists of the first, second, and third grades of the primary school. The second cycle consists of fourth, fifth, and sixth grades. And the third cycle consists of the first three years of secondary school.
In addition to General Basic Education three other educational levels constitute the Costa Rican formal system of public education: Initial Education (pre-school education or kindergarten), Diversified Education, and Higher Education. The initial Education level receives five or six year old children and is one year long. Diversified Education is two years long after General Basic Education, and offers several options: academic education, technical education, and artistic education. Higher Education is represented by the University of Costa Rica, The University of Heredia, and The Costa Rican Institute of Technology.

There is also the "Parallel System." This system is divided into two branches: 1) Special Education, and 2) Adult Education.

There are six areas of study in the first six years (first and second cycles) of General Basic Education:

1. Language and Social Studies.
2. Science and Mathematics.
3. Aesthetic Education.
5. Religious Education (Catholic religion only).
6. Elective Activities (group activities, democratic formation).
A typical week's work in the first and second cycles is distributed as follows:

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<td>4</td>
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(Ministerio de Educación Pública, 1979)

The "Plan Nacional de Desarrollo Educativo" (National Plan for Educational Development) changed the structure of our educational system in 1974. The whole system received a new orientation; therefore, the school programs were revised and changed.

The school programs were prepared by a group of advisors from the Ministry of Education, professors from the University of Costa Rica, and school teachers. The information updates the content according to the social needs of the moment and attempts to anticipate the future. For instance, the mathematics programs present the "new mathematics" as one of the most important areas. Also the Ministry of Education provided training for the teachers in the different areas in which the
contents were new.

The program information provides helpful tools for teachers to work in the four different areas (science, mathematics, language, and social studies). The programs are organized so that the teachers receive the information about the content and objectives, activities, and evaluation in relation to each grade level but the teachers are relatively free in applying these programs in the classroom. The administrators are aware that these programs are good guidelines for the teacher's work in the classroom, but the teacher is free to change some of the content of these programs and enrich them depending upon the characteristics and needs of the group of children.

In 1979 the school teachers received new programs for the four basic areas: language, social studies, mathematics, and science. The programs were not "new" but were a revised edition of the previous programs.

The advisors from the Ministry of Education point out that the programs were revised by a team of professionals from the Ministry, the University of Costa Rica, The Costa Rican Institute of Technology, and several groups of teachers. The mathematics committee also received advice and recommendations from professors Ernesto Ranucci and Donavan A. Johnson, who worked in Costa Rica for several months as advisers from the OEA (Organization of American States) (Ministerio de
The content of the new programs did not change much in relation to the previous programs. The change was mainly in the presentation of the objectives, contents, and activities. These three aspects are presented in three different columns showing horizontal correspondence among objectives-content-activities. The presentation enables the teacher to understand the relation between objectives, content, and activities (Ministerio de Educación Pública, 1977).

The description of the Costa Rican educational system gives some information to the reader about the educational setting in which this study was conducted. This helps to understand the recommendations offered by this study.

**Definition of terms**

The terms that follow are defined for the purpose of this study.

- **Costa Rican primary school children.** These children were Costa Rican fourth and sixth graders attending urban and rural day schools. Both public and private institutions were represented in the sample.

- **Arithmetic word problems.** Problems are presented through words in three different formats and with the presence or absence of extraneous information and their solutions require at least one arithmetic operation: multiplication or division.
of whole numbers.

**Prose format problems.** The prose format problem is an arithmetic word problem that is presented in the form of a short story. The number of words is greater than 150 but less than 200.

**Typical format problems.** A typical format problem is the kind of arithmetic word problem commonly found in any mathematics textbook. The number of words is between 20 and 30.

**Short format problems.** A short format problem is an arithmetic word problem that has the minimum number of words needed to communicate the conditions of the problem situation. The number of words is less than 20.

**Warm-up problems.** A warm-up problem is the kind of arithmetic word problem with which the students are familiar or of typical format. The same two warm-up problems appear at the beginning of each form of the word problem questionnaire.

**Reading comprehension test.** The reading comprehension test is a cloze test measuring reading comprehension level (Appendix A).

**Problems with extraneous information.** Problems with extraneous information are those arithmetic word problems having numerical data that are not relevant to the solution of the problems.
Problems without extraneous information. Problems without extraneous information are those arithmetic word problems having only the numerical data needed for solution.

Test of computation. The test of computation consists of eight arithmetic computations: one addition, one subtraction, three multiplications, and three divisions. These computations are the same that appear in the word problems.

Statement of the Problem

This study will investigate the ability of Costa Rican fourth and sixth grade students from rural, urban, and private schools to solve arithmetic word problems of short, typical, and prose length and which do or do not contain extraneous information. The relationships between the students' computational and reading abilities and their ability to solve word problems of the types included in the study will also be investigated.

Research Questions

1. Is there a difference in arithmetic word problem solving ability between students in rural, urban, and private schools?

2. Is there a difference in arithmetic word problem solving ability between students in the fourth and sixth grades?
3. Is there a difference in problem solving ability between short, typical, and prose length in arithmetic word problems?

4. Is there a difference in problem solving ability between problems with and problems without extraneous information?

5. Are there differences in problem solving ability due to combinations of school type, grade level, problem length, and problem content (presence or absence of extraneous information)?

6. Are there relationships between reading ability and the ability to solve problems of various length and content?

7. Are there relationships between computational ability and the ability to solve problems of various length and content?

Research Hypotheses

It is hypothesized that:

1. There will be a difference in arithmetic word problem solving ability between students in rural, urban, and private schools.

2. There will be a difference in arithmetic word problem solving ability between students in the fourth and sixth grades.
3. There will be a difference in problem solving ability between short, typical, and prose length in arithmetic word problems.

4. There will be a difference in problem solving ability between problems with and without extraneous information.

5. There will be a difference in arithmetic word problem solving ability due to a combination of type of school and word problem length.

6. There will be a difference in arithmetic word problem solving ability due to a combination of grade level and problem length.

7. There will be a difference in arithmetic word problem solving ability due to a combination of type of school and problem content.

8. There will be a difference in arithmetic word problem solving ability due to a combination of grade level and problem content.

9. There will be a difference in arithmetic word problem solving ability due to a combination of problem length and problem format.

10. There will be meaningful relationships between reading and the ability to solve arithmetic word problems of various combinations of length and content.

11. There will be meaningful relationships between computational ability and the ability to solve arithmetic
word problems of various combinations of problem length and content.

Note: The null hypothesis of no statistically significant difference between the levels of the variables of interest and combinations of these variables will be tested for each of the research hypotheses and will be rejected if the test of no difference is not significant at the 0.05 probability level.

Assumptions

1. An instrument having eight word problems presented in three different formats (prose, typical, and short) provides a value measure of the ability to solve problems.

2. A cloze test can be used to assess reading comprehension.

3. The students' performance in the arithmetic word problem test permits the investigator to establish relationships between the variables length of problem statement, the presence or absence of extraneous information, and computational ability and the ability to solve arithmetic word problems.

Limitations

1. The study was conducted during only four weeks.

2. The sample was restricted to grades four and six of urban public, rural public, and private schools from the Sub-Región San José of the Central Region of Costa Rica.
3. The arithmetic word problem test consisted of only eight problems.

4. Reading comprehension ability was measured by only one cloze test.

Need for Study

The study of the relationships between length of the arithmetic word problem, the presence or absence of extraneous information in the problem statement, reading comprehension, computational ability, and the ability to solve arithmetic word problems is important because the area of problem solving is not present in the official mathematics programs for primary schools in Costa Rica. The design of a structured program in mathematical problem solving should take into account the possible relationships between those variables and arithmetic problem solving. The study may have implications for prospective and in-service teachers in Costa Rica who need preparation in arithmetic problem solving and in teaching problem solving.

The study may suggest some patterns of relationship or correlation between the ability to solve arithmetic word problems of fourth and sixth grade students and the following four variables: length of the arithmetic word problem, the presence or absence of extraneous information, reading ability, and computational ability. These relationships might be generalizable to other subjects in other geographical
circumstances, and in other cultural settings.

The study may have implications for teacher education. This implications might suggest the need for adjustments in teacher education programs and policies.
CHAPTER II

REVIEW OF RELATED LITERATURE

The human ability to solve problems has been one of the greatest preoccupations of psychologists, philosophers, mathematicians, and mathematics educators. Each group has offered its ideas about this ability under different perspectives.

The purpose of this chapter is to present a review of literature relating problem solving to mathematics education especially in the context of elementary school, and to relate this literature to the characteristics and conditions in which the present study was conducted.

The literature reviewed deals with the following aspects of problem solving: 1) theories of human problem solving, and 2) variables that affect the student's problem solving performance. For the purpose of this study these variables are: length of the problem, the presence or absence of extraneous information, reading ability, and computational ability.

Theories of Human Problem Solving

In review of the literature about human problem solving it is important to point out first the work of Polya (1957) who related the problem solving process to mathematics. Polya
presented a four-stage problem solving approach. The four stages
in this approach are: 1) understanding the problem, 2) devising
a plan, 3) carrying out the plan, and 4) looking back.

In the first stage, the problem solver receives the in-
formation and must know what is needed to be found. The prob-
lem solver must identify the present conditions in order to solve
for the unknown. In the second stage the problem solver should
prepare a plan to solve the problem. He or she must know how
to find more information to seek the solution, and what opera-
tions apply. This is the stage in which the problem solver
searches for his/her past experiences in order to relate them
to the present problem situation. In the third stage, the
problem solver carries out the plan to obtain a solution. If the
plan does not work as anticipated, he/she must return to the
planning stage. In the last stage, the problem solver compares
the answer to the problem conditions and finds out if the an-
swer makes sense. This problem solving model helps the prob-
lem solver to be aware of the significant stages in the problem
solving process. It also provides specific suggestions for
educators.

Simon and Newell (1971) proposed a theory of human prob-
lem solving based on the process of thinking and learning in
terms of information processing approaches. They stated that
a theory of problem solving should answer the following ques-
tions:
"First, it should predict the performance of a problem solver handling specified tasks. It should explain how human problem solving takes place: what processes are used, and what mechanisms perform these processes. It should predict the incidental phenomena that accompany problem solving, and the relation of these to the problem solving process... It should show how changes in the attendant conditions - both changes "inside" the problem solver and changes in the task confronting him - alter problem solving behavior. It should explain how specific and general problem solving skills are learned, and what is it that the problem solver "has" when he has learned them." (quoted by the authors from previous work by Newell, Shaw, and Simon).

Simon and Newell's theory makes reference to three elements present in problem solving: an information processing system, a problem solver, and a task. The information processing system has access to a small short term memory and also to an infinite long term memory with fast retrieval but slow storage. The task is defined objectively in terms of a task environment, and it is defined by the problem solver in terms of a problem space. It is important to make a distinction between the task environment and the problem space. The task environment is the way a subject describes the problem. The problem space is the way a problem solver represents the task in order to work on it. Simon and Newell stated that there are several sources of information that help to construct a problem space. Some of them are: 1) the task instructions, which describe the elements of the environment; 2) previous experience with the same task; and 3) previous experience with analogous tasks.
Simon and Newell present four propositions that described the theory:

"1. A few, and only a few, gross characteristics of the human information-processing system are invariant over task and problem solver.
2. These characteristics are sufficient to determine that a task environment is represented (in the information-processing system) as a problem space, and that problem solving takes place in a problem space.
3. The structure of the task environment determines the possible structures of the problem space.
4. The structure of the problem space determines the possible programs that can be used for problem solving."

Resnick and Ford (1981) presented three aspects of mathematical problem solving strategy quite closely related to Simon and Newell's theory. They asserted that problem solving is a process that takes place depending upon: 1) the way problems are presented, 2) how the elements of the task environment interact with an individual's knowledge, and 3) how problems are analyzed and knowledge structures are searched to bring the needed information to approach a task. These aspects are strongly related to memory and language. The student needs to relate his/her prior knowledge to the new problem, so he/she has to encode the present material and to store it in his/her long-term memory.

According to Gagné (1979) human problem solving requires prerequisite skills and knowledge. Learning how to solve problems needs the involvement of at least five kinds of human capabilities:
1) Intellectual skills. This is a general name for the capability to retrieve information from long-term memory and to apply the information (concepts and rules). To have an intellectual skill means "knowing how."

2) Verbal information. This capability organizes knowledge in different ways. It has two specific and very important functions, namely, to help the individual in the initial understanding of the problem, and to transfer organized knowledge.

3) Cognitive strategies. These strategies "are capabilities that may control such processes as attention, the coding and retrieval of learned materials, as well as ways of thinking."

4) Attitude. This is a capability that enables an individual to have positive attitudes toward problem solving.

5) Motor skills. This capability may be required by some individuals in problem solving.

Krutetskii (1976) distinguished three basic stages of mental activity in the process of solving mathematical problems. The first stage is to receive information about the problem. The second stage is to process the information obtained in order to solve the problem and to obtain the desired result. And the third stage is to retain information about the problem.

It is interesting to identify an element that is present in these five conceptions of human problem solving. This
element is the way in which the problem solver receives the information. Resnick and Ford as well as Krutetskii have presented this element in their very first stage. Simon and Newell mentioned this element as a task environment which is the way a subject describes the problem. Polya has this element implicitly in his model in the first stage. In Gagné it is implicitly mentioned when he refers to the second human capability involved in the problem solving activity. He stated that verbal information helps the individual in the initial understanding of the problem. In order to be able to process information, the problem solver receives this information through different channels or vehicles. In the case of the primary school children the information usually arrives as verbal means. In relation to mathematics problem solving the information is presented in written form most of the time. Therefore, the ability to read is one of the most important skills the primary school child, as an arithmetic problem solver, has to have. The way in which the problems are presented is very important in the present study. The problems in this study were presented in three different formats: prose, typical, and short; thus, the students needed to read and process different amounts of words and information.
Variables that Affect the Student's Performance on Problem Solving

Abundant research on problem solving has identified several variables affecting the student's verbal problem solving ability. For the purpose of this study only four variables have been taken into consideration: length of the problem, the presence or absence of extraneous information, reading ability and computational ability.

a. Length of the problem. The relationship between length of the problem and success in problem solving can be found in the study conducted by Jerman (1973). This study was undertaken to determine whether the length of the problem (number of words in the statement of the problem) affected the level of difficulty of verbal arithmetic problems. This investigation was a replication of a previous study in which Jerman found that the variable length of the problem seemed to be a more important determiner of word problem difficulty for students in the upper grades than for those in the lower grades. The subjects of the later Jerman study (1973) were students from fourth grade through eighth grade. The instrument used, a modification of the one used in his previous study, consisted of a set of thirty word problems. The modification was made by adding articles or adjectives in order that the number of words in each problem was a multiple of three. Three forms of each problem were prepared: form two was the original problem
set, form one contained one-third fewer words in each problem than the original problem set, and form three contained one-third more words in each problem than the original problem set. Other elements of the structure of the problem such as the order of the operations were held constant. Jerman concluded that it was not simply the number of words in the problem that affected its difficulty, but the number of words in relation to other factors.

In relation to the variable length of the problem Lester (1978) stated that "problem size" is one of the determinants of mathematical problem difficulty for children in grades four to six.

LeBlanc et al. (1980) presented two different problem formats. These two problem formats are usually found in the standard textbook problems. They stated that an abbreviated story problem often can be found in textbooks for middle grades. This kind of problem is presented in short phrases and sentences with only the needed information. The following is an example of an abbreviated story problem presented by LeBlanc et al.

3 cartons.
6 bottles in each carton.
How many bottles in all?

The other problem format, referred as the predominant story problem in a textbook, is the story problem presented in a paragraph which gives a more complete description of the
situation. For example:

Joe went to the store to buy 3 cartons of Coke. If each carton contains 6 bottles, how many bottles of Coke did Joe buy?

From the above literature it can be stated that "problem size" is considered as one of the variables which affects problem solving success.

b. The presence or absence of extraneous information.
A number of studies have examined the relationship between the presence or absence of extraneous information and success in problem solving. Cruickshank (1948) performed an experiment in order to find out whether mentally retarded children had less ability for recognizing extraneous information from needed arithmetic facts than normal children of a similar mental age.

Two groups of fifteen boys each were tested; one group (the experimental) was formed of mentally retarded boys, and the other group (the control) was a group of normal boys. The instrument used contained eight sets of arithmetic problems. Each set consisted of three problems: one problem was presented in a form containing a great amount of extraneous material (verbal and numerical) a second problem was presented containing only the amount of words needed to understand the problem, a third problem was presented in the form of a computation. In comparing the responses of both groups, Cruickshank concluded that the presence of extraneous materials in a problem situation
caused confusion to both groups of children, but the amount of confusion was much greater for the mentally retarded group of boys.

Stevenson (1975) reported some conclusions of research in children's learning and cognitive development related to mathematics education. Regarding the absence or presence of extraneous information he stated that "the ability to observe selectively- to categorize the environment into what is critical and what is not- develops rather late; evidence indicates that not until the child is ten or twelve years old is he able to do this spontaneously." Therefore, for children, the presence of extraneous information acted as a distractor, and their performance suffered.

In relation to the presence or absence of extraneous information in word problems, Nesher (1976) conducted an investigation with eight hundred junior high students from Jewish and Arabic schools. She concluded that there is an effect of the variable "superfluous information" on the performance of subjects in solving the problems at the 0.001 level of significance.

Bana and Nelson (1978) conducted an exploratory study to determine the effects of distractors in four different settings involving the same problem. Four groups, each consisting of four boys and four girls from grades one through three were selected for this study. A nonverbal problem was used involving
partitive division. The results of this study indicated that distractors affect the problem solving performance of young children.

Glynn (1981) investigated the effect of the presence or absence of extraneous information in the successful solution of arithmetic word problems. Two hundred sixth grade students participated in the study. The findings suggested that the presence of extraneous information in the problem statement demands additional work by the problem solver.

The studies presented above indicated that problems with irrelevant data are more difficult than problems without irrelevant data. In other words the presence of extraneous information affects problem solving success.

c. Reading ability. The review of several research works about the relationship between reading ability and success in problem solving indicated that there is a lack of agreement among investigators concerning this relationship. Several investigators stated that there is a positive relationship between reading and problem solving ability while others presented reports indicating that the relationship between reading and problem solving is not significant.

Treacy (1944), working with a group of eighty high and eighty low achievers in problem solving, tried to determine whether general or specific reading skills of seventh graders
were significantly related to the ability to solve problems in arithmetic. Good achievers were found to be better than poor achievers at the one percent level of significance in quantitative relationships, perception of relationships, vocabulary in context, and integration of dispersed ideas.

Chase (1960) performed an experiment with a group of one hundred nineteen sixth grade students and reported that from the fifteen independent variables included in his study, a combination of three skills predict problem solving ability. These skills are the ability to compute, to note details in reading, and knowledge of the fundamental concepts in arithmetic.

