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AN EXPLORATORY STUDY OF THE PROBLEM-SOLVING PROCEDURES USED BY SELECTED COLLEGE FRESHMEN ON CERTAIN BASIC CONSUMER MATHEMATICS PROBLEMS

A Dissertation

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Lastly, I thank my children, Paul, Jr. and Carla, for their understanding, enthusiasm, assistance, patience, and interest during the time of this study. To them, this study is dedicated.

ABSTRACT

This study was designed to analyze the records of the problem-solving procedures used by students while they solved selected consumer mathematics problems. A Coding System, Check List, Error List, and Problem-Solving Questionnaire (PSQ) were developed. A pilot study was conducted during the Fall of 1975 using some of the consumer mathematics problems from the first assessment in mathematics conducted by the National Assessment of Educational Progress (NAEP). Eight of these problems were chosen to be used in the final study. Thirty-two students were chosen from among the freshmen who entered Walters State Community College (WSCC) in Morristown, Tennessee during the summer or fall quarter of 1975. They were divided into groups for various comparisons.

For the PSQ, the students were divided by sex for one comparison. For another comparison, they were divided into Hi-Math and Lo-Math groups based on their mathematics scores on the Cooperative School and College SCAT Test. The PSQ was completed by the students after they had solved the problems. The responses given on the PSQ gave information regarding the mathematical backgrounds, attitudes, and interests of the students.

On 80 percent of the 20 questions on the second part

of the PSQ, the responses indicated that the students in the Hi-Math and Lo-Math groups had similar opinions. This was also true when the sexes were compared. However, the majority of the Hi-Math group indicated that they do not have a difficult time concentrating on homework, like to discover different methods for solving the same problem, enjoy working on mathematical games and puzzles, and would rather respond slowly to a mathematics question than gamble an answer. The majority of the students in the Lo-Math group indicated opposite opinions on the above-mentioned items. According to responses on the PSQ, the majority of the females do not have a hard time concentrating on homework, like to discover different ways of solving the same problem, would rather give a wrong answer than no answer, and prefer doing to thinking while males think differently on each of these items.

For analyzing the problem-solving procedures, the students were divided into four groups based on their comprehension scores on the Nelson-Denny Reading Test as well as their mathematics scores on the SCAT test. For this analysis, they were also divided by sex. The students talked into a tape recorder as they solved the eight problems. Each tape was transcribed and an analysis of each problem for each student was made using the tapes as well as the protocols, work sheets, and observation remarks. The behaviors exhibited by the students that

corresponded to the various Coding System variables, Check List items, and Error List numerals were identified. Comparisons were made among the four groups and between the sexes relative to the three areas mentioned above. There were other errors identified that were peculiar to each problem that were not specifically stated in the Error List.

It was found that more students in the Hi-Math, Hi-Comp group displayed characteristics of efficient problem solvers than students in the other three groups. On the other hand, fewer students in the Lo-Math, Lo-Comp group displayed characteristics of efficient problem solvers than students in the other three groups.

Students in the Lo-Math, Lo-Comp group made more errors per problem than students in the other groups. Fewer errors per problem were made by students in the Hi-Math, Lo-Comp group.

A pattern in a problem-solving procedure as defined for this study was established by all students in finding an average and in correctly reading information from a graph.

More males did not finish the problems and did not understand the problems than females but more females used inappropriate algorithms and made more computational errors than males. The other behaviors that the two sexes

exhibited while solving the problems were very much alike.

The percentages of students from this study and the NAEP study who obtained correct results were very close. When data regarding incorrect responses were given, the percentages for the two groups were very close.

Various findings are given in the study which relate to specific types of errors, various mathematical skills used or not used, problem-solving procedures, patterns established, implications for the classroom teacher, and implications for future research.

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CHAPTER I

INTRODUCTION

I. INTRODUCTION

Green (1966) pointed out that problem solving has been easier to talk about than to investigate. Furthermore, disagreements about language and research strategy have provided a useful diversity in studying a poorly understood area. Both mathematics educators and psychologists realized that there was a need for more research in this area, and the last decade has seen an increase in studies devoted to special areas of problem solving. Some of these areas include the development of problem solving skills (Kleinmuntz, 1966; Pinzka, 1963; Polya, 1957; Post, 1967; Rosenbloom, 1966), ways of teaching problem solving (Dahmus, 1970; Fuller, 1971; Jerman, 1971; Kennedy, 1970; Marks, Purdy, and Kinney, 1965; Newell and Simon, 1972; Polya, 1966; Schminke, Maertens, and Arnold, 1973; Sloyan, 1961; Sowder, 1972; Spencer and Brydegaard, 1966; Whirl, 1973; Wickelgren, 1974), procedures for solving problems (Gagné, 1966; Kilpatrick, 1968; Polya, 1962; Sims, 1969; Smith, 1971), and traits of good problem solvers (Dodson, 1970; Forehand, 1967; Gagné, 1970). William James said that

the solution of problems is the most characteristic and peculiar sort of voluntary thinking (Polya, 1962).

Gagné (1966) thought of problem solving as a process by which the learner discovered a combination of previously learned rules that could be applied to achieve a solution for a new problem. Implicit in this belief was that there existed a close relationship between learning and problem solving. There was a difference of opinion as to the exact nature of this relationship. There were some who felt that problem solving was an extension of learning while others believed that learning was problem solving in disguise (Green, 1966). In other words, problem solving was an inferred change in human capability that resulted in acquiring a rule that could be generalized which was new to the individual. This rule could not have been established by direct recall and could be seen in the applications for solving a class of problems (Gagné, 1966).

Polya (1962) contended that to have a problem meant "to search consciously for some action appropriate to attain a clearly conceived, but not immediately attainable aim." To find such action was to solve a problem. He summed up his views by saying that problem solving was devising a well-conceived, coherent scheme of operations, of logical, mathematical or material operations which proceeded from the hypothesis to the

conclusion, from data to the unknown, from things we had to things we wanted.

The National Assessment of Educational Progress (NAEP) reported that students and young adults were very weak in problem-solving skills. This was demonstrated by their performance on the exercises in the mathematics assessment dealing with consumer mathematics (Branscombe, 1975). It was also reported that males performed better on these questions than females (NAEP, 1975c).

II. STATEMENT OF THE PROBLEM

The problem of this study was to analyze the records of the problem-solving procedures used by students while they solved selected consumer mathematics problems that were taken from the NAEP exercises. The specific questions answered were:

1. What were the similarities and differences in the problem-solving procedures and errors made among the following groups: Group I (Hi-Math, Hi-Comp), Group II (Hi-Math, Lo-Comp), Group III (Lo-Math, Hi-Comp), and Group IV (Lo-Math, Lo-Comp)?

2. What were the noticeable patterns established and identical skills used in the problem-solving procedures of the students in each of the four groups named above?

3. What were the similarities and differences in the problem-solving procedures and errors made by the female students as opposed to the male students?

4. What were the noticeable patterns established and identical skills used in the problem-solving procedures of the female and male students?

5. Were there differences in the answers given to the problems by the students in this study and the 17-year-olds in the NAEP study?

6. What were the similarities and differences in the responses given on the Problem Solving Questionnaire (PSQ) between students in Group A (Hi-Math) and Group B (Lo-Math)? (PSQ is found in Appendix B.)

7. What were the similarities and differences in the responses given on the PSQ between the female and male students?

III. PROCEDURES AND SOURCES OF DATA

Preparation for the Study

The following steps were taken in preparing for this study:

1. Permission was secured from the Technical Information Coordinator for NAEP for using the problems in the NAEP publication: Consumer Math: Selected Results from the First National Assessment of Mathematics (NAEP-CM).

2. A pilot study (see page 38) was conducted using the problems from NAEP-CM.

3. Eight questions were chosen from NAEP-CM for the final study.

4. A tape was made which had general instructions for the students and an example of the "thinking aloud" technique in working a problem (see Appendix D).

5. Permission was secured from Jeremy Kilpatrick to use portions of his dissertation.

6. A Coding System, Check List, Error List, and Problem Solving Questionnaire were developed (see page 46).

7. Permission was secured from the Dean of Students at Walters State Community College (WSCC) in Morristown, Tennessee to use the records of selected freshmen from that college.

8. Approval of the prospectus from the Human Subjects Committee at The University of Tennessee was received.

9. Students were chosen and letters written asking them to participate in the study (see Appendix C).

10. Each participant was assigned a code number.

Selection of the Population

Freshmen entering WSCC in 1975 were used for the study. All students who took the Nelson-Denny Reading Test and the Cooperative School and College SCAT Test

during the summer of 1975 were divided into two groups based on their mathematics scores on the SCAT Test. They were divided again, forming four groups, based on their comprehension scores on the Nelson-Denny Test (see page 39). Four males and four females were chosen from each of the four groups to participate in the study.

Selection of the Eight Problems

In the previously mentioned publication, NAEP-CM, data concerning students' responses to 21 selected problems used in the NAEP study were given. The problems fell into one of the following categories:

A. Household problems.

B. Determining costs.

C. Using the concepts of average and percent.

D. Reading and interpreting graphs and tables.

The problems used for the final study were representative of each of the above categories (see page 42).

Development of the Coding System

Dalton (1974) used a modification of Kilpatrick's (1968) coding system in his study. Herbert and Attridge (1975) gave some guidelines for developing a coding system. Suggestions from Dalton, Kilpatrick, Herbert and Attridge and the results of the pilot study were used to develop the Coding System for this study.

Development of the Check List and Error List

Kilpatrick's (1968) check list and interview rating form for the mathematics problems test were used to develop the Check List (see page 49). Certain modifications were made based on the questions being asked and the responses given during the administration of the pilot study. The Error List (see page 50) was developed from the errors made by the students who participated in the pilot study and some suggestions from NAEP-CM.

Development of the Problem Solving Questionnaire (PSQ)

Kilpatrick (1968) devised an excellent problem solving questionnaire for junior high school students. A slight modification of it was made for use in this study. Most of the changes required rephrasing or deleting statements so that they would be appropriate for college students (see Appendix B).

Procedure for the Study

1. A meeting was held for all students who had indicated an interest in participating in the study. (Additional meetings had to be scheduled because all students could not attend this one.)

2. An interview schedule was made based on the availability of the students and the interviewer.

3. Each student was informed of the time for the interview.

4. At the beginning of the individual interview, general instructions were given to the student.

5. After solving the eight problems, the PSQ was filled out by the student.

6. The tapes were transcribed and the protocols (see Appendix E) were analyzed using the Coding System, Check List, and Error List.

7. The PSQ statements were tabulated.

IV. IMPORTANCE OF THE STUDY

Conceptions of mental ability stem to a major degree from two traditions of mental testing: the psychometric and the clinical traditions. The psychometric approach describes the mental abilities of a student based on a set of problems assembled into a test. The description then emphasizes whether the answers were right or wrong. These impersonal tests do not give information on "how" the problems were solved. The clinical approach involves a situation where the student is observed by a skilled observer while solving problems. This description is one whereby the observer gives his interpretation about the student's mental ability (Forehand, 1967).

Another method is needed that would identify the deficiencies in problem solving by analyzing the procedures used in arriving at the solutions. From

determining these deficiencies, specific programs could be devised that would be based on these difficulties.

Research has been done which compares various methods of teaching problem solving, determines the kinds of errors made in problem solving and the frequency of such errors, and also looks at how students think when they solve problems (Dessart and Frandsen, 1973; Flaherty, 1975; Riedesel, 1969). The "thinking aloud" technique has been used to try to understand the thinking processes that students use in solving problems. It not only gives some insight into the difficulties encountered in solving problems but also helps in understanding various procedures that can be used successfully (Flaherty, 1975; Kilpatrick, 1968).

This study has provided data that describe the problem-solving procedures used by selected college freshmen in solving eight consumer mathematics problems. These data can be used to aid in the teaching of problem solving. The reports given by NAEP (1975a,b,c,d,e, 1976), and the numerous articles and speeches which are based on these reports indicate a need for strengthening the teaching of problem-solving skills (Knauer, 1975; McFeatters, 1975).

V. BASIC ASSUMPTIONS

The following basic assumptions were made:

1. The students chosen from each group were representative of that group.

2. The "thinking aloud" technique did not change the procedure that the students would normally have used for solving the problems.

3. The students were interested in participating in the study and did their best to think aloud while solving the problems.

4. The eight problems were representative of the basic mathematics problems that the consumer encounters each day.

5. The problems were well written and easily understood.

VI. SCOPE AND LIMITATIONS

This study was limited to entering freshmen at WSCC who took the Nelson-Denny Reading Test and the Cooperative School and College SCAT Test during the summer of 1975. The study was limited to four males and four females from each group because of the time required for each interview, transcribing each tape, and analyzing each protocol. Since there would be no statistical analysis of the data, there was no need to randomize the

selection of students from each group.

VII. DEFINITIONS

1. Statement problem - A written mathematical question which requires more than simple recall to answer. An immediate solution may not occur to the reader, but a solution does exist.

2. Problem-solving procedure or process sequence - A sequence of steps used to determine an answer to a statement problem, e.g., the initial step is "to read the problem." Other steps used in this study are listed in Chapter III with the Coding System (see page 46) and Check List (see page 49).

3. Pattern in a problem-solving procedure - A sequence of steps for solving a problem used by more than 50 percent of the students in a group.

4. Mathematical skills - Skills that take place at three cognitive levels: rote computation (accurately carrying out previously learned algorithms), comprehension (translating concepts, understanding and explaining algorithms and mathematical principles, and recognizing specific concepts), and problem solving (recognizing familiar problems, applying appropriate algorithms, and analyzing unfamiliar problems).

5. Thinking aloud - The method whereby the student talked into a tape recorder while solving a problem.

This talking consisted of saying what the student was writing or thinking in order to solve the problem.

6. Protocol - The written record of the words spoken by each student in solving each problem. This record is transcribed from the tapes.

VIII. ORGANIZATION OF THE STUDY

Chapter I contains an introduction to the study of problem-solving techniques. It presents a statement of the problem, procedures and sources of data, importance of the study, basic assumptions, scope and limitations, definitions, and organization of the study.

Chapter II contains a review of the literature related to problem solving in general, specific problem-solving techniques, and the National Assessment of Educational Progress.

Chapter III gives the design and the procedures used in completing the study.

Chapter IV has a presentation and analysis of the data.

Chapter V contains the conclusion, implications for teachers, and implications for future research.

CHAPTER II

REVIEW OF RELATED LITERATURE

I. INTRODUCTION

Rain is for feeling, sun is for warming, and problems are for solving (Inskeep, 1969). The development of the ability to solve problems is probably the most important part of one's education. It is at the very heart of the study of mathematics (Fine, 1966; O'Brien and Shapiro, 1969). Problem solving represents a skill that requires continuous development and refinement (Georges, 1956; Reys, 1974). Verbal problems often cause many frustrations for students and teachers. There is a desperate need for successful experiences in solving problems throughout one's school life. Techniques for solving problems need to be developed and practiced (Getzels, 1956; Reys, 1975).

Most writers on problem solving agree that the process takes a lot of time and proceeds through certain phases or stages (Henderson and Pingry, 1953; Polya, 1957; Silva, 1973; Weir, 1974). Some phases that were agreed to be standard are:

1. Statement of the problem or perceiving the problem.

2. Defining the problem by distinguishing essential features.

3. Searching for and formulating a hypothesis or selecting a plan.

4. Executing the plan or verifying and validating the solution.

5. Making a general review.

Essential ingredients of problem solving are the desire, the will, and the resolution to solve problems (Pottenger and Leth, 1969). As educators analyzed the act of problem solving, they found certain characteristics common to good problem solvers which are reflected in the phases given above (Troutman and Lichtenberg, 1974).

Dodson (1970) described successful insightful mathematics problem solvers in terms of their performance on mathematics achievement tests, their possession of certain cognitive and personality traits, and the characteristics of their teachers, school, and communities. The teacher who believes that development of problem-solving skills is an important instructional objective will help his students in the intelligent application of knowledge to the problems of the classroom as well as the problems of daily living.

This portion of the literature review has dealt with problem solving in general. There are many areas that

one could discuss that are related to problem solving. In this study certain specific topics have been used, and the remainder of this chapter will be devoted to these areas. The comprehension score on the Nelson-Denny Reading Test was used as a means of placing students into various groups. Part II of this chapter will be devoted to literature pertaining to reading and language as factors in solving verbal problems. Another area of the study focused on the procedures used by males as opposed to procedures used by females to solve the same problems. Part III will report findings in the area of sex differences in various learning areas and more specifically in the area of problem solving. Implicit in the entire study is the improvement of problem-solving skills. Part IV contains literature which deals with this area. Reviews of studies that compare methods for improving problem-solving skills will be found in Part V. The "thinking aloud" technique was used in this study as the writer secured the problem-solving procedures used by students. Part VI will deal with this procedure and some ramifications of it. The problems used for this study were developed by the National Assessment of Educational Progress. A brief history and explanation of NAEP will be found in Part VII.

II. READING AND LANGUAGE AS FACTORS IN PROBLEM SOLVING

Much research has been done on the relationship of reading ability to mathematical achievement (Aiken, 1972; Collier and Redmond, 1974; Coulter, 1972). Not only do "poor" readers have a problem with the language of mathematics, but students who are called "good" readers sometimes have difficulty. Many teachers take the attitude that all reading should be taught by the reading teacher and that the mathematics teacher should only teach mathematics (Barney, 1972).

Students must be taught how to read mathematics since it includes reading words and symbols with differing relations and orders that are represented in various ways depending on the situation (Hater, Kane, and Byrne, 1974). Since the vocabulary in mathematics is often technical and specific, attention must be given to vocabulary development. Language development involves four kinds of vocabularies: reading, listening, speaking, and writing. It was stated that one of the skills requisite for reading mathematics content successfully was the ability to translate words, phrases, sentences, and sentence combinations. This translation process requires four vocabularies: verbal symbol, numerical symbol, literal symbol, and operational symbol. In addition to these

vocabularies the student must have the ability to attack new words as well as develop new meanings or more precise mathematical meanings for familiar words.

Some students read mathematics narrative problems so slowly and laboriously that they forget what they read at the beginning of the problem by the time they get to the end of it. Barney (1972), Fouch and Nichols (1959), Hater, Kane, and Byrne (1974), Henney (1971), Spencer and Russell (1960), and many others have each described some very good procedures that would help students who have difficulty with general reading associated with mathematics.

Success in solving verbal problems definitely involves the ability to read. In addition to understanding the vocabulary, one must possess computational skills and be a critical thinker (Collier and Redmond, 1974; Henney, 1971). Reading verbal problems requires more intense concentration than that needed for reading other kinds of non-technical materials. Rereading is often essential for successfully understanding a verbal problem. Time must be taken periodically to reflect on what has been read, to search for relations in the information given, and to apply appropriate mathematical skills for the solution of the problem.

Thompson (1967) did a study that showed that mental ability and readability were each very signifi-

cant in their effect on problem solving. The interaction between these was found to be significant. Readability had a greater effect on the students with lower mental ability than those with higher mental ability. Readability referred to reading ease.

The efficiency of a mathematics student to solve verbal problems can be increased if he is given help in learning to read problems. No one method or technique is enough to remove all the deficiencies that exist in reading mathematics verbal problems and the general reading deficiencies need to be studied by all teachers (Barney, 1972; Henney, 1971). When discussing reading, methods to improve one's ability to read mathematics, and improving one's ability to read in general, it must be understood that with this reading comes comprehension. To be able to understand what a problem has asked implies that one has comprehended the problem and can then begin to follow the various steps involved in solving the problem (Brune, 1953; Coulter, 1972; Herber, 1970; Moulder, 1969).

III. SEX DIFFERENCES IN VARIOUS LEARNING AREAS

It has been found that males dominate in educational success in certain areas (NAEP, 1975a,c,e). Mullis (1975) looked at the results from various learning

areas where an assessment had been made by NAEP. She noted that:

1. In the 1970-1971 reading assessment, females surpassed males in most reading skills and for the most part read faster.

2. In the reading and literature assessment, females performed better than males.

3. In the 1969-1970 writing assessment, females had an advantage over males.

Other research has shown that females are generally superior to males in verbal ability which includes reading (Maccoby, 1966).

With this superior reading capability, which involves comprehension, it is difficult to understand why the performance of females in the areas of social science, mathematics, and science was not as good as that of males. Their poorer performance probably explains why relatively few women choose occupations that require a background in these areas.

In one report it was noted that high school males achieve in mathematics at higher levels than high school females (Fennema, 1974). It was found that this difference in achievement increases as adolescence progresses. Many speculations have been made as to the various factors involved which cause females to achieve at lower levels than males in mathematics. One factor suggested was that

females lack confidence in their ability to solve problems (Cody, 1961).

Koopman (1964) did a study whereby he had students work some problems then evaluate each solution as to whether they were sure or unsure the answer was correct, or sure the answer was incorrect. Decisions about the accuracy, goodness, suitability, or workability of the solution to each problem were obtained in the following manner:

1. Correct evaluation--gave correct solution and was sure it was correct, or obtained incorrect solution and was sure it was incorrect.

2. Unsure evaluation--gave a solution and was unsure of its correctness.

3. Incorrect evaluation--gave correct solution and was sure it was incorrect, or obtained incorrect solution and was sure it was correct.

Females made more unsure evaluations of their solutions than males. The males made significantly more correct evaluations and more incorrect evaluations than the females. These studies support the fact that what one believes about oneself significantly influences how one behaves. A positive belief in one's ability to learn and use mathematics is essential to learning and using mathematics (Bachman, 1970; Cleveland, 1967; Fennema, 1974; Fink, 1962).

In a study done by Post (1967) it was found that sex was not a significant factor in the determination of problem-solving ability. NAEP found that generally females tended to do better than males on "pure computation" exercises which required the application of a specific mathematical process. On the more difficult exercises and on word problems, males did better than females (Herman). Males consistently out performed females on exercises that involved buying and general household situations. This seemed very strange since some of the duties expected of women in our society today are those that involve buying and handling household affairs.

IV. IMPROVING PROBLEM-SOLVING SKILLS

Some of the difficulties which students have in developing mathematical problem-solving ability as stated by Wilson and Becker (1970) are:

1. Realizing that problem solving is more than answer getting.
2. Failing to consider exceptional cases.
3. Failing to review the solution.
4. Being mislead by the way the problem is presented.

Numerous educators have suggested ways of overcoming these difficulties through improving problem-solving skills.

It is important that problem-solving experiences begin in the early grades (Van Engen, 1963; Wisner, 1974). Snyder (1973) pointed out that many elementary school students ask for more story problems. She devised a voluntary type plan for her class so that she could provide problems for those who wanted them. By giving more story problems she found that the majority of her students lost their distaste for this type problem and no longer feared assignments that involved them.

The mathematics laboratory is a promising approach to the teaching of problem solving (Schaefer and Mauthe, 1970). The purpose of the mathematics laboratory is to provide students with opportunities to discover mathematical concepts through their active involvement in solving problems. The emphasis is on learning by doing. Schaefer and Mauthe gave numerous suggestions regarding activities that could be used in the laboratory. Through the laboratory experiences students get a deeper understanding of mathematical concepts and also learn that there are many approaches to solving a problem.

Sims (1969) presented some approaches that students could use as they begin to solve specific kinds of problems. The use of a developmental approach to the logical solution of problems might help clarify the processes involved. Teachers should provide their students with many opportunities to do each of the following: establish

and use guides to good thinking; follow directions; read, select, and evaluate; use problems without numbers; locate relevant and irrelevant data; find more than one question in a problem; find more than one way to work a problem; develop number sentences; use measures; use diagrams; and estimate a reasonable answer.

A method for teaching verbal problems was developed by Dahmus (1970) when he became interested in finding out why students have trouble in mathematics. He assumed that the causes of the difficulties did not lie in the student but in the teaching. He decided that problem solving could be an interesting area to investigate. The name of his method (DPPC) described the type of translation he felt was involved in solving problems--"direct," "pure," "piecemeal," and "complete." The key feature of this method is its concrete translation of all facts. He gave a very detailed description of his method as well as a demonstration and some examples of its use in the classroom. Dahmus gave some of the differences that exist between this method and others and also discussed some of the problems that are associated with teaching problem solving using this method. Boersig (1973) considered the DPPC method to be deceptive because of the meaning given to the term "problem solving." Dahmus meant successfully "getting the answer" through "derived" equations. The

more general meaning of problem solving is to search for implied relations and test hypotheses (Gagné, 1966 and 1970; Kinsella, 1970; Wilson and Becker, 1970). Boersig gave several reasons why she considered the DPPC method to be pedogogically unsound.