Martin (1963) reported a significant relationship between reading and success in arithmetic problem solving. He worked with a sample of five hundred twenty-three students of grade four and five hundred eighty-four students of grade eight.

Ballow (1964) designed an investigation to determine if the level of general reading ability was significantly associated with problem solving ability. This study involved fourteen hundred sixth grade students. He concluded that general reading ability does have an effect on problem solving ability at a level of significance of 0.05. However, when he controlled IQ the degree of relationship was reduced. Ballow also concluded that computation was a more important factor in problem solving than was reading ability. The level of significance for
computation was 0.01.

Hollander (1973) conducted an experiment working with twelve subjects from grade six whose reading was coded and analyzed using a modification of the Reading Miscue Inventory. She concluded that ability to accurately read verbal problems aloud does not necessarily lead to successful solution of the problems.

A study conducted by Jerman (1974) with three hundred forty students in grades four through nine indicated that there is not a universal set of linguistic variables for predicting student performance in problem solving. Jerman found indications that there may be specific sets of predictor variables which are significant at each age or grade level.

The purpose of the investigation conducted by Linville (1976) was to determine whether the difficulty of arithmetic verbal problems is significantly affected by different levels of difficulty in syntax and vocabulary of the problem when computational operations are held constant. He worked with a group of four hundred eight subjects and concluded that syntax and vocabulary level can determine difficulty in verbal arithmetic problems.

Knifong and Holtan (1976) designed an investigation in order to analyze children's written solutions to word problems. They worked with thirty-five sixth graders and concluded that reading might account for about 18% of the incorrectly solved
problems. Knifong and Holtan (1977) conducted a follow up of their work in order to search for reading difficulties among the erred word problems of their first investigation. Four to six weeks after the written test each of the thirty-five students was interviewed. They found that poor reading ability accounts for no more than 10% of the errors.

Ley, Henry, and Rowsey (1979) conducted a study with a group of one hundred fifty-two eighth grade students from science classes. Their purpose was to determine whether reading ability and computational skills are related positively to student performance on science-related word problems. They found that literal comprehension was highly correlated to problem solution.

Clements (1980) reported some data from research works by himself, by Newman, and by Casey. He stated that many errors made by children on written mathematical tasks are due among other variables to reading and reading comprehension.

Glynn (1981) conducted a study to determine relative contribution of the two variables reading comprehension ability and arithmetic computational ability to the successful solution of arithmetic word problems. Two hundred sixth grade students participated in the study. She found that reading comprehension ability contributes to success in the solution of arithmetic word problems, but the findings were not significant.
Several educators and researchers agreed that reading in mathematics requires many different reading skills that should be acquired in order to be able to work successfully in problem solving. Riley and Pachtman (1978) stated that "unlike the language of narrative material, the language of word problem is compact. Mathematical concepts and relationships are often 'hidden' or assumed and therefore not readily apparent to the student." In reading mathematics the student must read and interpret words, letters, charts and graphs, numerals, formulas, and several different signs and symbols (Collier and Redmond, 1974; Weintraub, 1967; Hater et al., 1974). In relation to mathematical vocabulary, educators agreed that students must understand the different kinds of vocabulary they read in mathematical materials, including general, technical, and symbolic vocabularies (Dunlap and Mcknight, 1978; Pachtman and Riley, 1978; Barney, 1972).

Several studies supported the need for teaching reading skills applicable to reading mathematics. Earp (1970) reported the study by Call and Wiggin who compared the effects of two approaches to teach problem solving. Call, an experienced mathematics teacher, taught a unit on problem solving using a conventional teaching approach with the control group. Wiggin, an English teacher with little training in mathematics, taught the experimental group the same unit with emphasis on vocabulary, use of content to get meaning and other skills. This
experiment was conducted with high school students. The results, according to the authors, indicated that the experimental group (who was taught the language skills) did better, even when reading abilities and mathematical aptitude were controlled.

Parler (1974) found no significant difference working with two seventh grade and two sixth grade classes when she compared the results of the experimental group which received six weeks of instruction in general reading skills in the regular mathematics lessons to the control group which was taught in the normal way without the reading instruction.

Muraski (1978) conducted a study which explored the effects of a five-week program on the reading of mathematics in the problem solving abilities of thirteen sixth graders. She concluded that, according to the statistical tests, the gains on problem solving in the experimental group were significant at the 0.005 level.

The relation between reading ability and problem solving success has received considerable attention in recent research works. However, the relationship is not clear. Even though there is considerable evidence that reading ability affects problem solving performances, there is also support for the assumption that reading is not a major determiner in problem solving success.
d. **Computational ability.** Several research studies have explored the relationship between success in verbal problem solving and computational ability. Suydam and Weaver, summarizing several studies (1977), stated that computation difficulties seemed to be a major cause for not succeeding in solving problems. Hollander (1978) reported several studies that investigated this relationship. She reported Stevens' study which found that ability in fundamental operations was most closely related to problem solving ability when general reading ability was held constant. Hansen (also reported by Hollander) working with a group of six hundred eighty-one sixth graders concluded that the factors related to numbers were closely related to success in problem solving.

Several researchers have studied computational ability and reading ability as variables closely related to success in verbal problem solving. The following studies were already reported and described above in section C, related to reading ability. Two major conclusions regarding computational ability and success in problem solving emerge from these studies. First, computational ability in combination with other variables, such as reading ability, is a predictor of problem solving success (Chase, 1960; and Martin, 1963). Second, computational ability is a variable that has a significant effect on problem solving ability (Ballow, 1964; Knifong and Holtan, 1976; and Glynn, 1981).
The studies reported above showed that computational ability is one of the factors that plays a major role in determining problem solving success.

The literature reviewed suggests in the first place that problem solving success depend upon a combination of several variables, such as length of the problem, the presence of extraneous information, reading ability, and computational ability. Secondly, that there is a need to investigate the effect of length of the problem and the presence or absence of extraneous information on problem solving performances. Thirdly, reading ability and computational ability are elements involved in successful problem solving. There is no agreement among researchers about the extent to which reading ability and computational ability are involved in successful word problem solving.
CHAPTER III

METHODOLOGY

The purpose of this study was to investigate the relationships between the ability to solve arithmetic word problems of Costa Rican fourth and sixth grade students, and the following four variables: length of the problem statement, the presence or absence of extraneous information, reading ability, and computational ability. The following sections are included in this chapter: 1) a description of the subjects who participated in this study, 2) the instruments used for data collection, 3) the results of the pilot study, 4) the procedure for data collection, and 5) the methods used for analysis of the data.

Subjects

Thirty schools were randomly selected using the table of random numbers presented by Minium (1978) and the official list of Costa Rican schools published by the Ministry of Education of Costa Rica (1980). These thirty schools are located in the sub-region San José of the Central Region of Costa Rica. In order to use the official list of schools for the random
selection, the schools of the sub-region San José were num-
bered taking into consideration the three different categories
of schools found throughout the region: public rural, public
urban, and private schools. The public rural schools were
numbered from 01 to 77, the public urban schools from 01 to
103, and the private schools from 01 to 27. To select the
grade four subjects the table of random numbers was used to
select seven rural schools, eight urban schools, and three
private schools. To select the grade six subjects the same
procedure was used and seven rural schools, eight urban schools,
and three private schools were selected. According to the Min-
istry of Education of Costa Rica (1979) the average number of
pupils per classroom in primary schools was twenty-eight.
Therefore, in order to have a sample of approximately eight
hundred subjects thirty school groups were selected.

The total number of schools in the sub-region San José
was 207. This consists of 103 public urban, 77 public rural,
and 27 private schools. In other words 50 per cent of the
total number of schools in sub-region San José are public urban,
38 per cent are public rural, and 12 per cent are private
schools. An effort was made to have the sample group of eight
hundred consist of 50 per cent (404) children from public urban
schools, 38 per cent (304) children from public rural schools
and 12 per cent (96) children from private schools.

Table 1 shows the distribution of schools, students, and
levels of sample group, by categories of schools.
# TABLE 1

DISTRIBUTION OF SCHOOLS, STUDENTS, AND LEVELS OF SAMPLE GROUP, BY CATEGORIES OF SCHOOLS.

<table>
<thead>
<tr>
<th>Schools from Central Region, Sub-region San Jose</th>
<th>The Sub-region</th>
<th>The Sample</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td># of schools</td>
<td>% of schools</td>
</tr>
<tr>
<td>PUBLIC URBAN</td>
<td>103</td>
<td>50%</td>
</tr>
<tr>
<td>PUBLIC RURAL</td>
<td>77</td>
<td>38%</td>
</tr>
<tr>
<td>PRIVATE</td>
<td>27</td>
<td>12%</td>
</tr>
<tr>
<td>Total</td>
<td>207</td>
<td>100%</td>
</tr>
</tbody>
</table>

(*) 28 children per classroom.
Since the schools visited had one, two or more fourth or sixth grade groups, the principal of the school selected the group to be worked with by the author.

Anticipating the possibility of not being able to obtain data from some selected schools, one extra group at each grade level was randomly selected in each of the different school categories: public urban, public rural, and private schools. Table 2 shows the list of schools obtained from the random selection.
<table>
<thead>
<tr>
<th>Public Urban, Grade Four</th>
<th>Republica del Paraguay</th>
<th>Rogelio Fernandez Güell</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>República de Venezuela</td>
<td>Lic. Claudio Cortés C.</td>
</tr>
<tr>
<td></td>
<td>República de Panamá</td>
<td>Virgen Poderosa</td>
</tr>
<tr>
<td></td>
<td>República Argentina No. 1</td>
<td>Joaquín García Monge *</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Public Rural, Grade Four</th>
<th>Salitral</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>República de Francia</td>
</tr>
<tr>
<td></td>
<td>Morado</td>
</tr>
<tr>
<td></td>
<td>Juan Flores</td>
</tr>
<tr>
<td></td>
<td>José Fabio Garnier</td>
</tr>
<tr>
<td></td>
<td>Santiago Alpízar Jiménez</td>
</tr>
<tr>
<td></td>
<td>Isabel la Católica *</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Private, Grade Four</th>
<th>Saint Anthony School</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Saint Francis Primary School</td>
</tr>
<tr>
<td></td>
<td>El Rosario *</td>
</tr>
</tbody>
</table>
Public Urban. Grade Six
Republíca de Venezuela
Esmeralda O. de Jiménez No. 1
Republíca del Paraguay
Napoleón Quesada Salazar
Juan Santamaría
Naciones Unidas
Unidad Educativa México
Miguel de Cervantes S. *

Public Rural. Grade Six
Manuel Ortúñio Boutin
Llano Bonito
Ninfa Cabezas
Pabellón
Quebrada Honda
Tomás de Acosta
José María Cañas *

Private. Grade Six
Católica Activa
Salesiano Don Bosco
Santa Catalina de Sena *

Note: The schools marked with * are the extra schools selected.
The sample included 398 fourth graders and 397 sixth graders. Of these 795 children 389 were enrolled in public urban schools, 243 were in public rural schools, and the remaining 163 children were in private schools. Table 3 shows the composition of the sample at each grade level and in each of the three different categories of schools.

TABLE 3

COMPOSITION OF THE SAMPLE GROUP
BY CATEGORIES OF SCHOOLS

<table>
<thead>
<tr>
<th>Grade Four</th>
<th>Grade Six</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Urban</td>
<td>201</td>
<td>188</td>
</tr>
<tr>
<td>Public Rural</td>
<td>117</td>
<td>126</td>
</tr>
<tr>
<td>Private</td>
<td>80</td>
<td>83</td>
</tr>
<tr>
<td>TOTAL</td>
<td>398</td>
<td>397</td>
</tr>
</tbody>
</table>

The decision to collect the data from grades four and six was based on the structure of the Costa Rican educational system. Grade four is the first year of the second three year cycle. At this level, the student is supposed to have met the academic requirements established by the Ministry of Education at the end of the first three year cycle. For instance, in the area of computation the students must be able to add, subtract, multiply, and divide natural numbers less than ten thousand at the
end of the first cycle (Ministerio de Educación Pública, 1977). Grade six is the third year of the second cycle and also the last year of primary school education. At the end of this year the students should have met the minimum academic standards required by the Ministry of Education in order to be able to receive the primary school diploma. Therefore, the author of this study identified fourth and sixth grades as the two school levels at which this study would be conducted.

**Instruments**

Three instruments were developed for use in this study: 1) the arithmetic word problem test, 2) a reading comprehension test, and 3) a test of computation.

1. **Arithmetic Word Problem Test.** This instrument was an eight item questionnaire designed originally in Spanish by the author of this study. This instrument was presented in six different basic forms. See Appendix A.

These eight items were arithmetic word problems. The first two items were warm-up problems, and they were the same for all forms of the test. These two problems were written in the typical format, the kind of problems with which the students were familiar. One problem was a one step problem requiring multiplication. The other was a two step problem requiring addition and subtraction. The purpose of presenting the warm-up problems was for the students to start working with the
kind of problems they knew. In other words, it was hoped the
students would feel confident in solving the problems.

The other six problems were designed in three different
formats: prose, typical, and short. From each prose multipli-
cation problem without extraneous information and from each
prose division problem without extraneous information one
typical and one short problem were obtained. The following
is an example of a prose problem without extraneous information
and the typical and the short problems without extraneous in-
formation generated by this prose problem:

Once upon a time Uncle Rabbit was invited to the
wedding of the Little Dora, the duck who was about
to get married to Rick Duck.
On the wedding day Uncle Rabbit woke up quite early
in the morning because he had to walk a distance of
7482 meters. He wore new pink shoes and a very fine
cotton coat. He also put on a fabric hat and tied
a red silk handkerchief around his neck. He used
his best cologne, groomed his moustache and left for
the wedding.
When he was going to the church, he stopped by Uncle
Tiger's store, bought the wedding present and some
band-aid strips because his new shoes hurt him.
Poor Uncle Rabbit arrived at the party with his shoes
in his hands and his toes wrapped with band-aid strips.
The party was a lot of fun and Uncle Rabbit, despite
the hurt in his feet, danced all the time with Aunt
Weasel.
Uncle Rabbit spent 6 hours walking back to his house
because he had to walk very slowly. How many meters
did he walk in 1 hour?

The related typical problem without extraneous information is:

Uncle Rabbit walked quite slowly with his new shoes.
He walked only 7482 meters in 6 hours. How many
meters did he walk in 1 hour?
The related short problem without extraneous information is:

748 meters in 6 hours.
Meters walked in 1 hour?

Finally, extraneous information was added in order to obtain prose problems with extraneous information and their corresponding typical and short problems with extraneous information.

The following is an example of prose problem with extraneous information and the typical and the short problems with extraneous information generated by this prose problem:

Once upon a time Uncle Rabbit was invited to the wedding of Little Dora, the duck who was about to get married to Rick Duck. On the wedding day Uncle Rabbit woke up quite early in the morning because he had to walk a distance of 7482 meters. He wore new pink shoes worth 258 colones and a very fine cotton coat. He also put on a fabric hat and tied a red silk handkerchief around his neck. He used his best cologne, groomed his moustache and left for the wedding. When he was going to the church, he stopped by Uncle Tiger's store, bought the wedding present and some band-aid strips because his new shoes hurt him. Poor Uncle Rabbit arrived at the party with his shoes in his hands and his toes wrapped with band-aid strips. The party was a lot of fun and Uncle Rabbit, despite the hurt in his feet, danced all the time with Aunt Weasel. Uncle Rabbit spent 6 hours walking back to his house because he had to walk very slowly. How many meters did he walk in 1 hour?

The related typical problem with extraneous information is:

Uncle Rabbit walked 7482 meters in 6 hours with new shoes worth 258 colones. How many meters did he walk in 1 hour?
The related short problem with extraneous information is:

7482 meters in 6 hours.
Shoes worth 258 colones.
How many meters in 1 hour?

The typical and short problems present in this study are the kind of problems that LeBlanc et al. (1980) presented as the type of problems that are found in a standard mathematics textbook for the middle grades.

Table 4 shows the different kinds of problems included in this instrument: multiplication or division problems presented in prose, typical, or short formats, with or without extraneous information.

The instrument was presented in six different basic forms (Appendix A). Each form contained six different problems, two prose, two typical, and two short, in addition to the warm-up problems. Three of them were multiplication problems and the other three were division problems. Three problems contained extraneous information and the other three did not. Table 5 shows in detail the composition of the six basic forms of the test named A, B, C, D, E, F.

Each basic form generated six derived forms in which the order of the problems was changed to spread across the sample any possible effects due to order which the subjects encounter with the problems. The six derived forms of the basic form A are included in Appendix B. The problems maintained the original number that they had in the basic form in order to facilitate the scoring of questionnaires and the analysis of the data.
<table>
<thead>
<tr>
<th>With Extranous Information</th>
<th>PROBLEM # MULTIPLIC.</th>
<th>PROBLEM # DIVISION</th>
</tr>
</thead>
<tbody>
<tr>
<td>PROSE</td>
<td>a       b       c</td>
<td>1 2 3</td>
</tr>
<tr>
<td>TYPICAL</td>
<td>d       e       f</td>
<td>IV V VI</td>
</tr>
<tr>
<td>SHORT</td>
<td>g       h       i</td>
<td>VII VIII IX</td>
</tr>
<tr>
<td>Without Extranous Information</td>
<td>PROSE</td>
<td>k       l       m</td>
</tr>
<tr>
<td>TYPICAL</td>
<td>n       o       p</td>
<td>XIII XIV XV</td>
</tr>
<tr>
<td>SHORT</td>
<td>q       r       s</td>
<td>XVI XVII XVIII</td>
</tr>
</tbody>
</table>
TABLE 5
THE SIX BASIC FORMS
OF INSTRUMENT NUMBER ONE

<table>
<thead>
<tr>
<th>MULTIPLICATION</th>
<th>DIVISION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PROSE</td>
</tr>
<tr>
<td>TEST A</td>
<td>a</td>
</tr>
<tr>
<td>TEST B</td>
<td>b</td>
</tr>
<tr>
<td>TEST C</td>
<td>c</td>
</tr>
<tr>
<td>TEST D</td>
<td>k</td>
</tr>
<tr>
<td>TEST E</td>
<td>l</td>
</tr>
<tr>
<td>TEST F</td>
<td>m</td>
</tr>
</tbody>
</table>
The Fry readability formula for Spanish language (Guilliam, Peña, and Mountain, 1980) was applied to measure the readability of the prose format problems. The levels of readability obtained were adequate for grade four according to this formula.

2. **Reading Comprehension Test.** This instrument was a cloze type test designed to assess reading comprehension ability. The instrument was written in Spanish and was constructed following the required steps: 1) the length of the story was two hundred fifty words; 2) the first and last sentences remained intact; 3) the word deletions started in the second sentence and the first word deleted was randomly selected; and 4) from that word every fifth word thereafter was deleted until there were fifty words deleted (Appendix A). In scoring the test, only responses that gave the exact word that was deleted were accepted as correct, synonyms were not accepted.