As has been pointed out in another section of this chapter, attitude has a lot to do with one's ability to solve problems. Sowder (1972) gave teachers some suggestions for things they could do to help provide students with a more nearly proper attitude toward problem solving and with "ammunition" beyond that provided by some algorithms. Included in his list were such things as teaching problem-solving processes as Polya (1957) has outlined, and giving students a lot of problems for practice with enough time to work on the problems.

Weir (1974) gave six working precepts that would help in solving problems. Three of these were preventive in that they showed how to avoid fixing attention on an incorrect line of reasoning. The other three were remedial and helped to keep one on the right track.

V. COMPARING METHODS FOR SOLVING PROBLEMS

In an effort to try to find the best method for teaching problem solving, many studies have been done which compare various methods. Richardson (1975)

reported on two different studies that compared two strategies for solving problems. In both studies the methods compared were the step method and the translation method. In one of the studies the teachers were involved in the experiment. Only preservice teachers who were student teaching at the time of the study were used. Each preservice teacher received four hours of instruction. They were divided into two groups for this instruction--one group received instruction in the two methods (step and translation) and the other group discussed enrichment topics that specifically did not relate to teaching verbal problems. After the instruction, the preservice teachers were chosen to teach a class that was not a part of their student teaching schedule. All students were taught the same material, in the same order for three days. This material included three verbal problems and an assignment sheet. It was found that teachers knowledgeable of strategies for solving problems could improve the problem-solving abilities of their students. In both studies the two methods were compared by comparing the verbal problem-solving achievement of the students taught using the two methods. It was found that both methods were about as equally effective in producing pupil achievement. Since the studies showed that the use of these problem-solving strategies resulted in increased

achievement, teachers should consider using the step method, the translation method, and/or a potential combination of the two methods.

In another study Jerman (1971) compared two programs that involve instruction in problem solving. One program which is called the Productive Thinking Program develops general problem-solving skills through systematic instruction. The student is expected to transfer this training to specific disciplines such as mathematics. Some studies have shown that this type program produced better problem solvers and some studies have failed to find any significant differences. The other program used in this study was the Modified Wanted-Given Program (MWGP). This program develops more specific skills for problem solving in a totally mathematical context. There was also a control group that did not receive instruction in either of these programs. There were no significant differences on the scores on posttest measures of problem-solving skills between each of the treatment groups and the control group or between the two treatment groups. On the word problem scale of a follow-up test, there was a difference found in favor of the MWGP. In an analysis of the procedures used by students to solve word problems, there was a significant difference in favor of the treatment groups over the control group.

Students in the MWGP used a correct procedure significantly more often on the posttest but not on the follow-up test than students in the other program. The treatments did influence the problem-solving strategies used by students. When there were significant differences, they favored the MWGP, and this should be a valid reason for using this approach.

One suggestion given in the previous section was to give students more problems and also give them enough time to work them (Sowder, 1972). A study conducted by Fuller (1971) showed that there are some students who use different procedures to solve problems when there is a time limit and when there is not a time limit. She tried to determine how these students differed from the students who did not change their procedure because of a time limit. She compared test anxiety scores, intelligence test scores, and the sexes. There were no significant differences in any of the three variables. She tried to identify any trends in the two types of students but found that no trends existed.

Several studies have been done that compare the problem-solving ability of students trained using an instructional strategy with students who are not given any training in this area. Hawkes (1971) studied students who were in these two groups (experimental and

control, respectively) and who were also divided according to scores on an intelligence test. Post (1967) did a similar study with the groups divided in the same manner. Hawkes found that instructional strategy training significantly influenced the scores of the experimental group. Post found that special instruction did not enhance the problem-solving ability of the students.

VI. "THINKING ALOUD" TECHNIQUE

There are various types of research designs that are used in mathematics education--action, philosophical, historical, survey, case study or clinical, and scientific experimentation (Johnson, 1966). This study was of a clinical nature and analyzed the procedures that students used in solving verbal problems. The technique used was called the "thinking aloud" technique. De Groot (1966) is a very strong advocate of this method and has a lot of confidence in it. Studies have been done using this method (Cody, 1961; Hawkes, 1971; Kilpatrick, 1968; Means, 1966).

When studies are done that involve analyzing problem-solving procedures, some kind of systematic procedure is needed for the analysis. Kilpatrick (1968) did an exploratory study in which he analyzed the solution of word problems in mathematics. In this study he devised coding system variables and a check list for

analyzing the protocols. He was aided in his system by previous work done by Polya. The subjects that he used were given problems to solve and were asked to think aloud as they solved each problem. The coding system variables and check list were then used to see how they were related to: (1) the use of systematic approaches to various spatial and numerical problems, (2) selected aptitude and achievement measures and to measures of cognitive styles, and (3) self-report measures of attitude toward mathematics, plans for the future, study habits, and the tendency to be reflective in problem solving. One important question that he posed was which dimensions from the coding system seemed most promising for grouping subjects into meaningful clusters. His results showed that the coding system proved to be both reliable and capable of identifying individual differences. Further research needs to be done to see how stable the coding system is in other situations.

Kropp (1953) did a study whereby in one method of interpretation of problem-solving procedures he assumed that students used the same method as the interpreter if they got the correct answer. His findings did not support this assumption. He used another method whereby he assumed that if the student got a correct response, then the student could successfully do the subsidiary

behaviors that were involved in the interpreter's solution. Again, this assumption was not validated.

A more detailed system is needed to analyze the protocols if any kind of conclusions are to be drawn from the procedures used. Smith (1971) devised a system which was called the Structure of Intellect Protocol Analysis System (SIPAS). She did a study using this system, and the results of her study confirmed the utility of the SIPAS technique for investigating problem-solving behavior for verbal problems. Kilpatrick (1968) did an exploratory study in which he analyzed the solution of mathematics word problems. In this study he devised coding system variables and a check list for analyzing the protocols. He found the system useful, and several other studies have used modifications of it. Both Kilpatrick and Smith recognize the fact that more studies need to be done using each of their systems.

Flaherty (1975) did a study in which he developed a coding system, then used it in analyzing problem-solving procedures used in the study. He compared the problem-solving behavior of students who were required to think aloud with those who were not required to verbalize overtly. He found that the requirement to think aloud appeared to exert an adverse effect on the problem-solving behavior of the verbal problem solvers.

In a study done by Dalton (1974) there was an effort made to determine whether there were patterns in the thinking processes used by average and below average ability mathematics students. He also determined the effects of "guiding questions" upon the thinking processes used and upon the attainment of correct solutions. He conducted individual interviews with students and had them think aloud as they solved certain problems. Each interview was recorded for later analysis. He used a modification of Kilpatrick's coding system. He was unable to draw any conclusions from his analysis of the protocols but certain observations were made relative to trends that were established.

Maxwell (1974) did an exploratory study with some geometry students and their methods for solving problems. She divided the students into convergent and divergent thinkers and then analyzed the methods that the two groups used to solve certain geometry problems. She found that the trial-and-error method was used initially but was replaced by a search for patterns or generalizations. She also found that an over-dependence on rules and generalizations interferred with effective problem solving. Maxwell also used a modification of Kilpatrick's coding system. She did not record the interview sessions which made it impossible to review the exact words used

by the students and made it difficult to analyze the responses.

VII. NATIONAL ASSESSMENT OF EDUCATIONAL PROGRESS

The National Assessment of Educational Progress is a project of the Education Commission of the States. It started with concerns of Francis Keppel when he was United States Commissioner of Education (1962-1965). He realized that standardized tests were giving very little information about what students were or were not learning (NAEP, 1974; Womer, 1970). After a series of conferences, John Gardner, who was president of the Carnegie Corporation, formed the Exploratory Committee on Assessing the Progress of Education (ECAPE). This committee, chaired by Ralph Tyler, was composed of outstanding educators and concerned persons.

ECAPE decided that it was feasible to start an assessment project that would give information regarding the quality of educational outcomes by a periodic assessment of the knowledges, understandings, skills, and attitudes in 10 learning areas at four age levels. The original project was called Committee on Assessing the Progress of Education (CAPE) and was funded by the Carnegie Corporation. When the Education Commission of the States and the United States Office of Education

became involved, the name was changed to the National Assessment of Educational Progress (NAEP).

This project provides information to education decision makers and practitioners to help them identify educational problem areas, establish educational priorities, and determine the national progress in education. Eight goals were established for the project and are listed below:

1. To measure change in the educational attainments of young Americans.

2. To make available on a continuing basis comprehensive data on the educational attainments of young Americans.

3. To utilize the capabilities of National Assessment to conduct special interest "probes" into selected areas of educational attainment.

4. To provide data, analyses and reports understandable to, interpretable by, and responsive to the needs of a variety of audiences.

5. To encourage and facilitate interpretive studies of NAEP data, thereby generating implications useful to educational practitioners and decision makers.

6. To facilitate the use of NAEP technology at state and local levels when appropriate.

7. To continue to develop, test and refine the

technologies necessary for gathering and analyzing NAEP achievement data.

8. To conduct an ongoing program of research and operational studies necessary for the resolution of problems and refinement of the NAEP model. (Implicit in this goal is the conduct of research to support previously mentioned goals.)

The 10 learning areas were art, career and vocational development, citizenship, literature, mathematics, music, reading, science, social studies, and writing. These areas were divided so that no more than three areas would be assessed in any one school year. The NAEP reporting populations included 9-, 13-, and 17-year-olds who were enrolled in public or private schools as well as 17-year-olds who were not enrolled in school. There was also a group of young adults in the age range of 26 to 35. Within these age groups, results were reported by geographic region, sex, color, parental education, and size and type of community.

The geographic regions were divided into four areas (Northeast, Southeast, Central, and West) and each state was included in one of these areas. Only Black and White results are reported because the other ethnic groups did not constitute a large enough group to include for reporting purposes. The distinction made for parental

education included four areas: no high school, some high school, graduated from high school, and post high school. There were seven size and type of community (STOC) reporting categories which comprised three "extreme" types of community (TOC) and four "residual" sizes of community (SOC). Each TOC category included about 10 percent of the respondents at each age level, and the remaining respondents were classified according to one of the SOC classifications.

The three TOC categories were: city areas where a high proportion of the adult population was either not regularly employed or on welfare and a low proportion was employed in professional or managerial positions; rural areas where a high proportion of adults were farm workers and a low proportion were professional, managerial, or factory workers; and near-city and city areas where a high proportion of adults were employed in professional or managerial positions and a low proportion were factory or farm workers, not regularly employed or on welfare. The respondents were placed in one of those categories if the occupational profile and location of the school or, in the case of the out-of-school sample, segment satisfied the extreme TOC definitions. The remaining respondents at each age level were classified according to the size of community in which the school or segment

was located. For the in-school sample at each age and the supplementary sample at age 17, the school principal of each selected school provided estimates of the percentage of students whose parents fit into the various occupational categories. Other occupational data for the out-of-school sample were obtained from the respondents themselves for the year the mathematics assessment was made. In some other years census data were used to determine other occupational data for the out-of-school sample (NAEP, 1974).

Numerous articles have been written about NAEP in general (Allison, 1972; Brain, 1972; Finley, 1972; Olson, 1975; Tyler, 1970, 1972, 1974; Von Ende, 1972; Womer, 1968). There are those who see the value of such an assessment and those who raise questions about its worth and implications. As various learning areas are assessed, articles are written concerning the results, implications of the results, and how the results can be used effectively in the classroom (Ahmann, et al., 1973; Giles, 1973; Johnson, 1972; NAEP, 1975b,d; Saylor, 1974; Womer and Mastie, 1971).

The mathematics assessment was done during the 1972-1973 school year. Included in mathematics was consumer mathematics. The results of the consumer mathematics assessment caused such startling headlines as

"Most Americans Flunk Math," and "Poor Math Skills Hurt Consumer." The president of the National Council of Teachers of Mathematics said, "Based on the NAEP report, improved mathematics education for consumer utilization is needed." These are but a few of the things that have caused mathematics educators to take a look at what is being taught and how it is being taught in an effort to improve mathematics education (Ahmann, 1972; Branscombe, 1975; Carpenter, et al., 1975; Foreman and Mehrens, 1971; Martin and Wilson, 1974; McFeatters, 1975; Merwin and Higgins, 1968; NAEP, 1976; Wolfe, 1972).

CHAPTER III

PROCEDURES

I. INTRODUCTION

The pilot study; procedures for the selection of the population and the problems; the problems; the development of the Coding System, Check List, Error List, and Problem Solving Questionnaire; and the general procedures used in this study are included in this chapter.

II. PILOT STUDY

A pilot study was conducted during the fall quarter of 1975. About 60 students were interviewed individually and each solved one or two problems. The students who were interviewed were not included in the population of the main study but were similar to those students from which the samples of the study were chosen.

The problems given in NAEP-CM were used in the pilot study. The participants were asked to read the problem aloud and say everything that they thought in solving the problem. Each interview was taped and the participants were aware of the taping. The participants knew that the primary interest was in determining how

students solve problems and not whether they obtained a correct answer. The students were in the room alone while they solved the problems.

The pilot study answered the following questions:

1. Would students talk aloud while solving problems if they were not reminded to do so?

2. What were some of the procedures used in solving the problems?

3. What type of problems provided the greatest interest and variety of procedures and solutions?

4. How many problems should be used in the final study so that each interview would take no more than one hour?

5. What type of errors were made in solving the problems?

Answers to these questions will be found in various sections of this chapter.

III. SELECTION OF THE POPULATION

Each summer, students who are planning to enter WSCC as freshmen during the summer or fall quarter of that year are given entrance tests. Students who were over 20 years of age at the time of testing were eliminated from the total population as well as those who did not enroll in WSCC in the summer and/or fall quarter of 1975. The over-20-year-olds were eliminated

because data from NAEP for 17-year-olds would be used for some comparisons. Those who did not enroll in WSCC in the summer and/or fall quarter of 1975 were eliminated because they could not be contacted for possible participation.

The Nelson-Denny Reading Test and the Cooperative School and College SCAT Test were tests administered in the summer of 1975. Various types of data could be secured from these tests. For this study only the comprehension score from the Nelson-Denny Test and the mathematics score from the SCAT Test were used. The comprehension score was used because research has shown that reading and comprehension are important factors in solving verbal mathematics problems (Aiken, 1969; Thompson, 1967).

Students whose comprehension scores were in the fifty-first percentile or above constituted the Hi-Comp group and the others were in the Lo-Comp group. Students whose mathematics scores were above the fiftieth percentile were in the Hi-Math group and the others were in the Lo-Math group. Students who took both of these tests in the summer of 1975 and had not already been eliminated, were divided into two groups (Group A and Group B) based on their mathematics score. They were divided again into four groups (Groups I-IV) based on their scores on the two tests.

Group A consisted of students who were in the Hi-Math group, while Group B was composed of those students who were in the Lo-Math group. Group I consisted of those students who were in the Hi-Math and Hi-Comp groups. Students who were in the Hi-Math and Lo-Comp groups were in Group II. Group III was composed of students in the Lo-Math and Hi-Comp groups. This left Group IV to consist of those students who were in the Lo-Math and Lo-Comp groups.

Letters (see Appendix C) were written at the end of December 1975 to five males and five females from each of the four groups, asking them to participate in the study. Some of those who were asked did not re-enter WSCC in the winter quarter of 1976, so alternates were chosen who represented the same sex and same group. A similar letter was sent to them. At least four males and four females from each of the four groups consented to participate in the study. The students (except for one who asked) did not know how they were chosen and that they were representing one of the various groups. Each participant was assigned a unique code number which had three parts. The first part was a Hindu-Arabic numeral from 1 through 4, the second part was the letter M or F depending on the sex, and the third part was a Roman numeral from I through IV which represented the group number.

IV. SELECTION OF THE PROBLEMS

In a letter from Wayne Martin, Technical Information Coordinator for NAEP, it was pointed out that since NAEP is federally funded, the released materials and reports are considered to be in the public domain. Therefore, anyone has access to the materials for their own use and the data for interpretative purposes.

The problems for the pilot study were taken from the consumer mathematics problems used by NAEP in the mathematics assessment which was conducted during the 1972-1973 school year. Before the problems were written, objectives which stated specific goals were developed by educators, scholars, and laymen from all over the country (Norris and Bowes, 1970). Exercise writers then developed measurement tools that were appropriate to the objectives. After these exercises passed extensive reviews by mathematics specialists and measurement experts, they were given a national try-out by students who represented the various regions of the country, the different sizes and types of communities, all socioeconomic levels, both colors, and both sexes (see page 34). After these tests were scored, mathematics specialists carefully reviewed all the responses. The exercises were again reviewed by the specialists and the ones chosen for use in the assessment were selected on

the basis of exercise quality, importance, difficulty, and coverage of desired objectives. These were then reviewed and approved by the United States Office of Education (NAEP, 1974).

Data concerning student responses on 21 of these problems were given in NAEP-CM. These 21 problems were divided into four main categories and used in the pilot study. Category A was on household problems and contained exercises dealing with proportion, and measures of weight, length, capacity, time, and area. In Category B on determining costs, the problems dealt with cost and percentage, taxes, costs over time and distance, and cost comparisons. Category C, which was on using the concepts of average and percent, had problems on finding averages and computations with percents. Reading and interpreting graphs and tables were the types of problems in Category D.

In the pilot study, the students tended to guess the answers to the multiple choice questions and so all questions of this type were eliminated from being considered for use in the final study. This type of behavior in answering multiple choice questions has been noted in other reports (Williams, 1974). It was hoped that problems could be selected from each of the areas within each of the four categories, but this would have caused the interview session to be too long. It was found during the pilot study that a maximum of eight problems could be

solved orally within one hour.

In the statements that follow, the rationale for choosing the eight problems is given. The numeral (numerals) within parentheses represents (represent) the number assigned to the problem for this study. The problem involving proportion was somewhat similar to the one involving taxes. The proportion problem was chosen since it dealt with calories and students are quite calorie conscious (one). In reviewing the problems that dealt with measurement, the results from the pilot study were used to choose the problem from this area. The variety of procedures used and the varying solutions given were responsible for the choice that was made (two). With the exception of the taxation problem, one problem was chosen from each of the subdivisions of Category B. When a choice had to be made, it was based on the fact that the problem was one that consumers face constantly: comparing prices (three, four, and five). In Category C there was only one problem concerning averages so it was used (six). One of the problems dealing with percent required more than finding the percent of a number and hence it was selected (seven). In the pilot study and also nationally more students had difficulty interpreting graphs than interpreting tables (NAEP, 1975b). The graph problem was chosen for that reason (eight). The questions used in the pilot study that were not used in

the final study are found in Appendix A.

V. THE PROBLEMS

The following problems were used in the final study. In the parentheses preceding each problem, the main category and the specific subdivision that it represented are given:

1. (Category A - Use of Proportion) - If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food?

2. (Category A - Measures of Time) - A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook?

3. (Category B - Cost and Percentage) - Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15 percent. What is the difference in the sale price of the two stores of a TV set that is regularly priced at $100?

4. (Category B - Costs over Time) - A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged?

5. (Category B - Cost Comparisons) - A new

automobile can be bought for cash for $2,850 or on credit with a down payment of $400 and $80 a month for three years. How much MORE would a person pay by buying on credit rather than buying the car for cash?

6. (Category C - Average) - Last summer Todd earned $205, Charlotte earned $562, and Dale earned $400. What is the average of their summer incomes?

7. (Category C - Computation with Percents) - In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percent of the total number of votes did Joe receive?

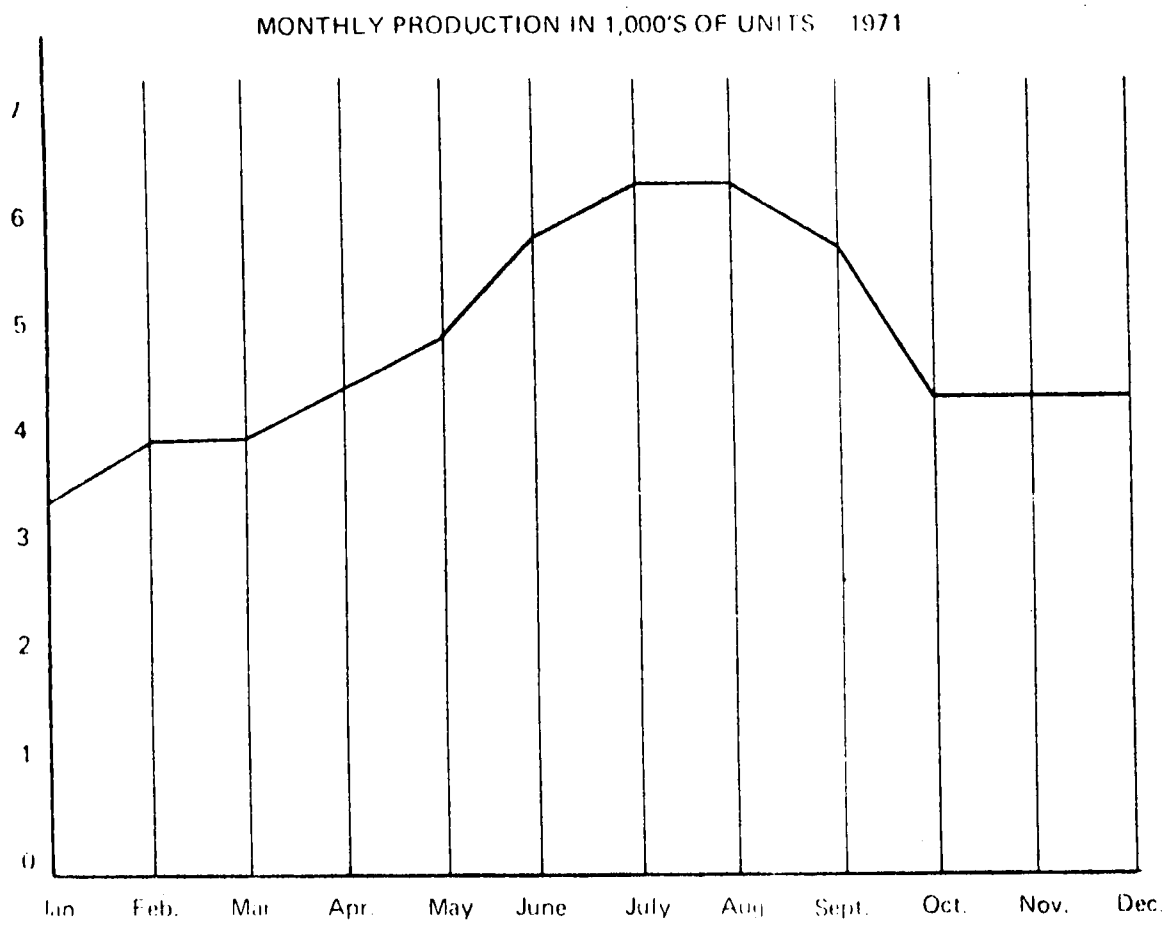
8. (Category D - Interpreting Graphs) - The graph on the opposite page shows the monthly production of Company X during 1971.

A. The greatest drop in production from one month to the next occurred between what two months?

B. The difference between the maximum and minimum monthly production during 1971 was approximately how many units?

VI. DEVELOPMENT OF THE CODING SYSTEM

Several studies have been done that required the use of a coding system for analyzing problem-solving procedures (Dalton, 1974; Flaherty, 1975; Kilpatrick, 1968; Kropp, 1953; Maxwell, 1974; Smith, 1971). Dalton



and Maxwell used a modification of the system devised by Kilpatrick (1968). Herbert and Attridge (1975) presented some excellent guidelines to use for developing coding and observation systems. Some of their ideas were utilized in the development of the Coding System used for this study. Kilpatrick developed one system and made many revisions before he devised a system that would satisfy the needs for his study. This system was divided into

three main sections: preparation, production, and evaluation. Kilpatrick refers to the elements of this system as coding system variables and that terminology is used in this study. Modifications were made in the subdivisions of the production section and the evaluation section was eliminated because it was difficult to ascertain whether the students checked their problems. The Coding System used in this study to analyze the protocols is given below. The meaning of the production section variables as used in this study is also given.