The cloze technique has been recommended by several investigators as a tool for measuring reading comprehension. Kaminsky (1979) stated that the reader's performance working in a cloze test is closely related to the mental processes required for comprehension in reading. In the process of reading the reader must use the text to make appropriate predictions about its meaning. The reader must make an educated guess in order to fill the blanks with the appropriate word. Russell (1978) stated that "the better guesser the student is, the
the better he comprehends the story."

Another reason for which the cloze type test was used in this study was because it can be administered to an entire group at once and with relatively little examiner training (Russell, 1978).

A Spanish readability formula presented by Spaulding (1956) was used to measure the readability of the cloze test. The level of readability was adequate for fourth grade level according to this formula. The difficulty index obtained was 72.4. It indicates that the "relative reading difficulty" of the material measured was easy according to the readability graph.

3. Test of Computation. This instrument was an eight item test that was used to assess student ability to perform the arithmetic computations present in the arithmetic word problem test. The eight arithmetic computations were exactly the same operations the students used when working on word problems in instrument number one (the arithmetic word problem test). See Appendix A.

The eight computations were designed taking into consideration the following facts:

1. The grade level of the subjects of the sample group. Thus, the computations were appropriate for fourth graders according to the Costa Rican mathematics program (Ministerio
2. The multiplications were designed having the following characteristics: a one digit multiplier (which was a six or a seven); four digits smaller than six in the multiplicand (only in one multiplication there was an eight); and no zeros in the multiplicand (carrying only in two digits). According to several researchers the difficult facts consist mainly of 6, 7, 8 or 9 as multipliers when the digits in the multiplicand are greater than five (Smith, 1921; Buswell and Judd, 1925; Washburne and Vogel, 1928; and Spitzer, 1954). They also agreed that zero as a factor causes difficulties.

3. The divisions were designed having the following characteristics: a digit divisor that was six or eight; four digits in the dividend (no zeros); and a remainder only in the first two digits. The division facts present in this instrument were not considered to be the hardest according to the research presented by Buswell and Judd, 1925; Washburne and Vogel, 1928; and Spitzer, 1954.

All three of the instruments were designed by the author of this study and were read by a Costa Rican professor, Dr. Víctor Buján, who has experience in mathematics teaching at different levels. The instruments were critiqued by four other Costa Rican teachers who were graduate students at The Ohio State University.
Five Spanish-speaking children from grades four to seven responded to initial drafts of the three instruments used in this study. As a result of the observations offered by the Costa Rican teachers and the work of the Spanish-speaking children some modifications were introduced in the instruments. For example, the numerical information in the prose problems was placed in a variety of positions within the story, not only in the last paragraph. There were other modifications related to grammar and vocabulary.

Results of the Pilot Study

A pilot study was conducted in three fourth grade groups and three sixth grade groups in two schools in San José, Costa Rica, during the third week of April, 1983. One hundred sixty-two students answered the three instruments: the arithmetic word problem test, the reading comprehension test, and the test of computation (Appendix A). Each student answered two different forms of the arithmetic word problem test on two different days. For instance, one fourth grade worked with form A of the test one day, and with form B a second day, and on the third day they answered the reading comprehension test and the test of computation.

The students' scores of the arithmetic word problem test were analyzed using the program STATPACK ITEMA computer program (O.S.U., 1977). Table 6 shows that the estimate of the reliability of forms A through F of the arithmetic word problem test
<table>
<thead>
<tr>
<th>TYPE OF QUESTIONNAIRE</th>
<th>NUMBER OF STUDENTS</th>
<th>MEAN TEST SCORE</th>
<th>STANDARD DEVIATION</th>
<th>KR-20</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>58</td>
<td>3.22</td>
<td>2.17</td>
<td>0.73</td>
</tr>
<tr>
<td>B</td>
<td>53</td>
<td>3.66</td>
<td>2.39</td>
<td>0.81</td>
</tr>
<tr>
<td>C</td>
<td>48</td>
<td>3.42</td>
<td>2.36</td>
<td>0.78</td>
</tr>
<tr>
<td>D</td>
<td>57</td>
<td>3.54</td>
<td>2.66</td>
<td>0.85</td>
</tr>
<tr>
<td>E</td>
<td>54</td>
<td>2.81</td>
<td>2.20</td>
<td>0.76</td>
</tr>
<tr>
<td>F</td>
<td>54</td>
<td>4.02</td>
<td>2.51</td>
<td>0.81</td>
</tr>
</tbody>
</table>
obtained using the Kuder-Richardson formula number twenty (K_{20}) is acceptable as each is in excess of 0.70.

Table 7 presents the point biserial correlation coefficient of items three through eight of the six forms A through F of the arithmetic word problem test. The point biserial correlation coefficient shows the relationship of the item to the total score on the test giving another measure of the reliability of that item. For instance, the point biserial for item number three of form A is 0.70 which is acceptable as it is in excess of 0.50. In the same form A the point biserial for item number five is 0.36 which is rather low.

Table 8 shows the relative difficulty and the discrimination index of items three through eight of the six questionnaire forms. The relative difficulty of the item is the percentage of students missing the item. As the percentage increases the item is more difficult. For instance, item five of form A has a percentage of 0.91, this means that this item is rather difficult. The discrimination index reflects the degree to which the item discriminates between the upper and lower groups. It is important to observe that items which are rather difficult show a rather low discrimination index such as item five form A with a discrimination index of 28.6.
TABLE 7
POINT BISERIAL CORRELATION COEFFICIENT
OF ITEMS THREE THROUGH EIGHT
BY TYPE OF QUESTIONNAIRE
PILOT STUDY

<table>
<thead>
<tr>
<th>ITEM NUMBER</th>
<th>TYPE OF QUESTIONNAIRE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A (n=58)</td>
</tr>
<tr>
<td>3</td>
<td>0.70</td>
</tr>
<tr>
<td>4</td>
<td>0.58</td>
</tr>
<tr>
<td>5</td>
<td>0.36</td>
</tr>
<tr>
<td>6</td>
<td>0.64</td>
</tr>
<tr>
<td>7</td>
<td>0.61</td>
</tr>
<tr>
<td>8</td>
<td>0.70</td>
</tr>
</tbody>
</table>
TABLE 8
RELATIVE DIFFICULTY AND DISCRIMINATION INDEX OF ITEMS THREE THROUGH EIGHT
BY TYPE OF QUESTIONNAIRE
PILOT STUDY

<table>
<thead>
<tr>
<th>ITEM NUMBER</th>
<th>TYPE OF QUESTIONNAIRE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>3</td>
<td>0.53\textsuperscript{a} &amp; 100.0\textsuperscript{b} &amp; 0.66 &amp; 82.4 &amp; 0.65 &amp; 84.6 &amp; 0.44 &amp; 93.8 &amp; 0.60 &amp; 66.7 &amp; 0.50 &amp; 87.3</td>
</tr>
<tr>
<td>4</td>
<td>0.55 &amp; 78.6 &amp; 0.38 &amp; 88.2 &amp; 0.56 &amp; 92.3 &amp; 0.70 &amp; 68.8 &amp; 0.69 &amp; 83.3 &amp; 0.52 &amp; 94.4</td>
</tr>
<tr>
<td>5</td>
<td>0.91 &amp; 28.6 &amp; 0.83 &amp; 29.4 &amp; 0.67 &amp; 69.2 &amp; 0.53 &amp; 93.8 &amp; 0.70 &amp; 55.6 &amp; 0.43 &amp; 76.2</td>
</tr>
<tr>
<td>6</td>
<td>0.50 &amp; 92.9 &amp; 0.51 &amp; 94.1 &amp; 0.73 &amp; 76.9 &amp; 0.72 &amp; 81.3 &amp; 0.89 &amp; 22.2 &amp; 0.74 &amp; 57.1</td>
</tr>
<tr>
<td>7</td>
<td>0.74 &amp; 64.3 &amp; 0.76 &amp; 76.5 &amp; 0.65 &amp; 92.3 &amp; 0.60 &amp; 100.0 &amp; 0.69 &amp; 83.3 &amp; 0.50 &amp; 94.4</td>
</tr>
<tr>
<td>8</td>
<td>0.67 &amp; 78.6 &amp; 0.57 &amp; 82.4 &amp; 0.54 &amp; 92.3 &amp; 0.74 &amp; 87.5 &amp; 0.74 &amp; 77.8 &amp; 0.59 &amp; 74.6</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Relative difficulty of the item. Percentage of students missing the item.

\textsuperscript{b} Discrimination index.
The scores obtained in the reading comprehension test were analyzed using the SPSS program FREQUENCIES (Hull and Nie, 1981). Table 9 shows that the mean of the reading comprehension test is 49.2% which is acceptable for this cloze type test.

TABLE 9
ANALYSIS OF THE READING COMPREHENSION TEST PILOT STUDY

<table>
<thead>
<tr>
<th>statistic</th>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>49.2%</td>
</tr>
<tr>
<td>Median</td>
<td>50.7%</td>
</tr>
<tr>
<td>Mode</td>
<td>52.0%</td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>11.9</td>
</tr>
<tr>
<td>Minimum</td>
<td>0.0%</td>
</tr>
<tr>
<td>Maximum</td>
<td>72.0%</td>
</tr>
</tbody>
</table>

Data Collection. Procedure

During the first week of June, 1983, permission from the Costa Rican Ministry of Education was obtained in order to administer the instruments to the school groups of the sample (Table 2). The written permission from the Director of Operations Division (Director de la División de Operaciones) of the Costa Rican Ministry of Education can be found in Appendix C.
The investigator and her husband, a professor at the University of Costa Rica, visited and administered the three instruments to the thirty school groups during the last three weeks of June, 1983. Each school group was visited twice. During the first visit the arithmetic word problem test was administered. The reading comprehension test and the test of computation were administered during the second visit. This order of administering the tests controlled the interaction between each student's performance on the arithmetic word problem test and the test of computation.

In most of the schools the principals permitted the researcher to visit the classrooms the very same day the permission was requested. In a few schools it was necessary to talk to the teacher first and make a special appointment. Each classroom session required approximately fifty minutes. The first five minutes were used to make a short explanation of the work and to give instructions about where to perform the arithmetic computations and where to place the answers to the problems.

For each classroom a package of thirty-six arithmetic word problem questionnaires was prepared. In each package, there were six derived forms of the basic form A: A1, A2, A3,..., A6; six derived forms of the basic form B: B1, B2, B3,..., B6, etc. In a word, there were thirty-six different questionnaires in one package. Thus, every student received
a questionnaire different from the others. Rotating the forms for every classroom assumed that interpretations of results would be generalizable.

On the average the students needed forty minutes to work on the questionnaires. It is important to point out that most of the classroom teachers were present in the classroom while the instruments were administered, thus the students who finished the work early were attended by the teacher.

It was necessary to work in two rural schools that were selected as extra groups (Table 2) because one of the schools selected for the sample was closed and another could not be reached for the road was in very bad condition.

Analysis of the Data

The data collected in this study includes the scores of the three instruments described above: the arithmetic word problem test, the reading comprehension test, and the test of computation.

A total score involving the eight items in instrument number one was computed. Six subscores were computed based on the student's performance on the arithmetic word problem test taking into account the factors problem length and format. The subscores were short format with or without extraneous information, typical format with or without extraneous information, and prose format with or without extraneous information.
Total scores were computed for each of the other two instruments (reading comprehension test and the test of computation). Analysis of the data was performed obtaining frequency distributions, correlation coefficients, cross tabulations, and analysis of variance. These analyses were accomplished using programs from the STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES, SPSS (Nie et al., 1975; and Hull and Nie, 1981); and the SOUPAC program (O.S.U.). A complete description of the statistical results is reported in Chapter Four.
CHAPTER IV

ANALYSIS OF THE DATA

The purpose of this study was to analyze the relationships between the ability to solve arithmetic word problems and the following variables: length of the problem statement, the presence or absence of extraneous information, reading ability, and computational ability. The results of this study are presented in three sections. The first section describes the composition of the sample group. The second focuses on the analysis of the responses given by the subjects to the three instruments. Section three reports for each of the hypotheses.

Composition of the Sample

Thirty schools were randomly selected from the schools of the sub-region San José of the Central Region of Costa Rica. The sample group consisted of seven hundred ninety-five Costa Rican students of grades four and six. The students were from three different types of schools: rural public, urban public, and private. Each form was answered by a sample of students that proportionately the characteristics of the entire
Responses Given by the Subjects

Figure 1 shows the percents of correct answers given by the subjects in the arithmetic word problem test by grade level, type of school and problem format. The percentages of correct answers given by the fourth grade subjects of urban and private schools are quite similar on the three different problem formats (short, typical, and prose), but percentages for students from rural schools are quite low in the three different problem formats in relation to urban and private schools. The percentages of correct answers given by sixth graders are higher on all three different problem formats when compared to fourth grade scores. In sixth grade the highest percentages of correct answers on each format were obtained in private schools, with low scores again found in rural schools.

Table 10 shows the number and percentages of correct answers on problems with and without extraneous information by problem format (short, typical, and prose), and grade level. Problems with extraneous information are more difficult whatever the format. Sixth graders performed better than fourth graders.

Figure 2 shows the percentages of correct answers on problems with and without extraneous information by format of problem and grade level. Students performed better on problems without extraneous information.
FIGURE 1

PERCENTS OF CORRECT ANSWERS GIVEN BY 795 SUBJECTS IN THE ARITHMETIC WORD PROBLEM TEST, BY GRADE LEVEL, TYPE OF SCHOOL, AND TYPE OF PROBLEM.
FIGURE 2
PERCENTAGES OF CORRECT ANSWERS ON PROBLEMS
WITH AND WITHOUT EXTRANEOUS INFORMATION
BY FORMAT OF PROBLEM AND GRADE LEVEL
398 FOURTH GRADERS (LIGHT BARS)
AND 397 SIXTH GRADERS (DARK BARS)
TABLE 10
NUMBERS AND PERCENTAGES OF CORRECT ANSWERS ON PROBLEMS WITH AND WITHOUT EXTRANEOUS INFORMATION BY FORMAT OF PROBLEM AND GRADE LEVEL

<table>
<thead>
<tr>
<th>FORMAT OF PROBLEM</th>
<th>SHORT</th>
<th>TYPICAL</th>
<th>PROSE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Grade Four</td>
<td>Grade Six</td>
<td>Grade Four</td>
</tr>
<tr>
<td>WITH EXTRANEOUS INFORMATION</td>
<td>54</td>
<td>13.6%</td>
<td>148</td>
</tr>
<tr>
<td>WITHOUT EXTRANEOUS INFORMATION</td>
<td>114</td>
<td>28.6%</td>
<td>227</td>
</tr>
</tbody>
</table>

Table 11 shows the number and percentages of correct answers on multiplication and division problems by problem format (short, typical, and prose). Division problems were more difficult than multiplication problems, especially on typical and prose format.
Table 11 shows the number and percentages of correct answers on multiplication and division problems with and without extraneous information. The percentages of correct answers for multiplication problems both with and without extraneous information were higher than the percentages for division problems of either type. The percentages of correct answers for each operation (multiplication and division) were higher for the problems without extraneous information than for problems with extraneous information.

<table>
<thead>
<tr>
<th>FORMAT OF PROBLEM</th>
<th>SHORT</th>
<th>TYPICAL</th>
<th>PROSE</th>
</tr>
</thead>
<tbody>
<tr>
<td>MULTIPLICATION</td>
<td>277</td>
<td>329</td>
<td>342</td>
</tr>
<tr>
<td></td>
<td>38.8%</td>
<td>41.4%</td>
<td>43.0%</td>
</tr>
<tr>
<td></td>
<td>n=795</td>
<td>n=795</td>
<td>n=795</td>
</tr>
<tr>
<td>DIVISION</td>
<td>266</td>
<td>289</td>
<td>255</td>
</tr>
<tr>
<td></td>
<td>33.5%</td>
<td>36.4</td>
<td>32.1%</td>
</tr>
<tr>
<td></td>
<td>n=795</td>
<td>n=795</td>
<td>n=795</td>
</tr>
</tbody>
</table>
TABLE 12
NUMBERS AND PERCENTAGES OF CORRECT ANSWERS
ON MULTIPLICATION AND DIVISION PROBLEMS
WITH AND WITHOUT EXTRANEOUS INFORMATION

<table>
<thead>
<tr>
<th></th>
<th>WITH EXTRANEOUS INFORMATION</th>
<th>WITHOUT EXTRANEOUS INFORMATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>MULTIPLICA...</td>
<td>511 35.3%</td>
<td>620 46.5%</td>
</tr>
<tr>
<td>n=1448</td>
<td></td>
<td>n=1333</td>
</tr>
<tr>
<td>DIVISION</td>
<td>389 29.2%</td>
<td>550 38.0%</td>
</tr>
<tr>
<td>n=1333</td>
<td></td>
<td>n=1448</td>
</tr>
</tbody>
</table>

Tables 13 and 14 present the distribution of students by number of correct answers obtained on the arithmetic word problem test and by number of correct answers obtained on the test of computation in fourth and sixth grade, respectively. These tables show that there is a rather high percent of students who answered correctly more than half of the computation items but only half or less of the arithmetic word problems. In fact
Table 13

DISTRIBUTION OF THE SUBJECTS BY NUMBER OF CORRECT ANSWERS OBTAINED IN THE ARITHMETIC WORD PROBLEM TEST AND BY NUMBER OF CORRECT ANSWERS OBTAINED IN THE TEST OF COMPUTATION

<table>
<thead>
<tr>
<th>NUMBER OF CORRECT ANS. TEST OF COMPUTATION</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>n (row)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
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<td>55</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>71</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>65</td>
</tr>
</tbody>
</table>

The table above shows the distribution of the subjects by the number of correct answers obtained in the arithmetic word problem test and by the number of correct answers obtained in the test of computation for Grade Four.
<table>
<thead>
<tr>
<th>NUMBER OF CORRECT ANSWERS IN ARITHMETIC WORD PROBLEM TEST</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>n (row)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0.0%</td>
<td>50.0%</td>
<td>50.0%</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>50.0%</td>
<td>25.0%</td>
<td>25.0%</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>16.7%</td>
<td>16.7%</td>
<td>33.3%</td>
<td>16.7%</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>23.5%</td>
<td>23.5%</td>
<td>4.8%</td>
<td>19.0%</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>21</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>14.8%</td>
<td>14.8%</td>
<td>25.9%</td>
<td>11.1%</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>27</td>
</tr>
<tr>
<td>6</td>
<td>1</td>
<td>1.7%</td>
<td>10.3%</td>
<td>10.3%</td>
<td>15.3%</td>
<td>22.0%</td>
<td>11</td>
<td>10.6%</td>
<td>13.6%</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>0.0%</td>
<td>3.7%</td>
<td>9.3%</td>
<td>18</td>
<td>13</td>
<td>14</td>
<td>19</td>
<td>23</td>
<td>108</td>
</tr>
<tr>
<td>8</td>
<td>4</td>
<td>2.4%</td>
<td>5.9%</td>
<td>5.9%</td>
<td>4.7%</td>
<td>11.8%</td>
<td>20</td>
<td>19</td>
<td>28</td>
<td>39</td>
</tr>
</tbody>
</table>

TABLE 14
DISTRIBUTION OF THE SUBJECTS BY NUMBER OF CORRECT ANSWERS OBTAINED IN THE ARITHMETIC WORD PROBLEM TEST AND BY NUMBER OF CORRECT ANSWERS OBTAINED IN THE TEST OF COMPUTATION GRADE SIX
82.0% of fourth graders and 41.5% of sixth graders fit this category.