Preparation

Read problem without changing its meaning.

Read problem incorrectly such that the meaning was changed.

Production

Began with certainty - After reading the problem, within 25 seconds the student began to discuss a possible solution without being hesitant.

Began with uncertainty - After reading the problem, the student said one thing then changed to another, until some decision was made about how to proceed; or the student indicated an inability to solve the problem; or after more than 25 seconds the student began to discuss a possible solution.

Changed procedure - While solving the problem, the

student changed the procedure that was being used.

Incorrect procedure or algorithm used - While solving the problem, the student used an inappropriate algorithm or an incorrect procedure.

Mental computation - A computation that took place according to the tape but was not written on the work sheet.

Written computation - A computation that took place according to the tape and was written on the work sheet.

In addition to these variables, a number was used to represent the result of the process when the process caused a result. Kilpatrick devised a scheme which Dalton and Maxwell both used in their studies. This scheme was used in this study with slight modifications and is given below:

1 - incomplete.

2 - incorrect computation.

3 - correct computation.

4 - incorrect final result.

5 - correct final result.

VII. DEVELOPMENT OF THE CHECK LIST AND ERROR LIST

Kilpatrick's check list and interview rating form for the mathematics problems test were the bases used in developing the Check List. Flaherty (1975) used a similar

system for the coding system for his study. The Check List used in this study is as follows:

1. Reads problem or portions of it more than once.
2. Works problem one way then tries another.
3. Has trouble understanding the problem.
4. Uses inappropriate algorithm.
5. Tries to relate problem to a similar problem.
6. Questions uniqueness of solution.
7. Has trouble deciding on a method for solving the problem.
8. Knows procedures but can't perform the calculations.
9. Makes computational error.
10. Indicates uncertainty about final answer.

The pilot study revealed the types of errors made while solving the problems. These errors have been categorized as follows:

Type I - didn't finish the problem.

Type II - computational error.

Type III - inappropriate algorithm used.

Type IV - misunderstood problem.

VIII. DEVELOPMENT OF THE PROBLEM SOLVING QUESTIONNAIRE (PSQ)

Kilpatrick devised a problem solving questionnaire to be used with junior high school students. This

questionnaire was used with certain modifications. Some of the questions as stated were not appropriate for college students and were rephrased or deleted. In the last part of his questionnaire, he had three degrees for agreeing and three degrees for disagreeing. In this study, the choices for "moderately" agreeing and disagreeing were eliminated. The Problem Solving Questionnaire is given in Appendix B.

IX. GENERAL PROCEDURES

The procedure for selecting the participants has already been given (see page 39). Postcards (see Appendix C) were sent to each student who had indicated an interest in participating in the study. This card announced a meeting for the purpose of acquainting the participants with the project. It was important for every student to hear the same remarks, and some students indicated that they could not attend this meeting. For this reason, a tape was made that included general information regarding the study and an example of a student "thinking aloud" while solving a problem. The transcription of the tape is found in Appendix D. Every student listened to this tape before solving the problems. Each problem was on a separate sheet of paper so that the students could do all their computations on that paper. The code number that was assigned to each student was

written on each problem, on the Check List for each problem, and on the Problem Solving Questionnaire.

All interviews were held in the office adjoining a mathematics classroom at WSCC during the winter and spring quarters of 1976. The pilot study indicated that students would not talk aloud unless they were reminded to do so. It was intended that the interviewer remain in the room with the students as they solved the problems. The students requested that this not be done and this request was granted. It was possible for the interviewer to be in the adjoining classroom. She could remind the students to talk aloud if it appeared that they were not and also make certain observations as the students solved the problems. There were some students who would not talk aloud even when they were asked to and reminded to do so.

At the beginning of each interview, the student read the following:

> READ YOUR CODE NUMBER BEFORE YOU BEGIN. READ EACH QUESTION ALOUD. ANYTIME THAT YOU RE-READ THE QUESTION OR PORTIONS OF IT, DO THAT ALOUD ALSO. EVERYTHING THAT YOU THINK, SAY IT ALOUD SO THAT IT WILL BE RECORDED. IF YOU HAVE ANY QUESTIONS WHILE SOLVING THE PROBLEMS, ASK ME ABOUT THEM. PLEASE DO NOT DISCUSS THESE QUESTIONS WITH ANYONE ELSE WHETHER THEY ARE IN THE PROJECT OR NOT. THERE ARE EIGHT PROBLEMS. WHEN YOU FINISH ONE, GO ON TO THE NEXT ONE. THANKS SO MUCH FOR YOUR COOPERATION.

After the eight problems were solved, the Problem Solving Questionnaire was completed by the student. The

tapes were transcribed and the protocols were analyzed according to the Coding System, Check List, and Error List (see page 46). The transcriptions of the tapes are found in Appendix E. Omitted from the transcriptions are times when the students were requested to talk aloud and the times when the students said "o.k."

Letters (see Appendix C) were sent to all participants expressing appreciation for their cooperation in the project.

CHAPTER IV

RESULTS

This chapter is divided into 12 sections. The first three sections pertain to the Problem Solving Questionnaire, the fourth section gives information about the procedures used for analyzing the problems, and the last eight sections deal with the analysis of each problem.

I. PROBLEM SOLVING QUESTIONNAIRE (PSQ) - INTRODUCTION

The results of the tabulations of the PSQ are given first in order to acquaint the reader with the mathematical attitudes and backgrounds of the students in the study. For analyzing the PSQ, the students were divided into Group A (Hi-Math) and Group B (Lo-Math) for one comparison and then into female and male groups for another comparison. In the Statement of the Problem (see page 4), questions six and seven specifically relate to the PSQ. There were two parts to the PSQ and the results of each will be presented separately.

II. RESULTS OF PART I OF THE PSQ

Information secured verbally and from the first part of the PSQ indicated that students in this study represented both races, both sexes, and the four

categories of parental education as the students in the NAEP reporting groups (see page 34). There were four students, all from Group B, who took general mathematics as their only high school mathematics course. Three of the four were females. The remaining 28 students had at least one course in algebra. The following gives the percentages of 16 students in each of Groups A, B, Female, and Male who took various mathematics courses while in high school.

	General Mathematics	Algebra	Geometry	Trigonometry	Senior Mathematics
Group A Hi-Math	25	100	75	12	19
Group B Lo-Math	56	75	31	6	6
Female Group	31	81	62	12	12
Male Group	50	94	44	6	12

According to some research (Fennema, 1974; Herman, NAEP, 1975a,c,e) males perform better than females in mathematics, and it would be expected that more males would take advanced mathematics courses than females. Of the sample used for this study, 69 percent of the females took at least one course above algebra while only 44 percent of the males, while in high school, took a course more advanced than algebra. However, 94 percent of the males plan to take a college mathematics course and only

69 percent of the females indicated an interest in a college mathematics course. There were more students in Group A (81 percent) than Group B (31 percent) who took at least one course above algebra while in high school, and 88 percent of Group A indicated that they plan to take a college mathematics course while 75 percent of Group B suggested such plans. The students in Group A were consistent with their interest in taking mathematics courses while in high school and college. When the same population was categorized by sexes, a pattern was not established. In high school more females took advanced mathematics courses, but in college more males expressed an interest in taking mathematics courses.

Problem Solving Aids

Thirty-one percent of the females indicated that they had special instruction in problem solving while in high school, but only 6 percent of the males fell into this category. Twenty-five percent of the students in Group A had special instruction, and only 12 percent of the students in Group B were sure that they had such instruction. Only 19 percent of the students in this study had special instruction in problem solving while in high school. As a result of this, 53 percent of the sample have developed their own system for solving certain kinds of mathematics problems. Fifty-six percent of the

females, 50 percent of the males, 69 percent of the students in Group A, and 37 percent of the students in Group B indicated that they had developed some type of system for solving certain types of mathematics problems.

Another aid in successfully solving verbal mathematics problems is setting them up neatly. When asked the question, "Does setting up a problem as neatly as possible on paper help you in solving it?" the percentages of 16 students in each of the four groups who made specific responses are given below:

	Always	Very Often	Quite Often	Sometimes	Hardly Ever	Never
Group A Hi-Math	25	6	31	25	12	0
Group B Lo-Math	25	6	12	25	25	6
Female Group	12	6	31	19	25	6
Male Group	37	6	12	44	12	0

The students in Group A were more consistent with setting up problems neatly than the students in Group B. The males were more consistent than the females in exhibiting this trait.

Checking answers to mathematics problems is another aid in solving verbal problems successfully. The percentages of 16 students in each of the four groups who gave various responses to the question, "How frequently

do you check your answers to mathematics problems?" are as follows:

	Always	Very Often	Quite Often	Sometimes	Hardly Ever	Never
Group A Hi-Math	12	31	19	31	6	0
Group B Lo-Math	0	12	31	31	19	6
Female Group	12	19	25	37	0	6
Male Group	0	25	25	25	25	0

In all four groups, the responses indicated that students were very inconsistent in checking their answers to mathematics problems.

The last area on the first part of the PSQ dealt with how frequently students studied mathematics alone. When asked the question, "Do you study mathematics alone?" the percentages of 16 students in each of the four groups who made various responses are given below:

	Always	Very Often	Quite Often	Sometimes	Hardly Ever	Never
Group A Hi-Math	31	25	12	25	6	0
Group B Lo-Math	19	12	12	44	6	6
Female Group	12	25	19	37	0	6
Male Group	37	12	6	31	12	0

Of the students in Group A, more fell in the category of always studying alone than any other category and none of them study mathematics with someone else. This was also true of the males. The responses of the students in Group B indicated that more of them were in the "sometimes" category of studying mathematics alone than any of the other categories. The females were in this same category.

III. RESULTS OF PART II OF THE PSQ

This part of the PSQ required the student to agree or disagree with a specific statement. Strongly and mildly agreeing or disagreeing were considered as agreeing or disagreeing, respectively, in the results that are given. The total number of students responding to a specific statement varied from 14 to 16 for each of the four groups. The percentages are based on the number of students who responded to the particular statement. Table 1 gives the percentages of students in each of the four groups who agreed and disagreed with the 20 statements (see Appendix B) on the second part of the PSQ.

A group was categorized as agreeing or disagreeing with a statement based on the opinions of the majority of students in the group, i.e., if 54 percent of the group agreed, then the majority of the group agreed. When 50

TABLE 1

PERCENTAGES OF 16 STUDENTS IN EACH OF GROUPS A, B, FEMALE, AND MALE WHO AGREED AND DISAGREED WITH THE STATEMENTS ON THE SECOND PART OF THE PROBLEM SOLVING QUESTIONNAIRE

Statement[a]	Group A Hi-Math		Group B Lo-Math		Female Group		Male Group	
	Agree	Disagree	Agree	Disagree	Agree	Disagree	Agree	Disagree
1	36	64	47	53	36	64	47	53
2	50	50	75	25	53	47	80	20
3	100	0	44	56	60	40	80	20
4	64	36	18	81	40	60	40	60
5	29	71	38	62	27	73	40	60
6	14	86	44	56	27	73	33	67
7	21	79	38	62	33	67	27	73
8	57	43	56	44	67	33	47	53
9	93	7	81	19	93	7	80	20
10	79	21	81	19	87	13	73	27
11	38	62	19	81	29	71	27	73
12	86	14	75	25	93	7	67	33
13	29	71	69	31	47	53	53	47
14	71	29	44	56	67	33	47	53
15	50	50	60	31	73	27	47	53
16	71	29	75	25	87	13	60	40
17	79	21	62	38	80	20	60	40
18	29	71	50	50	47	53	33	67
19	79	21	94	6	100	0	73	27
20	86	14	100	0	93	7	93	7

[a]See Appendix B.

percent of Group A agreed and 50 percent of Group A disagreed on a specific statement, then the opinion of the majority of Group A was considered to be the same as the opinion of the majority of Group B on that particular statement. The same procedure was used when a similar situation occurred with Group B. With the female and male groups, there was always a majority who had a specific opinion.

Comparison of Opinions of Groups A and B

On 80 percent of the statements, the majority of the students in Groups A and B had similar opinions. This indicates that the students in the Hi-Math and Lo-Math groups have very similar attitudes toward mathematics and problem solving. Of the statements where their opinions were similar, they were in agreement with 63 percent of the statements and disagreed with 37 percent of them.

The statements where the majority of the two groups had differing opinions are of interest and possibly explain why the students are in the Hi-Math or Lo-Math groups. All of the students in Group A agreed that they would rather respond slowly to a question asked by the mathematics teacher than gamble in their answers, and 56 percent of Group B disagreed with the statement.

Eighty-one percent of the students in Group B do not enjoy working on mathematical games and puzzles, but

64 percent of Group A do enjoy this type of activity. Seventy-one percent of the students in Group A do not have a hard time concentrating on their mathematics homework, and 69 percent of those in Group B do have a hard time concentrating. In Group A, 71 percent of them like to discover several different ways to do the same problem while 56 percent of Group B do not enjoy this type of discovery.

The interest in mathematical games, having no difficulty concentrating on homework, and liking to discover different methods for solving the same problem are attributes that the majority of the students in the Hi-Math group possessed that are lacking in the majority of students in the Lo-Math group. These attributes could be associated with good problem solvers since they indicate an interest in mathematics.

Comparison of Opinions of Females and Males

The majority of the females and males had similar opinions on 80 percent of the statements. Some of these are the same statements on which the students in Groups A and B had similar opinions and some are not. The majority of each sex agreed on 56 percent of these statements and disagreed on 44 percent of them. This appears to show that the sexes are also very similar in their attitudes toward mathematics and problem solving.

Sixty-seven percent of the females indicated that they would rather give a wrong answer than no answer at all while 53 percent of the males would rather not do this. The sexes, like Groups A and B, differ in their attitudes toward concentrating on homework. Fifty-three percent of the females do not have a hard time concentrating, and 53 percent of the males do have a hard time concentrating on their mathematics homework.

Another difference of opinion between the sexes and the Hi-Math and Lo-Math groups relates to discovering different methods for solving the same problem. Sixty-seven percent of the females like to discover different ways to do the same problem, and 53 percent of the males do not like this type of discovery. The last statement where the sexes differ in their opinions is the one which states, "I prefer doing to thinking." Seventy-three percent of the females agreed, and 53 percent of the males disagreed.

The majority of the females do not have a hard time concentrating on homework and like to discover different methods for solving the same problem. Since these attributes could be associated with good problem solvers and some NAEP research (Herman) has shown that males are better problem solvers than females, it is surprising that the majority of females possess these attributes rather than the majority of males.

Statements of Agreement

In the following statements the majority of the students in Groups A and B agree as well as the majority of the students in both sexes:

2. I would rather ask for help on a difficult problem than work on it alone.

9. The most important reasons for learning mathematics are those concerning its usefulness.

10. The best way to learn how to solve mathematics problems is to solve lots of them.

12. Frequently the answer to a problem occurs to me after I have gone on to do something else.

16. I only raise my hand when I know I have the correct answer.

17. I would rather ask for help on a difficult mathematics problem than have someone tell me the answer.

19. It's better to be slower and right all of the time than to be faster and right part of the time.

20. I always guess on a multiple-choice test when I don't know the right answer.

There were some statements where the majority of the students in Groups A and B agreed, but the majority of the students in each sex were not in agreement. These statements are listed below:

8. I would rather give a wrong answer than no answer at all.

15. I prefer doing to thinking.

The one statement where the majority of the females and males agreed, but the majority of the students in Groups A and B were not in agreement was: "I would rather respond slowly to a question my mathematics teacher has asked than gamble in my answer."

Statements of Disagreement

Just as there were statements of agreement among the students in Groups A and B and the sexes, there were statements where the majority of the students in Group A and Group B were in disagreement and the majority of the students when categorized by sexes were also in disagreement. Those statements are:

1. I usually guess the answer to a problem before working it out in detail.

5. I can tell without checking whether an answer I have gotten is correct.

6. I have found that a period of silence before answering a question does not help me.

7. It is more important to be able to discuss mathematical ideas than to be able to work a variety of mathematical problems.

11. My first choice of a subject to study in college was one concerning the foundations of mathematics.

There were no other statements where the majority of

students in Groups A and B disagreed. However, the majority of both sexes disagreed with the following two statements:

4. I have always thoroughly enjoyed working on mathematical games and puzzles.

18. I don't like to discuss the problems on a test after I've finished it.

Summary

The majority of the students in Group A (Hi-Math) were more consistent in possessing characteristics of good problem solvers than the majority of the students in Group B (Lo-Math). When the students were categorized by sexes, there were certain characteristics of good problem solvers that were found in the majority of both sexes and also certain characteristics not present in the majority of each sex. The majority of the females indicated that they had the potential to be better problem solvers than the males.

IV. PROCEDURES FOR ANALYZING THE PROBLEMS

The tapes that were made by the students in the study were transcribed. The protocols and an explanation of the abbreviations and symbols used in the protocols are found in Appendix E. There were very few cases in which students did not talk as they had been requested, but in

those cases enough information could be secured from their work sheets to understand the procedures. Through the use of the tapes, protocols, and work sheets, an analysis of each problem was made.

Development of Process Sequence

When the protocols and work sheets were analyzed according to the Coding System (see page 46), the process sequence (see page 11) for each student for each problem was developed. The preparation section of the Coding System, "reads problem correctly or incorrectly," was coded at the beginning of the process sequence only. If the student reread the problem after beginning to solve it, this variable was not coded again. The first two variables in the production section, "began with certainty or uncertainty," were also coded only once in the process sequence for a given problem. When the student began to solve the problem, the remaining variables of the production section were coded in the order in which they occurred.

For the mental and written computations, the numeral "2" was coded if the computation was incorrect or the numeral "3" was coded if the computation was correct. There were no numerals associated with the variables "changed procedure" and "incorrect procedure or algorithm used." The last numeral in the process sequence was a "4" or a "5." The numeral "5" indicated that a correct final

result was obtained while the numeral "4" indicated that an incorrect final result was obtained. In a few instances, students wrote one answer on the work sheet and said another aloud. Whichever was correct, if either were, was used as the final result for that problem for that student. If a student did not finish the problem, the numeral "1" was coded preceding the numeral "4."

Determining Frequencies for the Coding System Variables

After the process sequence was developed, the students who attempted to solve the problem were separated into two categories: those who answered the problem correctly and those who did not. Frequencies for each of the Coding System variables were found for Groups I - IV, females, and males in each category. If the process sequences indicated that the students did any one of the following things at least once, they were included in the frequency for that variable: performed a correct or incorrect mental or written computation, changed procedure, or used an incorrect procedure or algorithm. The frequencies were converted to percentages based on the number of students from each group who fell into one of the two categories. Students who did not attempt to solve the problem were not included in these percentages.

Use of Error Type List

The numerals used to represent the type of error(s) made are described on page 50. If students did not attempt to work the problem, they were considered as not finishing the problem (Type I) as well as not understanding the problem (Type IV). If students made any of the four types of errors at least once while solving the problem, the corresponding Error Type numeral was assigned to them. The numerals are recorded in the table in ascending order rather than the order in which they occurred, if more than one error occurred for a student for a particular problem.

Determining Frequencies for Check List Items

The Check List was completed based on information from the tapes, protocols, work sheets, and personal observations made while the students were working the problems. Frequencies for each of the Check List items were found for Groups I - IV, females, and males. An item was checked only once for a student for a particular problem even if the student used the item more than once. The frequencies were converted to percentages based on the number of students in each group (eight for each of Groups I - IV, 16 for each sex).

Symbols and Abbreviations Used for Coding System Variables

Listed below are various symbols and abbreviations used in the tables to represent the Coding System variables. The symbols in parentheses are used in tables which give the process sequences and the abbreviations are used in tables which give Coding System percentages.

Read problem correctly	(R)	---
Read problem incorrectly	(I)	---
Began with certainty	(C)	BWC
Began with uncertainty	(U)	BWU
Changed procedure	(P)	CP
Incorrect procedure or algorithm used	(A)	IP
Mental computation: correct result	(M3)	MCC
Mental computation: incorrect result	(M2)	MCI
Written computation: correct result	(W3)	WCC
Written computation: incorrect result	(W2)	WCI

Abbreviations Used for Check List Items

The following abbreviations are used in the table which gives information about the Check List percentages:

Reads problem or portions of it more than once	RPA
Works problem one way then tries another	TAW
Has trouble understanding the problem	TUP
Uses inappropriate algorithm	UIA
Tries to relate problem to a similar problem	RSP
Questions uniqueness of solution	QUS

Has trouble deciding on a method for solving the problem DMS

Knows procedures but can't perform calculations KPO

Makes computational error MCE

Indicates uncertainty about final answer UFA

V. ANALYSIS OF PROBLEM ONE

Explanation of Problem

This problem required the student to determine how many calories were in a three-ounce portion of a food, if the number of calories in a nine-ounce portion were known. Table 2 gives the process sequences, final results, and error types for problem one for all students in Groups I and II (Hi-Math). Table 3 provides the same information for the students in Groups III and IV (Lo-Math).

Comparison with NAEP Sample

Seventy-two percent of the students in this study answered the problem correctly, whereas 70 percent of the 17-year-olds in the NAEP study obtained the correct result. Fifty-six percent of those in this study who obtained a correct answer were in Groups I and II (Hi-Math), and 52 percent of them were female. Twelve percent of the WSCC students used the correct process, but their answers were incorrect; only 3 percent of the NAEP sample fell into this category. All of the students in Groups I and II used

TABLE 2

PROCESS SEQUENCES, FINAL RESULTS, AND ERROR TYPES FOR PROBLEM ONE FOR STUDENTS IN GROUPS I AND II (HI-MATH)

Group	Sex	Student	Process Sequence[a]	Final Result	Error Type[b]
I	FEMALE	1FI	RC W2 A W3 4	96 calories	II, III
		2FI	RC M3 M3 5	100 calories	
		3FI	RU M3 W3 5	100 calories	
		4FI	RC W3 W3 5	100 calories	
	MALE	1MI	RC M3 W3 5	100 calories	
		2MI	RC W2 A W3 4	99.9 calories	II, III
		3MI	RU M3 W3 5	100 calories	
		4MI	RC M3 W3 W3 5	100 calories	
II	FEMALE	1FII	RU W3 P W3 W3 5	100 calories	
		2FII	RC M3 W3 5	100 calories	
		3FII	RU M3 W3 P W3 M3 5	100 calories	
		4FII	RU M3 5	100 calories	
	MALE	1MII	RC M3 W3 5	100 calories	
		2MII	RU W3 W3 5	100 calories	
		3MII	RU W3 A W3 4	99.9 calories	III
		4MII	RC M3 W3 5	100 calories	

[a]See page 70 for explanation of symbols.

[b]See page 50 for explanation of numerals.

TABLE 3

PROCESS SEQUENCES, FINAL RESULTS, AND ERROR TYPES FOR PROBLEM ONE FOR STUDENTS IN GROUPS III AND IV (LO-MATH)

Group	Sex	Student	Process Sequence[a]	Final Result	Error Type[b]
III	FEMALE	1FIII	RU M3 W3 P W3 W3 5	100 calories	
		2FIII	RC W3 W3 5	100 calories	
		3FIII	RU W2 1 4	33 calories	II, IV
		4FIII	RU M3 5	100 calories	
	MALE	1MIII	RC M3 5	100 calories	
		2MIII	RU M3 W3 A W3 4	900 calories	III, IV
		3MIII	RU M3 5	100 calories	
		4MIII	RC W3 P M3 5	100 calories	
IV	FEMALE	1FIV	RU M3 W3 5	100 calories	
		2FIV	RU W2 P W3 A W3 A W3 A W3 4	99 calories	II, III, IV
		3FIV	RU M3 W3 5	100 calories	
		4FIV	IU A W1 P W3 1 4	33R3 calories	III, IV
	MALE	1MIV	RU W2 1 4	33 calories	II, IV
		2MIV	RC M3 M3 5	100 calories	
		3MIV	RU 1 4	No answer	I, IV
		4MIV	RU A W3 P W3 P M3 M3 5	100 calories	III, IV

[a]See page 70 for explanation of symbols.