Table 15 compares each item of the test of computation to the corresponding word problem. The second column shows the number and percentage of students who answered the computation and the corresponding word problem incorrectly. The third and fourth columns show the number and percentage of students who answered one or the other correctly but not both. The fifth column shows the number and percentage of students who answered both the computation and the corresponding word problem correctly. This table shows that there was a rather high percentage (39.2%) of students who answered the computation correctly and the corresponding word problem incorrectly. This percentage is greater than the percentage of students who answered both the computation and the corresponding word problem correctly. Thus many students who could perform the computations but could not apply the computations to problem situations.

Figure 2 shows the same information presented in Table 15. For example, 45.7% of the students answered the multiplication item "2142 x 6" correctly but missed the corresponding word problem.
<table>
<thead>
<tr>
<th>COMPUTATION</th>
<th>BOTH INCORRECT</th>
<th>ONLY PROBLEM CORRECT</th>
<th>ONLY COMPUTATION CORRECT</th>
<th>BOTH CORRECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>2142 X 6</td>
<td>38 4.8%</td>
<td>107 13.5%</td>
<td>363 45.7%</td>
<td>287 36.1%</td>
</tr>
<tr>
<td>2751 X 7</td>
<td>34 4.3%</td>
<td>187 23.5%</td>
<td>292 36.7%</td>
<td>282 35.5%</td>
</tr>
<tr>
<td>1782 + 6</td>
<td>28 3.5%</td>
<td>230 28.9%</td>
<td>275 34.6%</td>
<td>262 33.0%</td>
</tr>
<tr>
<td>7482 + 6</td>
<td>15 1.9%</td>
<td>199 25.0%</td>
<td>364 45.8%</td>
<td>217 27.3%</td>
</tr>
<tr>
<td>3312 + 6</td>
<td>32 4.0%</td>
<td>239 30.1%</td>
<td>268 33.7%</td>
<td>256 32.2%</td>
</tr>
<tr>
<td>4150 X 6</td>
<td>44 5.5%</td>
<td>181 22.8%</td>
<td>307 38.6%</td>
<td>263 33.1%</td>
</tr>
<tr>
<td></td>
<td>191 4.0%</td>
<td>1143 24.0%</td>
<td>1869 39.2%</td>
<td>1567 32.9%</td>
</tr>
</tbody>
</table>
FIGURE 3
CORRESPONDENCE BETWEEN COMPUTATION ITEMS AND THEIR CORRESPONDING PROBLEMS
TOTAL SAMPLE GROUP. n = 795
Testing Hypotheses

The design for the analysis of the arithmetic word problem data involves four factors (variables): 1) problem format (short, typical, and prose); 2) problem content (with or without extraneous information); 3) type of school (rural, urban, and private); and 4) grade level (fourth and sixth). These variables were arranged as seen in Table 16.

Since individual students are unique to each school and grade level combination and the arithmetic word problem test sequentially elicits responses to questions of unique combinations of problem length (format) and problem content (with or without extraneous information), the appropriate analytic technique involves a combination of repeated measures analysis with an analysis of factors which may cause differences between students.

The particular combination for this study is mixed model analysis of variance (ANOVA) known as a two between subjects, two within subjects ANOVA. This design is particularly efficient because: 1) all sources of variability in problem solving scores are entered simultaneously into the analysis; and 2) it minimizes unknown sources of variability (errors).

Table 16 depicts the means and standard deviations in the arithmetic word problem test by factor levels and cells. The means of fourth and sixth grades from private schools are higher than the means of fourth and sixth grades from urban and rural
TABLE 16
SCORE MEANS AND STANDARD DEVIATIONS
IN THE ARITHMETIC WORD PROBLEM TEST
BY FACTOR LEVELS AND CELLS

<table>
<thead>
<tr>
<th></th>
<th>SHORT</th>
<th>TYPICAL</th>
<th>PROSE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WITH W/O n=770</td>
<td>WITH W/O n=770</td>
<td>WITH W/O n=770</td>
</tr>
<tr>
<td>SHORT</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WITH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>W/O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WITH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>W/O</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prose</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WITH</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>W/O</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RURAL
n=1404

<table>
<thead>
<tr>
<th></th>
<th>4th n=702</th>
<th>6th n=702</th>
</tr>
</thead>
<tbody>
<tr>
<td>WITH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W/O</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WITH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W/O</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prose</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WITH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W/O</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

URBAN
n=2256

<table>
<thead>
<tr>
<th></th>
<th>4th n=1128</th>
<th>6th n=1128</th>
</tr>
</thead>
<tbody>
<tr>
<td>WITH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W/O</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WITH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W/O</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prose</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WITH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W/O</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PRIVATE
n=960

<table>
<thead>
<tr>
<th></th>
<th>4th n=480</th>
<th>6th n=480</th>
</tr>
</thead>
<tbody>
<tr>
<td>WITH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W/O</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WITH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W/O</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prose</td>
<td></td>
<td></td>
</tr>
<tr>
<td>WITH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>W/O</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

NOTE: n = number of observations, not subjects, except within cells. Cell's ns represent both.
schools. The means of fourth and sixth grades from urban schools are higher than the means of fourth and sixth grades from rural schools. The mean of the short problems without extraneous information is higher than the mean of the short problems with extraneous information. The mean of the typical problems without extraneous information is higher than the mean of the typical problems with extraneous information. The mean of the prose problems without extraneous information is higher than the mean of the prose problems with extraneous information.

The results of the analysis of variance are presented in Table 17. This table shows that:

1. There is a significant difference in arithmetic word problem solving ability due to a combination of problem format (short, typical and prose) and problem content (presence or absence of extraneous information) at \( p \leq 0.05 \) level of significance.
2. There is a significant difference in arithmetic word problem solving ability due to a combination of type of school (rural, urban, and private) and problem content at \( p \leq 0.01 \) level of significance.
3. There is a significant difference in arithmetic word problem solving ability between problems with and problems without extraneous information at \( p \leq 0.000001 \) level of significance.
4. There is a significant difference in arithmetic word problem solving ability due to a combination of grade level (fourth and sixth) and problem format at \( p \leq 0.05 \) level of significance.

5. There is a significant difference in problem solving ability between short, typical, and prose format in arithmetic word problems at \( p \leq 0.001 \) level of significance.

6. There is a significant difference in arithmetic word problem solving ability due to a combination of type of school and grade level at \( p \leq 0.05 \) level of significance.

7. There is a significant difference in arithmetic word problem solving ability between students in fourth and sixth grades at \( p \leq 0.000001 \) level of significance.

8. There is a significant difference in arithmetic word problem solving ability between students in rural, urban, and private schools at \( p \leq 0.000001 \) level of significance.
<table>
<thead>
<tr>
<th>Source of variation</th>
<th>DF</th>
<th>Mean square</th>
<th>F</th>
<th>Signif. of F</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Between Ss</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School</td>
<td>2</td>
<td>18.756</td>
<td>44.498</td>
<td>0.000001****</td>
</tr>
<tr>
<td>Grade Level</td>
<td>1</td>
<td>92.014</td>
<td>281.296</td>
<td>0.000001****</td>
</tr>
<tr>
<td>School by Grade Level</td>
<td>2</td>
<td>1.579</td>
<td>3.747</td>
<td>0.02402*</td>
</tr>
<tr>
<td>Subject Within School by Grade (error)</td>
<td>764</td>
<td>0.422</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Within Ss</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Problem Format</td>
<td>2</td>
<td>0.975</td>
<td>7.048</td>
<td>0.00090***</td>
</tr>
<tr>
<td>School by Problem Format</td>
<td>4</td>
<td>0.233</td>
<td>1.829</td>
<td>0.12076</td>
</tr>
<tr>
<td>Grade by Problem Format</td>
<td>2</td>
<td>0.464</td>
<td>3.334</td>
<td>0.03520*</td>
</tr>
<tr>
<td>School by Grade by Pbl. Format</td>
<td>4</td>
<td>0.198</td>
<td>1.422</td>
<td>0.22413</td>
</tr>
<tr>
<td>Subject by Pbl. Format Within School by Grade (error)</td>
<td>1528</td>
<td>0.138</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Problem Content</td>
<td>1</td>
<td>28.052</td>
<td>189.845</td>
<td>0.000001****</td>
</tr>
<tr>
<td>School by Problem Content</td>
<td>2</td>
<td>0.862</td>
<td>5.835</td>
<td>0.00305**</td>
</tr>
<tr>
<td>Grade by Problem Content</td>
<td>1</td>
<td>0.438</td>
<td>3.099</td>
<td>0.07871</td>
</tr>
<tr>
<td>School by Grade by Pbl. Content</td>
<td>2</td>
<td>0.104</td>
<td>0.703</td>
<td>0.49443</td>
</tr>
<tr>
<td>Subject by Pbl. Content Within School by Grade (error)</td>
<td>764</td>
<td>0.148</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Problem Format by Problem Content</td>
<td>2</td>
<td>0.632</td>
<td>3.806</td>
<td>0.02245*</td>
</tr>
<tr>
<td>School by Pbl. Format by Problem Content</td>
<td>4</td>
<td>0.309</td>
<td>1.861</td>
<td>0.11472</td>
</tr>
<tr>
<td>Grade by Pbl. Format by Problem Content</td>
<td>2</td>
<td>0.152</td>
<td>0.917</td>
<td>0.40009</td>
</tr>
<tr>
<td>School by Grade by Pbl. Format</td>
<td>4</td>
<td>0.031</td>
<td>0.307</td>
<td>0.87369</td>
</tr>
<tr>
<td>Subject by Pbl. Format by Pbl. Content</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Within School by Grade by Pbl. Content</td>
<td>1528</td>
<td>0.166</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>4619</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* p ≤ 0.05
** p ≤ 0.01
*** p ≤ 0.001
**** p ≤ 0.000001
Since significant results were obtained in the two-way interaction for problem format (short, typical and prose) and problem content, it is important to study the nature of that interaction. Table 18 shows the means of the arithmetic problem solving test by problem format and problem content. Figure 3 is the graphical representation of the interaction due to a combination of problem format and problem content.

TABLE 18
SCORE MEANS OF THE ARITHMETIC PROBLEM SOLVING TEST
BY PROBLEM FORMAT AND PROBLEM CONTENT

<table>
<thead>
<tr>
<th>FORMAT</th>
<th>WITH</th>
<th>WITHOUT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=2310</td>
<td>n=2310</td>
</tr>
<tr>
<td>SHORT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=1540</td>
<td>$X_{SW}=0.248$</td>
<td>$X_{SW/O}=0.429$</td>
</tr>
<tr>
<td></td>
<td>$n=770$</td>
<td>$n=770$</td>
</tr>
<tr>
<td></td>
<td>$X_S=0.338$</td>
<td></td>
</tr>
<tr>
<td>TYPICAL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=1540</td>
<td>$X_{TW}=0.334$</td>
<td>$X_{TW/O}=0.443$</td>
</tr>
<tr>
<td></td>
<td>$n=770$</td>
<td>$n=770$</td>
</tr>
<tr>
<td></td>
<td>$X_T=0.388$</td>
<td></td>
</tr>
<tr>
<td>PROSE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=1540</td>
<td>$X_{PW}=0.279$</td>
<td>$X_{PW/O}=0.457$</td>
</tr>
<tr>
<td></td>
<td>$n=770$</td>
<td>$n=770$</td>
</tr>
<tr>
<td></td>
<td>$X_P=0.368$</td>
<td></td>
</tr>
</tbody>
</table>

$X_W=0.287$, $X_{W/O}=0.443$
A Tukey's test (HSD = 0.060) was performed for post-hoc analysis. This test showed that it can be stated at a level of statistical significance of $p \leq 0.05$ that:

1. The mean of scores of the typical format problems with extraneous information was significantly higher than the mean of scores of the short format problems with extraneous information.

2. The mean of scores of the short format problems without extraneous information was significantly higher than the mean of scores of the short format problems with extraneous information.
3. The mean of scores of the typical format problems without extraneous information was significantly higher than the mean of scores of the typical format problems with extraneous information.

4. The mean of scores of the prose format problems without extraneous information was significantly higher than the mean of scores of the prose format problems with extraneous information.

5. The means of scores of the three different problem formats without extraneous information were significantly higher than the means of scores of the three different problem formats with extraneous information.

This test revealed that there was an overpowering problem content (presence or absence of extraneous information) effect that submerges nearly all problem format (short, typical, and prose) effect.

Significant results were obtained in the two-way interactions for type of school (rural, urban, and private) and problem content (presence or absence of extraneous information). Table 19 shows the means of the arithmetic problem solving test by type of school and problem content. Figure 4 is the graphical representation of the type of school and problem content interaction.
### TABLE 19
SCORE MEANS OF THE ARITHMETIC PROBLEM SOLVING TEST
BY TYPE OF SCHOOL AND PROBLEM CONTENT

<table>
<thead>
<tr>
<th>SCHOOL</th>
<th>WITH n=2310</th>
<th>WITHOUT n=2310</th>
</tr>
</thead>
<tbody>
<tr>
<td>RURAL</td>
<td>$X_{RW}=0.192$ n=702</td>
<td>$X_{RW/0}=0.292$ n=702</td>
</tr>
<tr>
<td>URBAN</td>
<td>$X_{UW}=0.293$ n=1128</td>
<td>$X_{UW/0}=0.482$ n=1128</td>
</tr>
<tr>
<td>PRIVATE</td>
<td>$X_{PW}=0.410$ n=480</td>
<td>$X_{PW/0}=0.571$ n=480</td>
</tr>
</tbody>
</table>

$X_W=0.287$ $X_{W/0}=0.443$

---

**FIGURE 5**
SCHOOL X CONTENT INTERACTION
Tukey's tests were performed for post-hoc analysis. These tests showed that it can be stated at a level of statistical significance of $p \leq 0.05$ that:

1. The mean of scores of the problem content (presence or absence of extraneous information) obtained by subjects of urban schools was significantly higher than the mean of scores obtained by subjects of rural schools (Tukey HSD = 0.031).

2. The mean of scores of the problem content obtained by subjects of private schools was significantly higher than the mean of scores obtained by subjects of rural schools (Tukey HSD = 0.038).

3. The mean of scores of the problem content obtained by subjects of private schools was significantly higher than the mean of scores obtained by subjects of urban schools (Tukey HSD = 0.036)

Significant results were obtained in the two-way interactions for grade level (fourth and sixth) and problem format (short, typical, and prose). Table 20 shows the means of the arithmetic problem solving test by grade level and problem format. Figure 5 is the graphical representation of the grade level and problem format interaction.
TABLE 20
SCORE MEANS OF THE ARITHMETIC PROBLEM SOLVING TEST
BY GRADE LEVEL AND PROBLEM FORMAT

<table>
<thead>
<tr>
<th>FORMAT</th>
<th>FOURTH</th>
<th>SIXTH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=2310</td>
<td>n=2310</td>
</tr>
<tr>
<td>SHORT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=1540</td>
<td>X₄S=0.209</td>
<td>X₆S=0.468</td>
</tr>
<tr>
<td></td>
<td>n=770</td>
<td>n=770</td>
</tr>
<tr>
<td></td>
<td>X₅=0.338</td>
<td></td>
</tr>
<tr>
<td>TYPICAL</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=1540</td>
<td>X₄T=0.227</td>
<td>X₆T=0.549</td>
</tr>
<tr>
<td></td>
<td>n=770</td>
<td>n=770</td>
</tr>
<tr>
<td></td>
<td>X₅=0.388</td>
<td></td>
</tr>
<tr>
<td>PROSE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=1540</td>
<td>X₄P=0.235</td>
<td>X₆P=0.301</td>
</tr>
<tr>
<td></td>
<td>n=770</td>
<td>n=770</td>
</tr>
<tr>
<td></td>
<td>X₅=0.368</td>
<td></td>
</tr>
</tbody>
</table>

FIGURE 6
GRADE LEVEL X FORMAT INTERACTION
A Tukey's test (HSD = 0.055) was performed for post-hoc analysis. This test showed that it can be stated at a level of statistical significance of $p \leq 0.05$ that:

1. The mean of scores of the typical problems was significantly higher than the mean of scores of the short problems obtained by sixth graders.
2. The mean of scores of the short problems obtained by sixth graders was significantly higher than the mean of scores of the short problems obtained by fourth graders.
3. The mean of scores of the typical problems obtained by sixth graders was significantly higher than the mean of scores of the typical problems obtained by fourth graders.
4. The mean of scores of the prose problems obtained by sixth graders was significantly higher than the mean of scores of the prose problems obtained by fourth graders.

This test revealed that there was an overpowering grade level effect that submerges nearly all problem format effect.

Significant results were obtained in the two-way interactions for type of school (rural, urban, and private) and grade level. Table 21 shows the means of the arithmetic problem solving test by type of school and grade level. Figure 6 is the graphical representation of type of school and grade level interaction.
TABLE 21
SCORE MEANS OF THE ARITHMETIC PROBLEM SOLVING TEST
BY TYPE OF SCHOOL AND GRADE LEVEL

<table>
<thead>
<tr>
<th>SCHOOL</th>
<th>GRADE LEVEL</th>
<th>FOURTH</th>
<th>SIXTH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>n=2310</td>
<td>n=2310</td>
</tr>
<tr>
<td>RURAL</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=1404</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>X_{RA} = 0.093</td>
<td></td>
<td>X_{RA} = 0.392</td>
</tr>
<tr>
<td></td>
<td>n=702</td>
<td></td>
<td>n=702</td>
</tr>
<tr>
<td>URBAN</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=2236</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>X_{UA} = 0.270</td>
<td></td>
<td>X_{UA} = 0.505</td>
</tr>
<tr>
<td></td>
<td>n=1128</td>
<td></td>
<td>n=1128</td>
</tr>
<tr>
<td>PRIVATE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n=960</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>X_{PA} = 0.306</td>
<td></td>
<td>X_{PA} = 0.675</td>
</tr>
<tr>
<td></td>
<td>n=480</td>
<td></td>
<td>n=480</td>
</tr>
</tbody>
</table>

\[ X_4 = 0.224 \] \[ X_6 = 0.506 \]

FIGURE 7
SCHOOL X GRADE INTERACTION
Tukey's tests were performed for post-hoc analysis. These tests showed that it can be stated at a level of statistical significance of $p \leq 0.05$ that:

1. The mean of scores of the arithmetic word problem test obtained by subjects of urban schools was significantly higher than the mean of scores obtained by subjects of rural schools (Tukey HSD = 0.056).
2. The mean of scores of the arithmetic word problem test obtained by subjects of private schools was significantly higher than the mean of scores obtained by subjects of rural schools (Tukey HSD = 0.065).
3. The mean of scores of the arithmetic word problem test obtained by subjects of private schools was significantly higher than the mean of scores obtained by subjects of urban schools.
4. The means of scores of the arithmetic word problem test obtained by sixth graders of the three different types of schools were significantly higher than the means of scores obtained by fourth graders.

The correlational analysis was performed using the point biserial correlation coefficients. Tables 22 and 23 show the point biserial correlation coefficients between means of the reading comprehension test and means of subtests of the arithmetic word problem test by grade level and type of school, and between means of the test of computation and means of subtests.
TABLE 22
POINT BISERIAL CORRELATION COEFFICIENTS
BETWEEN MEANS OF THE READING COMPREHENSION TEST
AND MEANS OF SUBTESTS OF THE ARITHMETIC WORD PROBLEM TEST
BY GRADE LEVEL AND TYPE OF SCHOOL
(TWO TAIRED TEST)

<table>
<thead>
<tr>
<th>SUBTEST</th>
<th>GRADE FOUR</th>
<th></th>
<th></th>
<th>GRADE SIX</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RURAL n=117</td>
<td>URBAN n=201</td>
<td>PRIVATE n=80</td>
<td>RURAL n=126</td>
<td>URBAN n=188</td>
<td>PRIVATE n=83</td>
</tr>
<tr>
<td>SHORT WITHOUT EXTRANEOUS INFO</td>
<td>0.24 1</td>
<td>0.20</td>
<td>r(n.s.)</td>
<td>0.47</td>
<td>0.27</td>
<td>0.31</td>
</tr>
<tr>
<td></td>
<td>0.0092</td>
<td>0.005</td>
<td></td>
<td>0.0001</td>
<td>0.0001</td>
<td>0.005</td>
</tr>
<tr>
<td>SHORT WITH EXTRANEOUS INFO</td>
<td>r(n.s.)</td>
<td>r(n.s.)</td>
<td>r(n.s.)</td>
<td>0.36</td>
<td>0.25</td>
<td>0.23</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.0001</td>
<td>0.001</td>
<td>0.001</td>
<td>0.033</td>
<td></td>
</tr>
<tr>
<td>TYPICAL WITHOUT EXTRANEOUS INFO</td>
<td>0.19</td>
<td>0.28</td>
<td>r(n.s.)</td>
<td>0.36</td>
<td>0.23</td>
<td>r(n.s.)</td>
</tr>
<tr>
<td></td>
<td>0.037</td>
<td>0.0001</td>
<td></td>
<td>0.0001</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>TYPICAL WITH EXTRANEOUS INFO</td>
<td>0.25</td>
<td>0.17</td>
<td>r(n.s.)</td>
<td>0.37</td>
<td>0.15</td>
<td>0.29</td>
</tr>
<tr>
<td></td>
<td>0.006</td>
<td>0.018</td>
<td></td>
<td>0.0001</td>
<td>0.037</td>
<td>0.008</td>
</tr>
<tr>
<td>PROSE WITHOUT EXTRANEOUS INFO</td>
<td>r(n.s.)</td>
<td>0.22</td>
<td>0.29</td>
<td>0.40</td>
<td>0.36</td>
<td>0.22</td>
</tr>
<tr>
<td></td>
<td>0.002</td>
<td>0.009</td>
<td></td>
<td>0.0001</td>
<td>0.001</td>
<td>0.047</td>
</tr>
<tr>
<td>PROSE WITH EXTRANEOUS INFO</td>
<td>r(n.s.)</td>
<td>0.31</td>
<td>r(n.s.)</td>
<td>0.37</td>
<td>0.26</td>
<td>r(n.s.)</td>
</tr>
<tr>
<td></td>
<td>0.0001</td>
<td>0.0001</td>
<td></td>
<td>0.0001</td>
<td>0.001</td>
<td></td>
</tr>
</tbody>
</table>

1 point biserial correlation coefficient, r
2 statistical significance of r
n.s. = non significant
TABLE 23
POINT BISERIAL CORRELATION COEFFICIENTS
BETWEEN MEANS OF THE TEST OF COMPUTATION
AND MEANS OF SUBTESTS OF THE ARITHMETIC WORD PROBLEM TEST
BY GRADE LEVEL AND TYPE OF SCHOOL
(TWO TAILED TEST)

<table>
<thead>
<tr>
<th>TEST OF COMPUTATION</th>
<th>GRADE FOUR</th>
<th>GRADE SIX</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RURAL n=117</td>
<td>URBAN n=201</td>
</tr>
<tr>
<td>SHORT WITHOUT EXTRANEOUS INFO</td>
<td>0.40&lt;sup&gt;1&lt;/sup&gt;&lt;sup&gt;2&lt;/sup&gt; 0.0001&lt;sup&gt;2&lt;/sup&gt;</td>
<td>0.29 0.0001</td>
</tr>
<tr>
<td>SHORT WITH EXTRANEOUS INFO</td>
<td>r(n.s.) 0.22 0.002</td>
<td>r(n.s.) 0.37 0.0001</td>
</tr>
<tr>
<td>TYPICAL WITHOUT EXTRANEOUS INFO</td>
<td>0.28 0.003</td>
<td>0.32 0.0001</td>
</tr>
<tr>
<td>TYPICAL WITH EXTRANEOUS INFO</td>
<td>0.33 0.0001</td>
<td>0.23 0.0001</td>
</tr>
<tr>
<td>PROSE WITHOUT EXTRANEOUS INFO</td>
<td>0.40 0.0001</td>
<td>0.24 0.001</td>
</tr>
<tr>
<td>PROSE WITH EXTRANEOUS INFO</td>
<td>0.22 0.19</td>
<td>0.17 0.013</td>
</tr>
</tbody>
</table>

<sup>1</sup> Point biserial correlation coefficient, r.
<sup>2</sup> Statistical significance of r.
n.s. non significant
of the arithmetic word problem test by grade level and type of school respectively.

**Hypothesis 1. There will be a difference in arithmetic word problem solving ability between students in rural, urban, and private schools.**

The analysis of variance permits the conclusion that there is a significant difference in arithmetic word problem ability between students in rural, urban, and private schools at a level of significance of $p \leq 0.000001$. The Tukey-HSD test showed that it can be stated at a level of statistical significance of $p \leq 0.05$ that:

1. The mean of scores of the arithmetic word problem test obtained by subjects of private schools was significantly higher than the mean of scores obtained by subjects of rural schools.
2. The mean of scores of the arithmetic word problem test obtained by subjects of private schools was significantly higher than the mean of scores obtained by subjects of urban schools.
3. The mean of scores of the arithmetic word problem test obtained by subjects of urban schools was significantly higher than the mean of scores obtained by subjects of rural schools.

In other words, the students from the three different schools performed differently in arithmetic word problem solving.
The students from private schools performed better than students from urban schools, and better than students from rural schools. The students from urban schools performed better than students from rural schools.

The results mentioned above lead to the conclusion that, at a level of statistical significance of $p \leq 0.000001$ hypothesis 1 can be supported under the conditions of this study.

Hypothesis 2. There will be a difference in arithmetic problem solving ability between students in the fourth and sixth grades.

The analysis of variance permits the conclusion that there is a significant difference in arithmetic word problem solving ability between students in fourth and sixth grades at a level of significance of $p \leq 0.000001$. In other words, sixth graders performed better in arithmetic word problem solving than fourth graders.

The result mentioned above leads to the conclusion that, at a high level of statistical significance hypothesis 2 can be supported under the conditions of this study.
Hypothesis 3. There will be a difference in problem solving ability between short, typical, and prose length in arithmetic word problem.

It is important to observe that even though there was a main effect due to a problem format (short, typical, and prose) at a level of significance of \( p \leq 0.001 \), the strong effects of the interactions due to a combination of grade level and problem format, and to a combination of problem content (presence or absence of extraneous information) and problem format overshadowed the main effect of problem format on arithmetic word problem solving ability. In short, grade level and the presence or absence of extraneous information in the problem statement were two strong factors that influenced the interpretation of the effects due to problem format.

The results mentioned above lead to the conclusion that hypothesis 3 can be partially supported under the conditions of this study.

Hypothesis 4. There will be a difference in problem solving ability between problems with and problems without extraneous information.

The analysis of variance permits the conclusion that there is a significant difference in problem solving ability between problems with and without extraneous information at a level of significance of \( p \leq 0.000001 \). The interaction analysis leads to the conclusion that subjects' performances were
significantly higher on problems without extraneous information than on problems with extraneous information. The presence or absence of extraneous information in the problem statement was a strong factor that affected the students' performances on arithmetic word problem solving.

The results mentioned above lead to the conclusion that, at a level of statistical significance of $p \leq 0.000001$ hypothesis 4 can be supported under the conditions of this study.

**Hypothesis 5.** There will be a difference in arithmetic word problem solving ability due to a combination of type of school and word problem length.

The analysis of variance permits the conclusion that there is not a significant difference in arithmetic word problem solving ability due to a combination of type of school and problem format. In other words, the combination of type of school (rural, urban, and private) and problem format (short, typical, and prose) did not affect the students' performances on arithmetic word problem solving.

The result mentioned above leads to the conclusion that, at a level of statistical significance of $p \leq 0.05$, hypothesis 5 cannot be supported under the conditions of this study.
Hypothesis 6. There will be a difference in arithmetic word problem solving ability due to a combination of grade level and problem length.

The analysis of variance permits the conclusion that there is a significant difference in arithmetic word problem solving ability due to a combination of grade level and problem format (short, typical, and prose) at a level of significance of $p \leq 0.05$. The Tukey HSD test showed that:

1. The mean of the typical problems was significantly higher than the mean of the short problems obtained by sixth graders.
2. The mean of the short problems obtained by sixth graders was significantly higher than the mean of the short problems obtained by fourth graders.
3. The mean of the typical problems obtained by sixth graders was significantly higher than the mean of scores of the typical problems obtained by fourth graders.
4. The mean of the prose problems obtained by sixth graders was significantly higher than the mean of the prose problems obtained by fourth graders.

In other words, sixth graders performed better on the three different problem formats than fourth graders.

The results mentioned above lead to the conclusion that, at a level of statistical significance of $p \leq 0.05$ hypothesis 6 can be supported under the conditions of this study.
Hypothesis 7. There will be a difference in arithmetic word problem solving ability due to a combination of type of school and problem content.

The analysis of variance permits the conclusion that there is a significant difference in arithmetic word problem solving ability due to a combination of type of school (rural, urban, and private) and problem content (presence or absence of extraneous information) at a level of significance of $p \leq 0.01$.

The Tukey HSD showed that:

1. The mean of the problem content obtained by subjects of urban schools was significantly higher than the mean obtained by subjects of rural schools.
2. The mean of the problem content obtained by subjects of private schools was significantly higher than the mean obtained by subjects of rural schools.
3. The mean of the problem content obtained by subjects of private schools was significantly higher than the mean obtained by subjects of urban schools.

In other words, the combination of type of school and problem content did affect the students' performances on arithmetic word problem solving. Students from private schools performed better than students from urban schools and rural schools. Students from urban schools performed better than students from rural schools. The presence or absence of extraneous information affected the students' performances on
problem solving.

The results mentioned above lead to the conclusion that, at a level of statistical significance of $p \leq 0.01$, hypothesis 7 can be supported under the conditions of this study.

**Hypothesis 8.** There will be a difference in arithmetic word problem solving ability due to a combination of grade level and problem content.

The analysis of variance permits the conclusion that there is not a significant difference in arithmetic word problem solving ability due to a combination of grade level and problem content (presence or absence of extraneous information) at a level of significance of $p \leq 0.05$. In other words the combination of grade level and problem content, did not affect the students' performances on arithmetic problem solving.

The result mentioned above leads to the conclusion that, at a level of statistical significance of $p \leq 0.05$ hypothesis 8 cannot be supported under the conditions of this study.

**Hypothesis 9.** There will be a difference in arithmetic word problem solving ability due to a combination of problem length and problem content.

The analysis of variance permits the conclusion that there is a significant difference in arithmetic word problem solving ability due to a combination of problem format (short, typical, and prose) and problem content at a level of significance of
p \leq 0.05. The Tukey HSD test showed that:

1. The mean of the typical problems with extraneous information was significantly higher than the mean of the short problems with extraneous information.
2. The mean of the short problems without extraneous information was significantly higher than the mean of the short problems with extraneous information.
3. The mean of the typical problems without extraneous information was significantly higher than the mean of the typical problems with extraneous information.
4. The mean of the prose problems without extraneous information was significantly higher than the mean of the prose problems with extraneous information.
5. The means of the three problem formats without extraneous information were significantly higher than the means of the three problem formats with extraneous information.

In other words, the combination of problem format and problem content did affect the students' performances on arithmetic word problem solving. Problems without extraneous information presented less difficulty than problems with extraneous information.

The results mentioned above lead to the conclusion that, at a level of statistical significance of p \leq 0.05, hypothesis 9 can be supported under the conditions of this study.
Hypothesis 10. There will be meaningful relationships between reading ability and the ability to solve arithmetic word problems of various combinations of length and content.

The point biserial correlation coefficients obtained permits the conclusion that the following relationships between reading ability and the ability to solve arithmetic word problems of various combinations of problem format and content are significant at a level of $p \leq 0.0001$:

1. Scores in subtest short without extraneous information are directly related to reading ability of sixth graders from rural schools.
2. Scores in subtest short with extraneous information are directly related to reading ability of sixth graders from rural schools.
3. Scores in subtest typical without extraneous information are directly related to reading ability of sixth graders from rural schools.
4. Scores in subtest typical with extraneous information are directly related to reading ability of sixth graders from rural schools.
5. Scores in subtest prose without extraneous information are directly related to reading ability of sixth graders from rural and urban schools.
6. Scores in subtest prose with extraneous information are directly related to reading ability of sixth graders
from rural schools.

In short, each length (short, typical, and prose) with and without extraneous information is significantly related (p \leq 0.0001) to sixth grade students' reading ability. This relationship also holds for urban sixth graders who worked in the prose format without extraneous information.

The results mentioned above lead to the conclusion that, at a level of statistical significance of p \leq 0.0001, hypothesis 10 can be partially supported under the conditions of this study.

Hypothesis 11. There will be meaningful relationships between computational ability and the ability to solve arithmetic word problems of various combinations of problem length and content.

The point biserial correlation coefficients obtained permits the conclusion that the following relationships between computational ability and the ability to solve arithmetic word problems of various combinations of problem format and content are significant at a level of p \leq 0.0001:

1. Scores in subtest short without extraneous information are directly related to computational ability of sixth graders from rural schools.
2. Scores in subtest short with extraneous information are directly related to computational ability of sixth
graders from rural and private schools.

3. Scores in subtest prose without extraneous information are directly related to computational ability of fourth and sixth graders from rural schools, and sixth grade students from private schools.

The results mentioned above lead to the conclusion that, at a level of statistical significance of $p \leq 0.0001$, hypothesis 11 can be partially supported under the conditions of this study.

**Summary of Results**

The analysis of variance showed that there were main effects due to the factors type of school, grade level, and problem content (presence or absence of extraneous information). Students from private schools performed better in the arithmetic word problem test than students from urban and rural schools. Students from urban schools performed better than students from rural schools. In general sixth graders performed better than fourth graders. The presence or absence of extraneous information was a strong factor on the overall scores on the arithmetic word problem test. In general students performed better on problems without extraneous information than on problems with extraneous information. There was a main effect due to a problem format (short, typical, and prose), but the strong effects of grade level and the presence or absence of extraneous information in the
problem statement influenced the interpretation of the effects due to a problem format.

There was a significant interaction due to a combination of problem format and problem content. In general the problems with extraneous information were more difficult than problems without extraneous information whatever the format.

The relationships between reading ability and problem solving, and computational ability and problem solving were not as meaningful as it was assumed.
CHAPTER V

SUMMARY, DISCUSSION OF RESULTS, CONCLUSIONS, AND RECOMMENDATIONS

Review of the Study

The purpose of this study was to investigate the relationships between Costa Rican fourth and sixth grade students' ability to solve arithmetic word problems and the following variables: length of the problem statement, the presence or absence of extraneous information, reading ability, and computational ability. The study was suggested by three facts: 1) there are no studies about the relationships among problem solving ability and the variables mentioned above for Costa Rican primary school children; 2) the Costa Rican mathematics program for primary school does not include a structured plan for teaching problem solving; and 3) Costa Rican educators seem not to be aware of the need to prepare students with good problem solving skills.

Thirty schools were randomly selected from the sub-region San José of the Central Region of Costa Rica. The sample included 398 fourth graders and 397 sixth graders. Of these 795 children 389 were enrolled in public urban schools, 243
were in public rural schools, and 163 children were in private schools.

Three instruments were used in this study: 1) the arithmetic word problem test consisting of eight arithmetic word problems (two warm up problems, two short problems, two typical problems, and two prose problems); 2) a test of computation containing the same eight computations presented in the arithmetic word problem test; and 3) a cloze test designed to assess reading comprehension. The three instruments were administered to the thirty school groups over a three-week period. Each school group was visited twice. During the first visit the arithmetic word problem test was administered. The reading comprehension test and the test of computation were administered during the second visit.

Summary of Results

This study tried to identify the effects on problem solving ability of the variables: 1) length of the problem statement; 2) the presence or absence of extraneous information; 3) reading comprehension ability; and 4) computational ability. Two variables were found to be partially significant: length of the problem (short, typical, and prose) and content (presence or absence of extraneous information) in relation to type of school and grade level. Six subscores were computed based on the student's performance on the arithmetic word problem test taking into account the factors problem length and format.
The subscores were short format with or without extraneous information, typical format with or without extraneous information, and prose format with or without extraneous information. An analysis of variance (ANOVA) was performed considering four factors (variables): 1) type of school (rural, urban, and private); 2) grade level (fourth and sixth); 3) problem length (format); and 4) problem content (presence or absence of extraneous information).