[b]See page 50 for explanation of numerals.

the correct process. For this problem, more students in this study understood the problem and knew the correct process than the NAEP sample of 17-year-olds.

Table 4 presents the percentages of students whose process sequences indicated that their behaviors corresponded to various Coding System variables in their solution of problem one and who answered the problem correctly.

Coding System Observations (Correct Result)

Of the students who answered the problem correctly, all of their computations, both mental and written, were

TABLE 4

PERCENTAGES OF STUDENTS WHOSE PROCESS SEQUENCES INDICATED BEHAVIORS CORRESPONDING TO VARIOUS CODING SYSTEM VARIABLES AND WHO ANSWERED PROBLEM ONE CORRECTLY

Variable[a]	Group I (Hi-Math Hi-Comp) (n = 6)	Group II (Hi-Math Lo-Comp) (n = 7)	Group III (Lo-Math Hi-Comp) (n = 6)	Group IV (Lo-Math Lo-Comp) (n = 4)	Female Group (n = 12)	Male Group (n = 11)
BWC	67	43	50	25	33	67
BWU	33	57	50	75	67	36
CP	0	29	33	25	25	18
IP	0	0	0	25	0	9
MCC	83	71	83	100	75	91
WCC	83	88	50	75	75	73

[a]See page 70 for explanation of abbreviations.

correct. Only one student, a male in Group IV, used an incorrect procedure and changed it when he realized that it was incorrect. There were students in all groups except Group I who changed their procedures, though the procedures they were using were not incorrect. More students in all groups, except Group I, began with uncertainty which perhaps explains why they changed their procedures. Every student in Group IV who answered the problem correctly performed at least one mental computation, but there were some students from each of the other groups who did not perform mental computations.

Although more females answered the problem correctly, more of them (67 percent) began with uncertainty than the males (36 percent). Ninety-one percent of the males performed at least one mental computation while only 75 percent of the females used mental computations in their solutions.

Table 5 gives the percentages of students whose process sequences indicated that their behaviors corresponded to a specified Coding System variable while solving problem one and their answers were incorrect. There was one student, a male in Group IV, who did not attempt to solve the problem. He is not included in the data of this table since he only used the variable, "began with

TABLE 5

PERCENTAGES OF STUDENTS WHOSE PROCESS SEQUENCES INDICATED BEHAVIORS CORRESPONDING TO VARIOUS CODING SYSTEM VARIABLES AND WHO ANSWERED PROBLEM ONE INCORRECTLY

Variable[a]	Group I (Hi-Math Hi-Comp) (n = 2)	Group II (Hi-Math Lo-Comp) (n = 1)	Group III (Lo-Math Hi-Comp) (n = 2)	Group IV (Lo-Math Lo-Comp) (n = 3)	Female Group (n = 4)	Male Group (n = 4)
BWC	100	0	0	0	25	25
BWU	0	100	100	100	75	75
CP	0	0	0	66	50	0
IP	100	100	50	66	75	75
MCC	0	0	50	0	0	25
WCC	100	100	50	66	75	75
WCI	100	0	50	66	75	50

[a]See page 70 for explanation of abbreviations.

uncertainty." If he were included, the percentages for Group IV and the male group would be misleading.

Coding System Observations (Incorrect Result)

All of the students in Groups II, III, and IV who solved the problem incorrectly began with uncertainty while all of the students in Group I began with certainty and their answers were also incorrect. There were no students in any group who answered the problem incorrectly and performed an incorrect mental computation. Only one

student, a male in Group III, performed a correct mental computation and obtained an incorrect result.

Procedures Used and Errors Made

Of the 31 students who tried to solve the problem, 32 percent of them attempted to find the number of calories in one ounce, 52 percent of them found one-third of 300, 16 percent set up a proportion, and 6 percent performed a mental computation where the procedure used was not clearly understood. The total of these percentages is more than 100 because two students were in two different categories.

Seventy percent of the students who attempted to find the number of calories in one ounce answered the problem incorrectly. Thirty percent of them, who were from Groups III and IV, considered the number of calories in one ounce to be the answer to the problem. The other 40 percent, who were from Groups I, II, and IV, incorrectly found the number of calories in one ounce before multiplying by three. Those who incorrectly found the number of calories in one ounce, truncated the remainder after dividing nine into 300.

All of the students, except one male in Group III, who found one-third of 300 answered the problem correctly. There were about the same number of students from each group (three or four) and the same number of females and

males (eight each) who used this procedure. The male who missed the problem found one-third of 300 correctly, but he then multiplied that result by nine.

Only students from Groups I, II, and III set up a proportion, such as: 300/9 equals x/3. All of them solved the problem correctly. There was one more male than female who used this procedure.

Table 6 gives the percentages of students whose protocols, tapes, and work sheets indicated that they exhibited behaviors that corresponded to the various Check List items.

TABLE 6

PERCENTAGES OF EIGHT STUDENTS IN EACH OF GROUPS I - IV AND 16 STUDENTS IN EACH SEX WHOSE PROBLEM SOLVING INFORMATION FOR PROBLEM ONE INDICATED BEHAVIORS CORRESPONDING TO VARIOUS CHECK LIST ITEMS

Item[a]	Group I (Hi-Math Hi-Comp)	Group II (Hi-Math Lo-Comp)	Group III (Lo-Math Hi-Comp)	Group IV (Lo-Math Lo-Comp)	Female Group	Male Group
RPA	25	50	50	50	56	31
TAW	0	25	50	37	31	25
TUP	0	0	37	50	19	25
UIA	25	12	12	37	19	25
DMS	12	37	87	75	50	56
KPO	25	12	0	0	6	12
MCE	25	0	12	25	19	12
UFA	0	0	0	12	6	0

[a]See page 70 for explanation of abbreviations.

Check List Observations

More students in Groups III and IV had trouble understanding the problem which may explain why more of them attempted the problem one way, then tried another way but had trouble deciding which method to use for solving the problem. The students in Groups I and II had no trouble understanding the problem. Only one person, a female in Group IV, indicated some uncertainty about her final answer which was incorrect because she only found the number of calories in one ounce.

General Remarks

Most of the students answered the problem correctly. However, the type error dealt with attempting to use a repeating decimal in a computation. Not knowing what to do with the repeating portion, the students truncated it. Being able to understand the problem is of vital importance in understanding what to do with a remainder. In a few cases, students were unable to interpret their results and answered the problem incorrectly.

VI. ANALYSIS OF PROBLEM TWO

Explanation of Problem

This problem involved finding out how long a turkey needed to be cooked and then determining what time it should be placed in an oven so that it would be done at a certain time. Tables 7 and 8 list the process sequences, final results, and error types for problem two for the students in this study.

TABLE 7

PROCESS SEQUENCES, FINAL RESULTS, AND ERROR TYPES FOR PROBLEM TWO FOR STUDENTS IN GROUPS I AND II (HI-MATH)

Group	Sex	Student	Process Sequence[a]	Final Result	Error Type[b]
I	FEMALE	1FI	RC W3 W3 M3 W3 A M2 4	1:50 p.m.	III
		2FI	RC W3 M3 M3 W3 M3 W3 5	12:50 p.m.	
		3FI	RC M3 W3 M3 A M2 W2 P M2 P M3 4	1:43 p.m.	II, III
		4FI	IRC W3 M3 M3 W3 A M2 M3 4	12:44 p.m.	II, III
	MALE	1MI	RC M3 W3 W3 A M2 W3 M2 4	1:44 p.m.	II, III
		2MI	RC W3 W3 A W2 W2 4	12:57 p.m.	II, III
		3MI	RC W3 M3 W3 W3 M3 5	12:50 p.m.	
		4MI	RC M3 W3 W3 M3 W3 5	12:50 p.m.	
II	FEMALE	1FII	RC W3 M3 W3 W3 M3 5	12:50 p.m.	
		2FII	RC W3 W3 M3 M2 4	12:40 p.m.	II
		3FII	RU W2 W2 P W2 P W2 A M2 4	2:40 p.m.	II, III
		4FII	RC W3 W3 M3 M3 5	12:50 p.m.	
	MALE	1MII	RC M3 W3 W3 M3 A W3 4	9:10 p.m.	III, IV
		2MII	RC M3 W3 M3 M3 M3 5	12:50 p.m.	
		3MII	RC M3 W3 W3 M3 W3 M3 5	12:50 p.m.	
		4MII	RU W3 A M2 4	2:50 p.m.	II, III

[a]See page 70 for explanation of symbols.

[b]See page 50 for explanation of numerals.

TABLE 8

PROCESS SEQUENCES, FINAL RESULTS, AND ERROR TYPES FOR PROBLEM TWO FOR STUDENTS IN GROUPS III AND IV (LO-MATH)

Group	Sex	Student	Process Sequence[a]	Final Result	Error Type[b]
III	FEMALE	1FIII	RC W3 A M2 P W3 A M2 W2 P M2 4	12:44 p.m.	II, III
		2FIII	RC M3 W3 W3 A M2 A M2 4	8:59 a.m.	III, IV
		3FIII	RC W3 P M3 A M2 M3 4	12:30 p.m.	II, III
		4FIII	RU W3 A W3 A M2 M2 4	1:40 p.m.	II, III
	MALE	1MIII	RC W3 A M2 W3 4	2:10 p.m.	II, III
		2MIII	RC W2 M3 M3 M3 M2 4	3:30 p.m.	II
		3MIII	RC M3 W3 M3 M3 5	12:50 p.m.	
		4MIII	RC W2 W3 A M2 A M2 4	11:10 a.m.	II, III, IV
IV	FEMALE	1FIV	RU M2 W3 A W3 W3 M2 4	3:59 p.m.	II, III
		2FIV	RU W2 P A W2 P A W3 A M2 W2 4	3:40 p.m.	II, III, IV
		3FIV	RC W3 M2 W3 W2 A M2 W3 4	2:40 p.m.	II, III
		4FIV	RC W2 A M2 P W3 M3 M3 A M2 M2 4	10 til 2	II, III
	MALE	1MIV	RU W2 A M2 M2 4	2:30 p.m.	II, III
		2MIV	RC A M2 4	4:30 a.m.	II, III, IV
		3MIV	RU 1 4	No answer	I, IV
		4MIV	RC W3 W3 M3 M3 5	12:50 p.m.	

[a]See page 70 for explanation of symbols.

[b]See page 50 for explanation of numerals.

Comparison with NAEP Sample (Correct Result)

Only 28 percent of the students in this study answered the problem correctly whereas 35 percent of the 17-year-olds in the NAEP study obtained a correct result. Of the nine students in this study who worked the problem correctly, 67 percent were males and 78 percent were in Groups I and II (Hi-Math).

Table 9 gives the percentages of students whose process sequences showed behaviors corresponding to the various Coding System variables and who obtained the correct result to problem two. Table 10 gives the same information about problem two for the students who worked the problem incorrectly. One student, a male in Group IV, did not work the problem. He is not included in the data of either of these tables.

Coding System Observations

All students who worked the problem correctly displayed the same characteristics: began with certainty, performed at least one mental computation correctly, and performed at least one written computation correctly. They also did not change their procedures, use an incorrect algorithm, or perform any type of incorrect computations.

Of the students who worked the problem incorrectly, none of the males changed their procedure. Seventy-eight percent of the males began with certainty while only 69

TABLE 9

PERCENTAGES OF STUDENTS WHOSE PROCESS SEQUENCES INDICATED BEHAVIORS CORRESPONDING TO VARIOUS CODING SYSTEM VARIABLES AND WHO ANSWERED PROBLEM TWO CORRECTLY

Variable[a]	Group I (Hi-Math Hi-Comp) (n = 3)	Group II (Hi-Math Lo-Comp) (n = 4)	Group III (Lo-Math Hi-Comp) (n = 1)	Group IV (Lo-Math Lo-Comp) (n = 1)	Female Group (n = 3)	Male Group (n = 6)
BWC	100	100	100	100	100	100
MCC	100	100	100	100	100	100
WCC	100	100	100	100	100	100

[a]See page 70 for explanation of abbreviations.