The analysis of variance showed that there were main effects due to the factors type of school, grade level, and problem content. Significant variance was found among the three types of schools (rural, urban, and private). There was a significant difference in arithmetic word problem ability between students in rural, urban, and private schools at a level of significance of $p \leq 0.000001$. The students from private schools performed better than students from urban and rural schools, and students from urban schools performed better than than students from rural schools (Tukey $p \leq 0.05$). The grade level factor accounted for a significant variance between fourth and sixth graders' performances on arithmetic word problem solving at a level of significance of $p \leq 0.000001$. In general sixth graders performed better than fourth graders. The analysis showed that there was a significant content effect on arithmetic problem solving at a level of significance of
The presence or absence of extraneous information was a strong factor on the overall scores on the arithmetic word problem test. In general students performed better on problems without extraneous information than on problems with extraneous information.

It is important to observe that even though there was a main effect due to a problem format (short, typical, and prose) at a level of significance of \( p \leq 0.001 \), the strong effects of the interactions due to a combination of grade level and problem format, and to a combination of problem content (presence or absence of extraneous information) and problem format (short, typical, and prose) overshadowed the main effect of problem format on arithmetic word problem solving ability. In short, grade level and the presence or absence of extraneous information in the problem statement were two strong factors that influenced the interpretation of the effects due to problem format.

There was a significant interaction due to a combination of problem format (short, typical, and prose) and problem content (presence or absence of extraneous information) at a level of \( p \leq 0.05 \). A Tukey's test showed that:

1. The short format problems with extraneous information were more difficult than the typical format problems with extraneous information.
2. The short format problems with extraneous information
were more difficult than the short format problems without extraneous information.

3. The typical format problems with extraneous information were more difficult than the typical format problems without extraneous information.

4. The prose format problems with extraneous information were more difficult than the prose format problems without extraneous information.

5. In general, the three different problem formats with extraneous information were more difficult than the three different problem formats without extraneous information. The effect of the problem content (presence or absence of extraneous information) was so strong that it submerged nearly all problem format (short, typical, prose) effects.

Significant results were obtained in the interaction due to a combination of type of school (rural, urban, and private) and problem content (presence or absence of extraneous information) at $p \leq 0.01$ level of significance. A Tukey's test showed that:

1. Subjects of urban schools performed better on problems with or without extraneous information than subjects of rural schools.

2. Subjects of private schools performed better on problems with or without extraneous information than subjects of urban and rural schools.
Significant results were obtained in the interaction due to a combination of grade level (fourth and sixth) and problem format (short, typical, and prose) at $p \leq 0.05$ level of significance. A Tukey's test showed that:

1. Sixth graders performed better on typical format problems than on short format problems.
2. Sixth graders performed better on short format problems than fourth graders.
3. Sixth graders performed better on typical format problems than fourth graders.
4. Sixth graders performed better on prose format problems than fourth graders.

The grade level effect was so strong that it submerged nearly all problem format effect.

Significant results ($p \leq 0.05$ level) were obtained in the interaction due to a combination of type of school (rural, urban, and private) and grade level. A Tukey's test showed that:

1. Subjects of urban schools performed better on the arithmetic word problem test than subjects of rural schools.
2. Subjects of private schools performed better on the arithmetic word problem test than subjects of urban and rural schools.
3. Sixth graders of the three different types of schools performed better on the arithmetic word problem test than
fourth graders.

The relationships between reading ability and the ability to solve problems of different length (short, typical, and prose) and content (presence or absence of extraneous information) were obtained by the analysis of the point biserial correlation coefficients. The correlation coefficients were not as meaningful as they were anticipated. For instance, the correlations between reading comprehension and five of the six subtests of the arithmetic word problem test were not significant for grade four students from private schools. The highest correlations were obtained by sixth grade students from rural schools for all of the six subtests. The same analytical technique was performed in order to obtain the relationships between computational ability and the ability to solve problems of different length and content. The same thing happened for fourth grade students from private schools; the correlations were not significant for five of the six subtests of the arithmetic word problem test.

Finally, it is important to consider the results obtained by the analysis of the correspondence between computation item and their corresponding word problems. Each computation item in the test of computation is present in a problem in the arithmetic word problem test. This analysis showed that only 32.9% of the students answered the computations and their corresponding word problems correctly, but 39.2% of the students answered
the computations correctly and the corresponding word problems incorrectly. This means that 39.2% of the students knew how to do the computations, but they could not apply the computations to problem solving situations.

Conclusions

Based on the findings of this study, but subject to the limitations, delimitations, and assumptions set forth in previous chapters, certain conclusions can be presented.

The arithmetic word problem test and the cloze test used in this study presented various limitations affecting the results of the study. The arithmetic problem test had only one problem of each category: one short problem with extraneous information and one without extraneous information; one typical problem with extraneous information and one without extraneous information; and one prose problem with extraneous information and one without extraneous information. The reading comprehension test, a cloze type test, was designed and piloted to be used in this study. The use of only one test of this kind to assess reading ability may be a limitation to the experiment; perhaps more accurate results could be obtained using more than one test.

The students from private schools performed significantly better on arithmetic word problems than students from urban and rural schools, and students from urban schools performed significantly better than students from rural schools. These
results may be explained by the fact that socioeconomic background affects the arithmetic word problem solving ability of Costa Rican sixth and fourth graders. Students from private schools are from higher socioeconomic background than students from urban or rural schools, and urban school students are from higher socioeconomic background than students from rural schools. Private schools have more and better human and physical resources than urban or rural schools when judged on either qualitative or quantitative grounds. The same is true for urban schools in relation to rural schools. This is consistent with the results for private and urban schools reported by Buján (1982).

Sixth grade students performed better on arithmetic word problems in each of the different types of problems than fourth grade students. This finding was predictable because of the two additional years which sixth graders have spent in school.

The presence of extraneous information in the problem statement gave children a great deal of difficulty. Students at each grade level performed better on problems without extraneous information than on problems with extraneous information. This is consistent with performance in other studies. Nesher (1976) stated that the variable "superfluous information" affected the performance of subjects in solving the problems. Bana and Nelson (1978) concluded that distractors affect the problem solving performances of young children.

The presence or absence of extraneous information in
combination with problem format (short, typical, and prose) affected students' performances on problem solving; in general, the three different problem formats with extraneous information were more difficult than the three problem formats without extraneous information. Specifically, there was a significant difference between short format problems with extraneous information and typical format problems with extraneous information. Short format problems were more difficult than typical format problems. In relation to this variable (length of the problem) the findings of this study seem to be in agreement with Jerman's study (1973). He concluded that the number of words in the problem statement in relation to other factors affected the problem difficulty.

Although problem format (short, typical, and prose) did affect the students' performances on arithmetic word problem solving, the effects of grade level and problem content overwhelmed the statistics concerning the format variable. Although the significance level in the ANOVA was 0.001, the conclusions about the format variable need to be interpreted with caution.

The relationships between reading ability and the ability to solve arithmetic word problems of different length and content were not as meaningful as projected. A possible explanation for this may be that the cloze test was not sufficiently sensitive to detect relationships. This author thinks as Barnett (1982) that "the ability to read and interpret word problems with facility is a necessary, but not sufficient condition to problem-solving success."
Finally, it was found that a rather high percentage of students knew how to do the computations, but they could not apply them to problem situations. Costa Rican fourth and sixth graders did not exhibit the problem solving skills needed for subsequent work in mathematics nor for applying mathematics in day-to-day living.

**Recommendations**

In the light of the findings and conclusions already presented, several recommendations are offered: 1) for future investigations, and 2) for teacher education.

**Recommendations for future investigations**

Conclusions and interpretations of data concerning some variables, such as problem format, were difficult to make because of the complexities of the research design. Replications with research designs that would permit singular attention on particular variables would be worthwhile. Other studies should be made, possibly at a single grade level, using more than one item (problem) of each type in the arithmetic word problem test, or using an instrument that contains only problems of different formats (short, typical, and prose) without the presence of extraneous information. The second choice would be preferable if the purpose of the study is to detect effects due to a problem format. If the number of problems is increased the test should be administered in more than one
work session, the students would not have time to work on more than six problems at one sitting.

This study should be replicated in other cultures using other languages, for example English, French, Italian, German, et cetera. It would be interesting to compare children's performances on problem solving in different cultural settings under the conditions of this study.

The problems of the arithmetic word problem test should be subjected to the kind of linguistic study of coherence implicitly suggested by Halliday (1976). This study might contribute to clarify the cause effect relationship between the variable length of the problem and problem solving performance.

There is a need for the development of valid and reliable paper and pencil instruments for measuring problem solving ability, and reading comprehension ability for Costa Rican primary schools.

Recommendations for teacher education

Teachers, educational administrators, and educational leaders should be aware that ability to solve problems is a vital element in mathematics education. The National Council of Supervisors of Mathematics (1977) expressed this idea stating: "learning to solve problems is the principal reason for studying mathematics." Therefore, classroom teachers should be prepared to teach how to solve problems and to help students
to acquire the needed skills to be competent problem solvers.

Problems with extraneous information presented more difficulties for problem solving than problems without extraneous information. The students need to acquire skills in order to identify the relevant form the irrelevant information. Teachers should be aware of this fact in order to give students the needed instruction.

The prose problems presented fewer difficulties than the short format problems. Several of the children enjoyed the stories when they were reading the prose format problems during the administration of the test. According to the experience of the author as a primary schools teacher, children regularly report a dislike of verbal arithmetic problems; something of this nature which they enjoy should be encouraged and it may come closer to a life-like setting for a problem.

Costa Rican sixth and fourth graders need to have a more structured instruction in problem-solving. Teachers may offer a problem solving model like the one presented by Polya (1975). This model will give the students a meaningful tool to work on problem solving.

Costa Rican schools, especially rural schools should receive more attention and supervision in the area of mathematics problem solving.

The educational leaders and authorities of Costa Rica
should train pre-service and in-service teachers in problem solving and in how to teach problem solving.

The Costa Rican Ministry of Education should implement a structured plan for teaching problem solving in the mathematics program of the primary schools.
BIBLIOGRAPHY


Buswell, G. T. and Judd, C. H. *Summary of Educational Investigations Relating to Arithmetic*. The University of Chicago, 1925.


APPENDIX A

INSTRUMENTS
1. Ana had 718 colones. She bought a doll worth 376 colones and a book worth 218 colones. How much money was left?

ANSWER______________________________________________

2. There are three vases on an altar. Six white roses are in each vase. How many roses are on that altar?

ANSWER______________________________________________

3. The fourth grade students wanted to decorate their classroom during vacation. They wanted to have it clean and attractive for the beginning of the course.

   The children organized two groups. The boys painted the classroom, and the girls made the drapes and looked for 18 appropriate plants for the classroom.

   Since the children did not have any money, they had to ask different stores in the community and their families for the needed materials.

   When Ms. Jiménez, the fourth grade teacher, came to the first day of classes, she almost fainted when she entered the classroom. One of the walls was painted red, the next was green, the third one was blue, and the last one was yellow. The ceiling was brown because the children could not paint it, and the floor was practically covered by thousands of little spots in different colors. Some curtains had flowers and others were purple.

   The girls had all the materials needed for planting the plants. If every pot can hold 2142 cubic centimeters of dirt, how many cubic centimeters of dirt are needed to fill 6 pots?

ANSWER______________________________________________

4. The mysterious flutist took 2751 rats from the town. How many gold coins did the flutist receive if they gave him 7 gold coins for each rat?

ANSWER______________________________________________
5. 4.98 liters of milk.  
6 colonas each liter.  
462 liters of sour cream were lost.  
Total money earned?  

ANSWER

6. Pinocchio had become a very correct and hard working child. He helped his father in the carpentry workshop. One day, Pinocchio received a letter from his friends in Sarchí. They asked him to help in the oxcart carpentry workshop of Carlos Castillo.  

Pinocchio started working the very same day he arrived in Sarchí because they had to finish 1782 decorative oxcarts to be sold in 6 stores in San José.  

Pinocchio was very gifted in working with small pieces of wood and that is why they assigned him to the task of cutting the parts for small carts and putting them together. Pinocchio worked so fast that he finished all the available wood in less than one week.  

Since there were no more pieces of wood to be cut, Pinocchio started painting the small oxcarts. Nobody had seen such well painted oxcarts at Carlos Castillo's oxcart workshop.  

Carlos and Pinocchio went to San José to sell the oxcarts. How many oxcarts did they sell in each store?  

ANSWER

7. There are 8 persons marking 3312 green turtles in Tortuguero National Park. Each turtle lays 144 eggs. How many turtles does each person mark?  

ANSWER

8. 7482 meters in 6 hours.  
Meters walked in 1 hour?  

ANSWER
1. Ana had 716 colones. She bought a doll worth 376 colones and a book worth 216 colones. How much money was left?

**ANSWER**

2. There are three vases on an altar. Six white roses are in each vase. How many roses are on that altar?

**ANSWER**

3. In some far country there was an incredible plague of rats. The king, who had tried many different types of mousetraps and poisons, offered a reward of 7 gold coins for each rat to the person who could exterminate them.

Many people came to show the king their ideas about how to make the rats disappear and then ask for the reward. The king did not find any of those ideas to his entire satisfaction. One day, a strange short man came to the city and offered to end the rat plague by playing his mysterious flute.

Standing up in the middle of the city's square, the little man started playing a very strange music. To the surprise of the people of the city, the rats came from everywhere and surrounded the musician to listen to his melody.

Without stopping his concert, the flutist left the center of the town and headed for the river followed by an immense parade of rats. The flutist crossed the shallow river but the rats disappeared under the water.

The flutist played during 3 hours and took 2751 rats from the town. How many gold coins did he receive?

**ANSWER**

4. How much money does Larry earn each week if he sells 4158 liters of milk at 6 colones each?

**ANSWER**
5. 18 plants.
   2142 cubic centimeters of dirt in each pot.
   How much dirt for 6 pots?

   ANSWER

6. Berta, the green turtle, is one of the thousands of turtles that come every year to lay eggs in Tortuguero Beach. Last year there were 3312 turtles.

   Berta likes to come to this place because she is a friend of Beto and Betina, two children who live in Tortuguero National Park. Berta the turtle knows that these children work with other people who take care of the turtles. Berta feels she is safe for she knows that her little turtles will not be facing any risk when they hatch.

   Beto and Betina make sure that the turtles' eggs are not taken from their pits by other animals. These children also make sure that the young turtles find their way to the sea free from predators.

   Berta and other turtles have been identified and marked with a special number written on a little piece of metal attached to their shells. This identification number allows the scientists to know the number and kind of turtles that come every year to Tortuguero Beach.

   There are 8 persons marking turtles. How many turtles does each person mark?

   ANSWER

7. Uncle Rabbit walked 7482 meters in 6 hours with new shoes worth 258 colones. How many meters did he walk in 1 hour?

   ANSWER

8. 1782 oxcarts sold
   in 6 stores.
   How many sold in each store?

   ANSWER
1. Ana had 718 colonas. She bought a doll worth 376 colonas and a book worth 218 colonas. How much money was left?

ANSWER ________________________________________________

2. There are three vases on an altar. Six white roses are in each vase. How many roses are on that altar?

ANSWER ________________________________________________

3. At Larry's dairy farm the cows have different colors and are divided into four groups. The black cows with white freckles are milked in the morning. The white cows with black freckles are milked at noon. The red cows with white spots are milked in the afternoon and the white cows with red spots are milked in the evening.

   The cows produce different qualities of milk. The milk from the white freckled cows is used to make sour cream. The black freckled cows give milk to make ice cream. The red cows' milk is used to make cheese and the white cows' milk is to drink.

   These cows do not like to be separated because they can not talk with their friends in other groups. So, they decided to make only one group. The resulting confusion was so big that Larry could not milk them for several days and he lost 462 liters of sour cream.

   Larry decided to give the cows Sunday free so they could talk with their friends. With the new schedule the cows were happier and they increased the production of milk. Now Larry obtains 4158 liters of milk each week.

   How much money does Larry earn if he sells each liter of milk for 6 colonas?

ANSWER ________________________________________________

4. The girls found some plants and 6 pots for the school. If each pot takes 2142 cubic centimeters of dirt, how much dirt is needed for the 6 pots?

ANSWER ________________________________________________
5. 2751 rats in 3 hours.
7 gold coins for each rat.
How many coins in all?

ANSWER ________________________________

6. Once upon a time Uncle Rabbit was invited to the wedding of the Little Dora, the duck who was about to get married to Rick Duck.

On the wedding day Uncle Rabbit woke up quite early in the morning because he had to walk a distance of 7482 meters. He wore new pink shoes and a very fine cotton coat. He also put on a fabric hat and tied a red silk handkerchief around his neck. He used his best cologne, groomed his moustache and left for the wedding.

When he was going to the church, he stopped by Uncle Tiger's store, bought the wedding present and some band-aid strips because his new shoes hurt him.

Poor Uncle Rabbit arrived at the party with his shoes in his hands and his toes wrapped with band-aid strips. The party was a lot of fun and Uncle Rabbit, despite the hurt in his feet, danced all the time with Aunt Weasel.

Uncle Rabbit spent 6 hours walking back to his house because he had to walk very slowly. How many meters did he walk in 1 hour?

ANSWER ________________________________

7. Carlos and Pinocchio sold 1782 decorated oxcarts worth 162 colones each, in 6 stores in San José. How many oxcarts did they sell to each store?

ANSWER ________________________________

8. 3312 turtles to mark.
8 persons marking.
Each person marks ______?
1. Ana had 718 colones. She bought a doll worth 376 colones and a book worth 218 colones. How much money was left?

**Answer:__________________________**

2. There are three vases on an altar. Six white roses are in each vase. How many roses are on that altar?

**Answer:__________________________**

3. The fourth grade students wanted to decorate their classroom during vacation. They wanted to have it clean and attractive for the beginning of the course.

   The children organized two groups. The boys painted the classroom, and the girls made the drapes and looked for some appropriate plants for the classroom.

   Since the children did not have any money, they had to ask different stores in the community and their families for the needed materials.

   When Ms. Jiménez, the fourth grade teacher, came to the first day of classes, she almost fainted when she entered the classroom. One of the walls was painted red, the next was green, the third one was blue, and the last one was yellow. The ceiling was brown because the children could not paint it, and the floor was practically covered by thousands of little spots in different colors. Some curtains had flowers and others were purple.

   The girls had all the materials needed for planting the plants. If every pot can hold 2142 cubic centimeters of dirt, how many cubic centimeters of dirt are needed to fill 6 pots?

**Answer:__________________________**

4. The flutist played during 3 hours and took 2751 rats from the town. How many gold coins did he receive if they gave him 7 gold coins for each rat?

**Answer:__________________________**
5. 4158 liters of milk.
    6 colones each liter.
    Total money earned?

   ANSWER

6. Pinocchio had become a very correct and hard working child.
   He helped his father in the carpentry workshop. One day, Pinocchio
   received a letter from his friends in Sarchí. They asked him to
   help in the oxcart carpentry workshop of Carlos Castillo.

   Pinocchio started working the very same day he arrived in
   Sarchí because they had to finish 1782 decorative oxcarts to be sold
   in 6 stores in San José.

   Pinocchio was very gifted in working with small pieces of wood
   and that is why they assigned him to the task of cutting the parts
   for small carts and putting them together. Pinocchio worked so fast
   that he finished all the available wood in less than one week.

   Since there were no more pieces of wood to be cut, Pinocchio
   started painting the small oxcarts. Nobody had seen such well
   painted oxcarts at Carlos Castillo's oxcart workshop.

   Carlos and Pinocchio went to San José to sell each oxcart for
   162 colones. How many oxcarts did they sell in each store?

   ANSWER

7. There are 8 persons marking 3312 green turtles in Tortuguero Na-
    tional Park. How many turtles does each person mark?

   ANSWER

8. 7482 meters in 6 hours.
    Shoes worth 258 colones.
    How many meters in 1 hour?

   ANSWER
1. Ana had 718 colones. She bought a doll worth 376 colones and a book worth 218 colones. How much money was left?

Answer

2. There are three vases on an altar. Six white roses are in each vase. How many roses are on that altar?

Answer

3. In some far country there was an incredible plague of rats. The king, who had tried many different types of mouse traps and poisons, offered a reward of 7 gold coins for each rat to the person who could exterminate them.

Many people came to show the king their ideas about how to make the rats disappear and then to ask for the reward. The king did not find any of those ideas to his entire satisfaction. One day, a strange short man came to the city and offered to end the rat plague by playing his mysterious flute.

Standing up in the middle of the city's square, the little man started playing a very strange music. To the surprise of the people of the city, the rats came from everywhere and surrounded the musician to listen to his melody.

Without stopping his concert, the flutist left the center of the town and headed for the river followed by an immense parade of rats. The flutist crossed the shallow river but the rats disappeared under the water.

The flutist took 2751 rats from the city. How many gold coins did he receive?

Answer

4. Larry could not milk his cows and lost 462 liters of sour cream. How much money does Larry earn if he sells 4158 liters of milk at 6 colones each?

Answer
5. **2142 cubic centimeters of dirt in each pot.**  
   How much dirt for 6 pots?

**ANSWER**

6. **Berta, the green turtle, is one of the thousands of turtles that come every year to lay eggs in Tortuguero Beach. Last year there were 3312 turtles.**

   Berta likes to come to his place because she is a friend of Beto and Betina, two children who live in Tortuguero National Park. Berta the turtle knows that these children work with other people who take care of the turtles will not be facing any risk when they hatch.

   Beto and Betina make sure that the turtles' eggs are not taken from their pits by other animals. These children also make sure that the young turtles find their way to the sea free from predators.

   Berta and other turtles have been identified and marked with a special number written on a little piece of metal attached to their shells. The identification number allows the scientists to know the number and kind of turtles that come every year to Tortuguero Beach.

   There are 8 persons marking turtles. Each turtle lays 144 eggs.  
   How many turtles does each person mark?

   **ANSWER**

7. **Uncle Rabbit walked quite slowly with his new shoes. He walked only 7482 meters in 6 hours. How many meters did he walk in 1 hour?**

   **ANSWER**

8. **1782 oxcarts sold in 6 stores.**  
   162 colonas each oxcart.  
   How many sold in each store?

   **ANSWER**
1. Ana had 718 colones. She bought a doll worth 376 colones and a book worth 218 colones. How much money was left?

ANSWER______________________________________________

2. There are three vases on an altar. Six white roses are in each vase. How many roses are on that altar?

ANSWER______________________________________________

3. At Larry's dairy farm the cows have different colors and are divided into four groups. The black cows with white freckles are milked in the morning. The white cows with black freckles are milked at noon. The red cows with white spots are milked in the afternoon and the white cows with red spots are milked in the evening.

The cows produce different qualities of milk. The milk from the white freckled cows is used to make sour cream. The black freckled cows give milk to make ice cream. The red cows' milk is used to make cheese and the white cows' milk is to drink.

These cows do not like to be separated because they can not talk with their friends in other groups. So, they decided to make only one group. The resulting confusion was so big that Larry could not milk them for several days.

Larry decided to give the cows Sunday free so they could talk with their friends. With the new schedule the cows were happier and they increased the production of milk. Now Larry obtains 4138 liters of milk each week.

How much money does Larry earn if he sells each liter of milk for 6 colones?

ANSWER______________________________________________

4. The girls found 18 plants and 6 pots for the school. If each pot takes 2142 cubic centimeters of dirt, how much dirt is needed for the 6 pots?

ANSWER______________________________________________
5. 2751 rats.
7 gold coins for each rat.
How many coins in all?

ANSWER

6. Once upon a time Uncle Rabbit was invited to the wedding of Little Dora, the duck who was about to get married to Rick Duck.

On the wedding day Uncle Rabbit woke up quite early in the morning because he had to walk a distance of 7482 meters. He wore new pink shoes worth 258 colones and a very fine cotton coat. He also put on a fabric hat and tied a red silk handkerchief around his neck. He used his best cologne, groomed his moustache and left for the wedding.

When he was going to the church, he stopped by Uncle Tiger's store, bought the wedding present and some band-aid strips because his new shoes hurt him.

Poor Uncle Rabbit arrived at the party with his shoes in his hands and his toes wrapped with band-aid strips. The party was a lot of fun and Uncle Rabbit, despite the hurt in his feet, danced all the time with Aunt Weasel.

Uncle Rabbit spent 6 hours walking back to his house because he had to walk very slowly. How many meters did he walk in 1 hour?

ANSWER

7. Carlos and Pinocchio sold 1782 decorative oxcarts in 6 stores in San José. How many oxcarts did they sell to each store?

ANSWER

8. 3312 turtles to mark.
Each turtle lays 144 eggs.
8 persons marking.
Each person marks _____?

ANSWER
1. Ana compró una muñeca en 376 colonas y un libro en 218 colonas. Si ella tenía 718 colonas, ¿Cuánto dinero le quedó?

RESPUESTA

2. En un altar hay 3 floreros. Cada florero tiene 6 rosas blancas. ¿Cuántas rosas hay en ese altar?

RESPUESTA

3. Los estudiantes de cuarto grado querían decorar el aula durante las vacaciones. Deseaban tenerla limpia y atractiva para cuando comenzaran las clases.

Los niños se organizaron en dos grupos. Los varones pintaron la clase, y las mujeres hicieron las cortinas y buscaron 18 plantas apropiadas para el aula.

Como los niños no tenían dinero tuvieron que pedir los materiales necesarios a diferentes almacenes de la comunidad y a sus familias.

Cuando la niña Amparito, la maestra del grado, llegó a la escuela el primer día de clases casi se desmayó al entrar al aula. Una de las paredes estaba pintada de verde, otra de rojo, otra de azul y otra de amarillo. El cielo raso lo dejaron color café porque no lo pudieron pintar y el piso estaba cubierto de gotitas de diferentes colores. Las cortinas eran unas floreadas y otras moradas.

Las niñas tenían todos los materiales necesarios para sembrar las plantas. Si cada maceta necesita 2142 centímetros cúbicos de tierra, ¿cuántos centímetros cúbicos de tierra necesitan para llenar 6 macetas?

RESPUESTA

4. El flautista misterioso sacó 2751 ratas de la ciudad. ¿Cuántas monedas de oro recibió si por cada rata le dieron 7 monedas?

RESPUESTA
4158 litros de leche
a 6 colonas cada litro.
Se perdieron 462 litros de natilla.
¿Cuánto dinero se ganaron?

RESPUESTA

6. Pinocho se había convertido en un niño muy obediente y trabajador. El ayudaba a su papá en el taller de carpintería. Un buen día Pinocho recibió una carta de sus amigos de Sarchí. Ellos le pedían su ayuda en el taller de carretas decorativas de Carlos Castillo.

Pinocho comenzó a trabajar el mismo día que llegó a Sarchí porque tenían que terminar 1782 carretas para vender en 6 tiendas de San José.

Pinocho tenía gran habilidad para trabajar con piezas pequeñas de madera. Por eso le dieron a él la tarea de cortar las piezas de las carretas pequeñas y armarlas. Pinocho trabajó tan rápido que en menos de una semana terminó con toda la madera disponible.

Como ya no había más madera que cortar, Pinocho se dedicó a pintar las carretas. Nunca antes hubo carretas tan bien pintadas en el taller de Carlos Castillo.

Carlos y Pinocho fueron a San José a vender las carretas. ¿Cuántas carretas vendieron en cada tienda?

RESPUESTA

7. En el Parque Nacional de Tortuguero hay 8 personas marcando 3312 tortugas verdes. Cada tortuga pone 144 huevos. ¿Cuántas tortugas marca cada persona?

RESPUESTA

8. 7482 metros en 6 horas.
¿Cuántos metros caminó en 1 hora?

RESPUESTA
1. Ana compró una muñeca en 376 colonas y un libro en 218 colonas. Si ella tenía 716 colonas, ¿Cuánto dinero le quedó?

RESPUESTA

2. En un altar hay 3 floreros. Cada florero tiene 6 rosas blancas. ¿Cuántas rosas hay en ese altar?

RESPUESTA

3. En una ciudad de un país muy lejano había una increíble plaga de ratas. El rey había probado todas clases de ratoneras y venenos para ratas. Decidió entonces ofrecer una recompensa de 7 monedas de oro por cada rata a la persona que acabara con ellas.

Muchas personas se presentaron ante el rey para ofrecer sus ideas de cómo terminar con las ratas y así reclamar la recompensa. Pasaban los meses y el rey no encontraba ninguna de esas ideas satisfactorias. Hasta que un día llegó un extraño hombrillocillo quien ofreció terminar con la plaga de ratas usando su flauta misteriosa.

El flautista parado en la plaza de la ciudad empezó a tocar una extraña música. Los vecinos de la ciudad muy sorprendidos vieron cómo las ratas salían de todos los rincones y rodeaban al flautista para escuchar su música.

El flautista, sin dejar de tocar, se alejó de la plaza hacia el río seguido de una inmensa procesión de ratas. El flautista cruzó el río caminando y las ratas desaparecieron bajo el agua.

El flautista tocó durante 3 horas y sacó 2731 ratas de la ciudad. ¿Cuántas monedas de oro recibió?

RESPUESTA

4. En la lechería de Lenco se venden 4158 litros de leche por semana. ¿Cuánto dinero recibe si cada litro cuesta 6 colonas?

RESPUESTA
5. 18 plantas, 2142 centímetros cúbicos de tierra en cada maceta. ¿Cuánta tierra para 6 macetas?

RESPUESTA

6. Berta, la tortuga verde, es una de las miles de tortugas que vienen cada año a poner sus huevos en las playas de Tortuguero. El año pasado vinieron 3312 tortugas.

A Berta le gusta venir a este lugar porque es amiga de Beto y Betina. Éstos son dos niños quienes viven en el Parque Nacional de Tortuguero. Berta la tortuga sabe que estos niños trabajan con otras personas que cuidan a las tortugas. Berta está tranquila porque sabe que sus tortuguitas no van a pasar peligros cuando salgan de sus huevos.

Beto y Betina cuidan de que los huevos de las tortugas no sean sacados de los nidos por otros animales. Estos niños también cuidan de que las pequeñas tortugas no corran peligro cuando nacen y van camino al mar.

Berta y otras tortugas han sido identificadas con un número especial que se les pone en una placa de metal prendida de la concha. Esta identificación permite que los científicos se den cuenta del número y la clase de tortugas que llegan cada año a las playas de Tortuguero.

Hay 8 personas marcando tortugas. ¿Cuántas tortugas marca cada persona?

RESPUESTA

7. Tío Conejo caminó 7482 metros en 6 horas con zapatos nuevos que le costaron 258 colonas. ¿Cuántos metros caminó en 1 hora?

RESPUESTA

8. 1782 carreras vendidas en 6 tiendas. ¿Cuántas carreras vendieron en cada tienda?

RESPUESTA
1. Ana compró una muñeca en 376 colonas y un libro en 218 colonas. Si ella tenía 718 colonas, ¿cuánto dinero le quedó?

**RESPUESTA**

2. En un altar hay 3 floreros. Cada florero tiene 6 rosas blancas. ¿Cuántas rosas hay en ese altar?

**RESPUESTA**

3. En la lechería de Lencho las vacas son de diferentes colores y están separadas en cuatro grupos. Las vacas negras con pecas blancas son ordenadas en la mañana. A las vacas blancas con pecas negras las ordenan al medio día. A las vacas rojas con manchas blancas las ordenan en la tarde y a las vacas blancas con manchas rojas las ordenan en la noche.

Estas vacas producen leche de diferente calidad. La leche de las vacas con pecas blancas es para hacer natilla. Las vacas con pecas negras dan leche para hacer helados. Las vacas rojas dan leche para hacer queso y las vacas blancas dan leche para tomar.

A las vacas no les gustaba estar separadas porque no podían conversar con sus amigas. Entonces decidieron formar un solo grupo. Fue tal la confusión que Lencho no pudo ordenar por varios días y perdió 462 litros de natilla.

Lencho decidió darle a las vacas el domingo libre para que pudieran conversar con sus amigas. De esta manera las vacas estaban más contentas y aumentaron la producción. Ahora Lencho obtiene 4158 litros de leche cada semana.

¿Cuánto dinero se gana Lencho, si vende cada litro de leche en 6 colonas?

**RESPUESTA**

4. Las niñas consiguieron algunas plantas y 6 macetas para la escuela. Si cada maceta necesita 2142 centímetros cúbicos de tierra, ¿cuánta tierra necesitan para 6 macetas?

**RESPUESTA**
5. 2751 ratas en 3 horas
    a 7 monedas de oro cada rata.
    ¿Cuántas monedas de oro por todo?
    
    **RESPUESTA**

6. Una vez estaba tío Conejo invitado a la boda de la patita Tatiana que se casaba con el pato Patillas Pintas.

   El día de la boda tío Conejo se levantó muy temprano en la mañana. El pobre tenía que caminar una distancia de 7482 metros. Estrenó unos zapatos rosados y un saco de casimir azul muy fino. También se puso un sombrero de lona y se amarró un pañuelo de seda rojo al cuello. Después se puso agua de colonia, se peinó los bigotes y se fue a la boda.

   De camino a la iglesia pasó a la tienda de tío Tigre, compró el regalo para los novios y unas curitas pues los zapatos nuevos lo lastimaban.

   El pobre tío Conejo llegó a la fiesta con los zapatos en la mano y con los dedos de los pies cubiertos de curitas. La fiesta estuvo muy alegra y tío Conejo, a pesar de su dolor de pies, bailó todo el tiempo con tía Comadreja.

   Tío Conejo tardó 6 horas en regresar a su casa porque tuvo que caminar muy despacio. ¿Cuántos metros caminó en 1 hora?
    
    **RESPUESTA**

7. Carlos y Pinocho vendieron 1782 carretas decorativas a 162 colones cada una, en 6 tiendas de San José. ¿Cuántas carretas vendieron en cada tienda?
    
    **RESPUESTA**

8. 3312 tortugas para marcar.
    8 personas marcando.
    ¿Cuántas tortugas marca cada persona?
    
    **RESPUESTA**
1. Ana compró una muñeca en 376 colones y un libro en 218 colones. Si ella tenía 718 colones, ¿Cuánto dinero le quedó?

RESPUESTA

2. En un altar hay 3 floreros. Cada florero tiene 6 rosas blancas. ¿Cuántas rosas hay en este altar?

RESPUESTA

3. Los estudiantes de cuarto grado querían decorar el aula durante las vacaciones. Querían tenerla limpia y atractiva para cuando comenzaran las clases.

Los niños se organizaron en dos grupos. Los varones pintaron la clase, y las mujeres hicieron las cortinas y buscaron algunas plantas apropiadas para el aula.

Como los niños no tenían dinero tuvieron que pedir los materiales necesarios a diferentes almacenes de la comunidad y a sus familias.

Cuando la niña Amparito, la maestra del grado, llegó a la escuela el primer día de clases casi se desmaya al entrar al aula. Una de las paredes estaba pintada de verde, otra de rojo, otra de azul y otra de amarillo. El cielo raso lo dejaron color café porque no lo pudieron pintar y el piso estaba cubierto de gotitas de diferentes colores. Las cortinas eran unas floreadas y otras moradas.

Las niñas tenían todos los materiales necesarios para sembrar las plantas. Si cada maceta necesita 2142 centímetros cúbicos de tierra, ¿cuántos centímetros cúbicos de tierra necesitan para llenar 6 macetas?

RESPUESTA

4. El flautista tocó durante 3 horas y sacó 2751 ratas de la ciudad. ¿Cuántas monedas de oro recibió si por cada rata le dieron 7 monedas?

RESPUESTA
5. 4158 litros de leche
a 6 colones cada litro.
¿Cuánto dinero se gana?

RESPUESTA

6. Pinocho se había convertido en un niño muy obediente y trabajador. Él ayudaba a su papá en el taller de carpintería. Un buen día Pinocho recibió una carta de sus amigos de Sarchí. Ellos le pedían su ayuda en el taller de carretas decorativas de Carlos Castillo.

Pinocho comenzó a trabajar el mismo día que llegó a Sarchí porque tenían que terminar 1782 carretas para vender en 6 tiendas de San José.

Pinocho tenía gran habilidad para trabajar con piezas pequeñas de madera. Por eso le dieron a él la tarea de cortar las piezas de las carretas pequeñas y armarlas. Pinocho trabajó tan rápido que en menos de una semana terminó con toda la madera disponible.

Como ya no había más madera que cortar, Pinocho se dedicó a pintar las carretas. Nunca antes hubo carretas tan bien pintadas en el taller de Carlos Castillo.

Carlos y Pinocho fueron a San José a vender cada carreta en 162 colones. ¿Cuántas carretas vendieron en cada tienda?

RESPUESTA

7. En el Parque Nacional del Tortuguero hay 8 personas marcando 3312 tortugas verdes. ¿Cuántas tortugas marca cada persona?

RESPUESTA

8. 7482 metros en 6 horas.
Los zapatos costaron 258 colones.
¿Cuántos metros caminó en 1 hora?

RESPUESTA
1. Ana compró una muñeca en 376 colones y un libro en 218 colones. Si ella tenía 718 colones, ¿Cuánto dinero le quedó?

RESPUESTA

2. En un altar hay 3 floreros. Cada florero tiene 6 rosas blancas. ¿Cuántas rosas hay en ese altar?

RESPUESTA

3. En una ciudad de un país muy lejano había una increíble plaga de ratas. El rey había probado toda clase de ratoneras y venenos para ratas. Decidió entonces ofrecer una recompensa de 7 monedas de oro por cada rata, a la persona que acabara con ellas.

Muchas personas se presentaron ante el rey para ofrecer sus ideas de cómo terminar con las ratas y así reclamar la recompensa. Pasaban los meses y el rey no encontraba ninguna de esas ideas satisfactoria. Hasta que un día llegó un extraño hombrecillo quien ofreció terminar con la plaga de ratas usando su flauta misteriosa.

El flautista parado en la plaza de la ciudad empezó a tocar una extraña música. Los vecinos de la ciudad muy sorprendidos vieron cómo las ratas salían de todos los rincones y rodeaban al flautista para escuchar su música.

El flautista, sin dejar de tocar, se alejó de la plaza hacia el río seguido de una inmensa procesión de ratas. El flautista cruzó el río caminando y las ratas desaparecieron bajo el agua.

El flautista sacó 2751 ratas de la ciudad. ¿Cuántas monedas de oro recibió?

RESPUESTA

4. Lancho no pudo ordenar las vacas por varios días y perdió 462 litros de natilla. ¿Cuánto dinero recibe Lancho si vende 4158 litros de leche a 6 colones cada litro?

RESPUESTA
5. 2142 centímetros cúbicos de tierra en cada maceta. ¿Cuánta tierra para 6 macetas?

RESPUESTA

6. Berta, la tortuga verde, es una de las miles de tortugas que vienen cada año a poner sus huevos en las playas de Tortuguero. El año pasado vinieron 3312 tortugas.

A Berta le gusta venir a este lugar porque es amiga de Bato y Betina. Estos son dos niños quienes viven en el Parque Nacional de Tortuguero. Berta la tortuga sabe que estos niños trabajan con otras personas que cuidan a las tortugas. Berta está tranquila porque sabe que sus tortuguitas no van a pasar peligros cuando salgan de sus huevos.

Bato y Betina cuidan de que los huevos de las tortugas no sean sacados de los nidos por otros animales. Estos niños también cuidan de que las pequeñas tortugas no corran peligro cuando nacen y van camino al mar.

Berta y otras tortugas han sido identificadas con un número especial que se les pone en una placa de metal prendida de la concha. Esta identificación permite que los científicos se den cuenta del número y la clase de tortugas que llegan cada año a las playas de Tortuguero.

Hay 8 personas marcando tortugas. Cada tortuga pone 144 huevos. ¿Cuántas tortugas marca cada persona?

RESPUESTA

7. Tío Conejo caminó muy despacio con sus zapatos nuevos 7482 metros en 6 horas. ¿Cuántos metros caminó en una hora?

RESPUESTA

8. 1782 carretas vendidas en 6 tiendas a 162 colones cada carreta. ¿Cuántas carretas vendieron en cada tienda?

RESPUESTA
1. Ana compró una muñeca en 376 colones y un libro en 218 colones. Si ella tenía 718 colones, ¿cuánto dinero le quedó?

RESPUESTA

2. En un altar hay 3 floberos. Cada flobero tiene 6 rosas blancas. ¿cuántas rosas hay en ese altar?

RESPUESTA

3. En la lechería de Lencho las vacas son de diferentes colores y están separadas en cuatro grupos. Las vacas negras con pecas blancas son ordeñadas en la mañana. A las vacas blancas con pecas negras las ordeñan al medio día. A las vacas rojas con manchas blancas las ordeñan en la tarde y a las vacas blancas con manchas rojas las ordeñan en la noche.

Estas vacas producen leche de diferente calidad. La leche de las vacas con pecas blancas es para hacer natillas. Las vacas con pecas negras dan leche para hacer helados. Las vacas rojas dan leche para hacer queso y las vacas blancas dan leche para tomar.

A las vacas no les gustaba estar separadas porque no podían conversar con sus amigas. Entonces decidieron formar un solo grupo. Fue tal la confusión que Lencho no pudo ordeñar por varios días.

Lencho decidió darle a las vacas el domingo libre para que pudieran conversar con sus amigas. De esta manera las vacas estaban más contentas y aumentaron la producción. Ahora Lencho obtiene 4156 litros de leche cada semana.

¿Cuánto dinero se gana Lencho, si vende cada litro de leche en 6 colones?

RESPUESTA

4. Las niñas consiguieron 18 plantas y 6 macetas para la escuela. Si cada maceta necesita 2142 centímetros cúbicos de tierra, ¿cuánta tierra necesitan para 6 macetas?

RESPUESTA

Nombre: ____________________________  Sexo: __________
Apellido: __________________________  __________

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3. Salieron 2731 ratas a 7 monedas de oro cada una. ¿Cuántas monedas de oro por todo?

RESPUESTA

6. Una vez estaba tío Conejo invitado a la boda de la patita Tatiana que se casaba con el pato Patillas Pintas.

El día de la boda tío Conejo se levantó muy temprano en la mañana. El pobre tenía que caminar una distancia de 7482 metros. Estrenó unos zapatos rosados que le costaron 258 colonas y un saco de camisón azul muy fino. También se puso un sombrero de lona y se amarró un pañuelo de seda rojo al cuello. Después se puso agua de colonia, se peinó los bigotes y se fue a la boda.

De camino a la iglesia pasó a la tienda de tío Tigre, compró el regalo para los novios y un par de zapatos nuevos lo lastimaban.

El pobre tío Conejo llegó a la fiesta con los zapatos en la mano y con los dedos de los pies cubiertos de curitas. La fiesta estuvo muy alegre y tío Conejo, a pesar de su dolor de pies, bailó todo el tiempo con tía Comadreja.

Tío Conejo tardó 6 horas en regresar a su casa porque tuvo que caminar muy despacio. ¿Cuántos metros caminó en 1 hora?

RESPUESTA

7. Carlos y Pinocho vendieron 1782 carretas decorativas en 6 tiendas de San José. ¿Cuántas carretas vendieron en cada tienda?

RESPUESTA

8. 3312 tortugas para marcar.
144 huevos pone cada tortuga.
8 personas marcando.
¿Cuántas tortugas marca cada persona?

RESPUESTA

y sus hermanos desean un televisor para poder programas educativos. Como ellos durante el año, decidieron cafe durante las vacaciones poder reunir el dinero para pagar el televisor.

cogidas de cafe comenzaron primera semana de noviembre. Juanita, sus hermanos Pancho se presentaron con canastos muy temprano en cafetal de don Lalo. el monito, resultó ser gran cogador de cafe. se sentaba en el de uno de los y con mucho cuidado únicamente los granitos rojos. vez en cuan-
do Pancho al suelo para recoger granos caídos. De esta Juanita y sus hermanos perdían tiempo recogiendo cafe suelo.

La hora almuerzo era una fiesta Pancho y para los cogedores de cafe. Todas personas se sentaban en suelo y sacaban las con queso y frijoles las botellas con agua. Pancho recibía como recompensa su labor un banano maduro y una bolsita maní. Alguno de los tocaban guitarra y cantaban, Pancho bailaba muy contento.

la ayuda de Pancho, y sus hermanos ganaron dinero para comprar un televisor a colores.

Juanita y familia están felices. Ahora todos ven programas educativos y están muy agradecidos con Pancho.
Pancho El Cogedor De Café

Juanita es la hija mayor de una familia de campesinos. Juanita tiene seis hermanos y todos son estudiantes. Pancho es también parte de la familia. Él es un gracioso monito cariblanco que ayuda a los muchachos en los oficios de la casa y en la huerta.

Juanita y sus hermanos desean comprar un televisor para poder ver programas educativos. Como ellos estudian durante el año, decidieron coger café durante las vacaciones para poder reunir el dinero necesario para pagar el televisor.

Las cogidas de café comenzaron la primera semana de noviembre. Ese día Juanita, sus hermanos y Pancho se presentaron con sus cañastos muy temprano en el cafetal de don Lalo. Pancho, el monito, resultó ser un gran cogedor de café. Él se sentaba en el hombro de uno de los muchachos y con mucho cuidado cogía únicamente los granos rojos. De vez en cuando Pancho saltaba al suelo para recoger los granos caídos. De esta manera Juanita y sus hermanos no perdían tiempo recogiendo café del suelo.

La hora del almuerzo era una fiesta para Pancho y para los otros cogedores de café. Todas las personas se sentaban en el suelo y sacaban las tortillas con queso y frijoles y las botellas con agua dulce. Pancho recibía como recompensa a su labor un banano bien maduro y una bolsita de maní. Algunos de los muchachos tocaban guitarra y cantaban, mientras Pancho bailaba muy contento.

Con la ayuda de Pancho, Juanita y sus hermanos ganaron suficiente dinero para comprar un buen televisor a colores.

Juanita y su familia están felices. Ahora todos ven programas educativos y están muy agradecidos con Pancho.
Pancho the coffee collector

Juanita is the oldest daughter of a peasant family. Juanita has six brothers and all of them are students. Pancho is part of the family as well. He is a pretty little monkey who helps the boys with the house chores and the orchard work.

Juanita and her brothers wish to buy a television set for watching educational programs. They decided to work on a coffee plantation during their vacation to earn the money needed to pay for the television.

Picking the coffee beans started in the first week of November. That day Juanita, her brothers and Pancho arrived quite early with their baskets at the Lalo's plantation. Pancho, the little monkey, turned out to be a great coffee collector. He used to sit down on one of the boy's shoulders and carefully pick only the red beans. From time to time Pancho jumped down to pick up the fallen beans from the ground. Therefore, Juanita and her brothers did not spend any time picking up the beans from the ground.

At lunch time Pancho and the other coffee-bean pickers had a lot of fun. Everybody sat on the ground having tortillas with cheese and beans, and water sweetened with molasses. The only things that Pancho asked for as a reward for his labor were a very ripe banana and a little bag of peanuts. Some of the boys used to play the guitar and sing while Pancho danced very happily.

With Pancho's help, Juanita and her brothers earned enough money to buy a good color television set.

Juanita and her family are very happy. Now they watch educational television programs and all of them are quite grateful to Pancho.
RESUELVA LAS SIGUIENTES OPERACIONES:

(1) \[ \begin{array}{c}
376 \\
+ 218 \\
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(5) \[ \begin{array}{c}
718 \\
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(2) \[ 2142 \times 6 \]

(6) \[ 7482 \times 6 \]

(3) \[ 2751 \times 7 \]

(7) \[ 3312 \times 8 \]

(4) \[ 1782 \times 6 \]

(8) \[ 4158 \times 6 \]
1. Ana compró una muñeca en 376 colones y un libro en 218 colones. Si ella tenía 718 colones, ¿cuánto dinero le quedó?

**RESPUESTA**

2. En un altar hay 3 floreros. Cada florero tiene 6 rosas blancas. ¿Cuántas rosas hay en ese altar?

**RESPUESTA**

3. Los estudiantes de cuarto grado querían decorar el aula durante las vacaciones. Deseaban tenerla limpia y atractiva para cuando comenzaran las clases.

Los niños se organizaron en dos grupos. Los varones pintaron la clase, y las mujeres hicieron las cortinas y buscaron 18 plantas apropiadas para el aula.

Como los niños no tenían dinero tuvieron que pedir los materiales necesarios a diferentes almacenes de la comunidad y a sus familias.

Cuando la niña Amparito, la maestra del grado, llegó a la escuela el primer día de clases casi se desmayó al entrar al aula. Una de las paredes estaba pintada de verde, otra de rojo, otra de azul y otra de amarillo. El cielo raso lo dejaron color café porque no lo pudieron pintar y el piso estaba cubierto de gotitas de diferentes colores. Las cortinas eran unas floreadas y otras moradas.

Las niñas tenían todos los materiales necesarios para sembrar las plantas. Si cada maceta necesita 2142 centímetros cúbicos de tierra, ¿cuántos centímetros cúbicos de tierra necesitan para llenar 6 macetas?

**RESPUESTA**
5. 4158 litros de leche
    a 6 colones cada litro.
    Se perdieron 462 litros de natilla.
    ¿Cuánto dinero se ganaron?

Respuesta

6. Pinocho se había convertido en un niño muy obediente y trabajador. El ayudaba a su papá en el taller de carpintería. Un buen día Pinocho recibió una carta de sus amigos de Sarchí. Ellos le pedían su ayuda en el taller de carretas decorativas de Carlos Castillo.

    Pinocho comenzó a trabajar el mismo día que llegó a Sarchí porque tenían que terminar 1782 carretas para vender en 6 tiendas de San José.

    Pinocho tenía gran habilidad para trabajar con piezas pequeñas de madera. Por eso le dieron a él la tarea de cortar las piezas de las carretas pequeñas y armarlas. Pinocho trabajó tan rápido que en menos de una semana terminó con toda la madera disponible.

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Respuesta

7. En el Parque Nacional de Tortuguero hay 8 personas marcando 3312 tortugas verdes. Cada tortuga pone 144 huevos. ¿Cuántas tortugas marca cada persona?

Respuesta

8. 7482 metros en 6 horas.
    ¿Cuántos metros caminó en 1 hora?

Respuesta
1. Ana compró una manzana en 376 colones y un libro en 216 colones. Si ella tenía 718 colones, ¿Cuánto dinero le quedó?

RESPUESTA

2. En un altar hay 3 floreros. Cada florero tiene 6 rosas blancas. ¿Cuántas rosas hay en ese altar?

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RESPUESTA
8. 7482 metros en 6 horas. ¿Cuántos metros caminó en 1 hora?

RESPUESTA

4. El flautista misterioso sacó 2751 ratas de la ciudad. ¿Cuántas monedas de oro recibió si por cada rata le dieron 7 monedas?

RESPUESTA

3. Los estudiantes de cuarto grado querían decorar el aula durante las vacaciones. Deseaban tenerla limpia y atractiva para cuando comenzaran las clases.

Los niños se organizaron en dos grupos. Los varones pintaron la clase, y las mujeres hicieron las cortinas y buscaron 18 plantas apropiadas para el aula.

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RESPUESTA

5. 4158 litros de leche a 6 colones cada litro. Se perdieron 462 litros de natilla. ¿Cuánto dinero se ganaron?

RESPUESTA
1. Ana compró una muñeca en 376 colones y un libro en 218 colones. Si ella tenía 718 colones, ¿cuánto dinero le quedó?

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   ¿Cuántos metros caminó en 1 hora?

**RESPUESTA**

7. En el Parque Nacional de Tortuguero hay 8 personas marcando 9312 tortugas verdes. Cada tortuga pone 144 huevos. ¿Cuántas tortugas marca cada persona?

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¿Cuánto dinero se ganaron?

RESPUESTA

4. El flautista misterioso sacó 2751 ratas de la ciudad. ¿Cuántas monedas de oro recibió si por cada rata le dieron 7 monedas?

RESPUESTA
1. Ana compró una muñeca en 376 colones y un libro en 218 colones. Si ella tenía 718 colones, ¿cuánto dinero le quedó?

RESPUESTA

2. En un altar hay 3 floreros. Cada florero tiene 6 rosas blancas. ¿Cuántas rosas hay en ese altar?

RESPUESTA

4. El flautista misterioso sacó 2751 ratas de la ciudad. ¿Cuántas monedas de oro recibió si por cada rata le dieron 7 monedas?

RESPUESTA

3. Los estudiantes de cuarto grado querían decorar el aula durante las vacaciones. Desearan tenerla limpia y atractiva para cuando comenzaran las clases.

Los niños se organizaron en dos grupos. Los varones pintaron la clase, y las mujeres hicieron las cortinas y buscaron 18 plantas apropiadas para el aula.

Como los niños no tenían dinero tuvieron que pedir los materiales necesarios a diferentes almacenes de la comunidad y a sus familias.

Cuando la niña Amparito, la maestra del grado, llegó a la escuela el primer día de clases casi se desmaya al entrar al aula. Una de las paredes estaba pintada de verde, otra de rojo, otra de azul y otra de amarillo. El cielo vaso lo dejaron color café porque no lo pudieron pintar y el piso estaba cubierto de gotitas de diferentes colores. Las cortinas eran unas floreadas y otras moradas.

Las niñas tenían todos los materiales necesarios para sembrar las plantas. Si cada maceta necesita 2142 centímetros cúbicos de tierra, ¿cuántos centímetros cúbicos de tierra necesitan para llenar 6 macetas?

RESPUESTA
8. 7482 metros en 6 horas. ¿Cuántos metros caminó en 1 hora?

RESPUESTA 

7. En el Parque Nacional de Tortuguero hay 8 personas marcando 3312 tortugas verdes. Cada tortuga pone 144 huevos. ¿Cuántas tortugas marca cada persona?

RESPUESTA 

6. Pinocho se había convertido en un niño muy obediente y trabajador. Él ayudaba a su papá en el taller de carpintería. Un buen día Pinocho recibió una carta de sus amigos de Sarchí. Ellos le pedían su ayuda en el taller de carretas decorativas de Carlos Castillo.

Pinocho comenzó a trabajar el mismo día que llegó a Sarchí porque tenían que terminar 1782 carretas para vender en 6 tiendas de San José.

Pinocho tenía gran habilidad para trabajar con piezas pequeñas de madera. Por eso le dieron a él la tarea de cortar las piezas de las carretas pequeñas y armarlas. Pinocho trabajó tan rápido que en menos de una semana terminó con toda la madera disponible.

Como ya no había más madera que cortar, Pinocho se dedicó a pintar las carretas. Nunca antes hubo carretas tan bien pintadas en el taller de Carlos Castillo.

Carlos y Pinocho fueron a San José a vender las carretas. ¿Cuántas carretas vendieron en cada tienda?

RESPUESTA 

5. 4158 litros de leche a 6 colones cada litro. Se perdieron 462 litros de natilla. ¿Cuánto dinero se ganaron?

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RESPUESTA
APPENDIX C

PERMISSION LETTER

FROM COSTA RICAN MINISTRY

OF EDUCATION
San José, Lunes 6 de junio de 1983.

Sr. Director
División de Operaciones
Ministerio de Educación Pública
San José

Estimado Señor Director:

Por este medio me permito dirigirme a Vd. muy atenta y respetuosamente para rogarle sirva extenderme un permiso escrito para presentarme a algunas escuelas del país a administrar un cuestionario de matemática para cuartos y sextos años.

El cuestionario mencionado es uno de los instrumentos que me propongo usar en mi trabajo de tesis doctoral en The Ohio State University donde me encuentro estudiando actualmente. A continuación le presento en detalle los nombres de las escuelas que desearía visitar, cada una con sus datos de regionalización y localización geográfica.

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Agradeciéndole de antemano la ayuda que se sirva prestarme, quedo del Sr. Director de la División de Operaciones muy atenta servidora,

MARÍA JIMÉNEZ DE BUJÁN, M.A.
Señor
Lin. Rafael Angel Bocón Vargas
Director Regional de Educación
Región Central
S. G.

Estimado señor:

La Prof. María A. Jiménez de Buján M. A., va a realizar una investigación en las Escuelas y grados indicados en el oficio fecha 6 de junio de 1983, que le adjunto.

Como el trabajo es de utilidad para el país y para obtener el Doctorado de la Prof. Jiménez, le solicito autorizar a la portadora de la presente para realizar el trabajo propuesto.

Atento y seguro servidor,

JOSE ALFREDO NURIZADO CHAVERRI
Director de División de Operaciones

cc: Prof. María A. Jiménez de Buján M.A.
Arch.