TABLE 10

PERCENTAGES OF STUDENTS WHOSE PROCESS SEQUENCES INDICATED BEHAVIORS CORRESPONDING TO VARIOUS CODING SYSTEM VARIABLES AND WHO ANSWERED PROBLEM TWO INCORRECTLY

Variable[a]	Group I (Hi-Math Hi-Comp) (n = 5)	Group II (Hi-Math Lo-Comp) (n = 4)	Group III (Lo-Math Hi-Comp) (n = 7)	Group IV (Lo-Math Lo-Comp) (n = 6)	Female Group (n = 13)	Male Group (n = 9)
BWC	100	50	86	50	69	78
BWU	0	50	14	50	31	22
CP	20	25	29	33	46	0
IP	100	75	86	100	92	89
MCC	80	50	43	17	54	33
MCI	80	75	100	100	100	78
WCC	100	75	86	67	92	67
WCI	40	25	43	67	46	44

[a]See page 70 for explanation of abbreviations.

percent of the females began with certainty. All of the students in Group I began with certainty even though their answers were incorrect. All of the students in Groups III and IV (Lo-Math) and all of the females who obtained an incorrect result, performed at least one incorrect mental computation.

Procedures Used and Errors Made on First Part of Problem

The first part of the problem required the student to find out how long the turkey had to be cooked if it weighed 12-1/2 pounds and was to be cooked 20 minutes for each pound. It was apparent from the work sheets that all students who worked the problem knew that they were to multiply 12-1/2 times 20. Eight of the students could not do this multiplication. Six of these were females. There was one student from Group II, two from Group III, and five from Group IV who could not perform this computation correctly.

Of the 23 who could perform the multiplication, 15 of them were unable to change 250 minutes to four hours and 10 minutes. Ten of these 15 interpreted 250 minutes as two hours and 50 minutes or the time 2:50 p.m. The breakdown by sex and group for students who made this error is as follows: six females, four males, two from Group II, and four from each of Groups III and IV. The other five of the 15 divided 250 by 60 and obtained a quotient consisting

of the whole number four and a decimal. They interpreted this decimal as minutes, i.e., 4.16 meant four hours and 16 minutes. This mistake was made by four females, one male, three students from Group I and two from Group III.

The mistakes just described were made by students in all four groups and both sexes. In some cases, students made more than one kind of error. There were three students from each of Groups I and II, eight from Group III, and nine from Group IV who made the errors explained above. The majority of the students were from Groups III and IV (Lo-Math). There were 16 females who made these errors and only seven males who made them.

Procedures Used and Errors Made on Second Part of Problem

The second part of the problem involved subtracting from 5:00 p.m. the number of hours the turkey needed to be cooked. Only 12 students subtracted correctly. Three of these used the wrong numbers and obtained an incorrect result. There were 15 students who could not perform this type of subtraction. Ten of these were females, and there were students representing all four groups.

Two students attempted to add the number of hours the turkey needed to cook and 5:00 p.m. One was a male from Group II, and the other was a female from Group III. Two other students changed the number of hours the turkey needed to be cooked into a time, i.e., 250 minutes became

2:50 p.m. which they considered the answer to the problem. Both of these were from Group II and represented both sexes.

The errors on the second part were made by four students from each of Groups I and II, five from Group III, and six from Group IV. There were 12 females and seven males who made these kinds of errors. All of the students from Group II and Group IV who answered the problem incorrectly made errors on the last part as well as errors on the first part. The majority of the students who made errors on the second part were also the majority of the students who made errors on the first part. They were females and represented Groups III and IV (Lo-Math).

Table 11 provides the percentages of students whose problem solving information for problem two indicated behaviors corresponding to various Check List items.

Check List Observations

Students in Groups I and II who obtained the correct answer did not exhibit any of the behaviors represented by the various Check List items. Three students, all females, were uncertain about their final answers and only one of them responded correctly. Students in Groups II, III, and IV had trouble understanding the problem which probably caused them to have trouble deciding on a

TABLE 11

PERCENTAGES OF EIGHT STUDENTS IN EACH OF GROUPS I - IV AND 16 STUDENTS IN EACH SEX WHOSE PROBLEM SOLVING INFORMATION FOR PROBLEM TWO INDICATED BEHAVIORS CORRESPONDING TO VARIOUS CHECK LIST ITEMS

Item[a]	Group I (Hi-Math Hi-Comp)	Group II (Hi-Math Lo-Comp)	Group III Lo-Math Hi-Comp)	Group IV (Lo-Math Lo-Comp)	Female Group	Male Group
RPA	50	25	37	50	62	12
TAW	12	12	25	25	37	0
TUP	0	25	37	50	31	25
UIA	62	37	75	62	75	50
DMS	25	37	25	50	50	19
KPO	62	25	50	62	62	31
MCE	62	37	87	75	81	50
UFA	12	12	12	0	19	0

[a]See page 70 for explanation of abbreviations.

method to use for solving the problem. All the students in Group I who missed the problem knew the procedure but couldn't perform the calculations. At least one-half of the students in each of the other groups knew the procedure and couldn't perform the calculations.

General Remarks

In performing the multiplication of 12-1/2 by 20, some students changed 12-1/2 to 12.5. There were three times as many males as females who used 12.5 in this

multiplication. There were students in all groups except Group IV who used "12.5" instead of "12-1/2." Some students multiplied 12 times 20, then added 10 to that result since 10 is one-half of 20. Again, there were no students in Group IV who used this method, but there were students in all the other groups. There was one more female than male who chose this latter method.

This problem was one of the more difficult ones used in this study, yet it is a common cooking problem. The kinds of errors made by the students in this study are similar to those reported in NAEP-CM.

VII. ANALYSIS OF PROBLEM THREE

Explanation of Problem

Problem three required the student to find the difference in the sale price of two TV sets that regularly cost $100 if one had a 10 percent discount and the other had a 15 percent discount. Tables 12 and 13 give the process sequences, final results, and error types for problem three.

Comparison with NAEP (Correct Result)

Seventy-two percent of the WSCC students answered the problem correctly, while 76 percent of the 17-year-olds in the NAEP study obtained the correct result. Fifty-seven percent of the WSCC students who answered the

TABLE 12

PROCESS SEQUENCES, FINAL RESULTS, AND ERROR TYPES FOR PROBLEM THREE FOR STUDENTS IN GROUPS I AND II (HI-MATH)

Group	Sex	Student	Process Sequence[a]	Final Result	Error Type[b]
I	FEMALE	1FI	RC M3 M3 M3 W3 W3 5	$ 5.00	
		2FI	RC W3 W3 M3 5	$ 5.00	
		3FI	RC M3 M3 M3 5	$ 5.00	
		4FI	RC W3 M3 W3 M3 M2 4	$15.00	II
	MALE	1MI	RC M3 M3 A W2 W3 W3 5	$ 5.00	II, III
		2MI	RC W3 W3 W3 5	$ 5.00	
		3MI	RC M3 M3 M3 5	$ 5.00	
		4MI	IRC W3 W3 M3 M3 M3 5	$ 5.00	
II	FEMALE	1FII	RC W3 A W3 M3 W3 W3 W3 W3 5	$ 5.00	III
		2FII	RC W3 W3 M3 M3 M3 5	$ 5.00	
		3FII	RC A W2 A W2 M3 4	$ .05	II, III
		4FII	RC W3 W3 W3 M3 W3 5	$ 5.00	
	MALE	1MII	IRC W3 W3 W3 W3 W3 5	$ 5.00	
		2MII	RC M3 M3 W3 M3 M3 5	$ 5.00	
		3MII	RC W3 W3 W3 5	$ 5.00	
		4MII	RC A W3 A M2 A W2 A M2 4	$110 and $115.10	II, III, IV

[a]See page 70 for explanation of symbols.

[b]See page 50 for explanation of numerals.

TABLE 13

PROCESS SEQUENCES, FINAL RESULTS, AND ERROR TYPES FOR PROBLEM THREE FOR STUDENTS IN GROUPS III AND IV (LO-MATH)

Group	Sex	Student	Process Sequence[a]	Final Result	Error Type[b]
III	FEMALE	1FIII	RC W3 M3 W3 M3 M3 5	$5.00	
		2FIII	RC W3 M3 W3 M3 M3 5	$5.00	
		3FIII	IC W3 M3 W3 M3 M3 5	$5.00	
		4FIII	IRU W3 W3 W3 W3 M3 5	$5.00	
	MALE	1MIII	RC A W3 A W3 4	$1 and $6	III, IV
		2MIII	RC W3 W3 M3 5	$5.00	
		3MIII	RC A W3 A W3 1 4	No answer	I, III, IV
		4MIII	RC M3 5	$5.00	
IV	FEMALE	1FIV	RC M3 W3 M3 M3 M3 5	$5.00	
		2FIV	RC M3 M3 M3 M3 M3 5	$5.00	
		3FIV	IC A M3 M3 P M3 M2 M3 4	$10.00	II, III
		4FIV	RU W3 A P W3 A W3 M2 4	5 percent	II, III, IV
	MALE	1MIV	RU 1 4	No answer	I, IV
		2MIV	RC M3 M3 W3 5	$5.00	
		3MIV	RU 1 4	No answer	I, IV
		4MIV	RC M3 M3 M3 M3 M3	$5.00	

[a]See page 70 for explanation of symbols.

[b]See page 50 for explanation of numerals.

problem correctly were in Groups I and II, and 52 percent were females.

Table 14 gives the percentages of students who answered the problem correctly and whose process sequences indicated that their behaviors corresponded to various Coding System variables. Table 15 supplies the same information for students who obtained an incorrect result. There were three students, all males, who did not complete the problem. Two of them, both from Group IV, did not attempt to solve the problem, and they are not included in the data of these tables. The other one, from Group

TABLE 14

PERCENTAGES OF STUDENTS WHOSE PROCESS SEQUENCES INDICATED BEHAVIORS CORRESPONDING TO VARIOUS CODING SYSTEM VARIABLES AND WHO ANSWERED PROBLEM THREE CORRECTLY

Variable [a]	Group I (Hi-Math Hi-Comp) (n = 7)	Group II (Hi-Math Lo-Comp) (n = 6)	Group III (Lo-Math Hi-Comp) (n = 6)	Group IV (Lo-Math Lo-Comp) (n = 4)	Female Group (n = 12)	Male Group (n = 11)
BWC	100	100	83	100	92	100
BWU	0	0	17	0	8	0
IP	14	17	0	0	8	9
MCC	86	67	100	100	100	73
WCC	71	100	83	50	83	73
WCI	14	0	0	0	0	9

[a]See page 70 for explanation of abbreviations.

TABLE 15

PERCENTAGES OF STUDENTS WHOSE PROCESS SEQUENCES INDICATED BEHAVIORS CORRESPONDING TO VARIOUS CODING SYSTEM VARIABLES AND WHO ANSWERED PROBLEM THREE INCORRECTLY

Variable [a]	Group I (Hi-Math Hi-Comp) (n = 1)	Group II (Hi-Math Lo-Comp) (n = 2)	Group III (Lo-Math Hi-Comp) (n = 2)	Group IV (Lo-Math Lo-Comp) (n = 2)	Female Group (n = 4)	Male Group (n = 3)
BWC	100	100	100	50	75	100
BWU	0	0	0	50	25	0
CP	0	0	0	100	50	0
IP	0	100	100	100	75	100
MCC	100	50	0	50	75	0
MCI	100	50	0	100	75	33
WCC	100	50	100	50	50	100
WCI	0	100	0	0	25	33

[a]See page 70 for explanation of abbreviations.

III, started working the problem but gave up before finishing. He is included in the data of Table 15.

Coding System Observations (Correct Result)

There were no students who changed their procedure or performed an incorrect mental computation and solved the problem correctly. Only one student, a female from Group III, began with uncertainty and obtained a correct result. Everyone, except one male from Group I, who performed a written computation and got the problem right, made no computational errors.

Coding System Observations (Incorrect Result)

Everyone, except a female from Group IV, began with certainty. Although students in each of Groups II, III, and IV used an incorrect procedure, only those in Group IV changed their procedures. Students from both sexes used an incorrect procedure, but only two females changed their procedures. In all cases they obtained an incorrect result.

The females and students from Groups I, II, and IV performed mental computations, both correct and incorrect. One male performed a mental computation which was incorrect, and none of the students in Group III used mental computations. There were students from all four groups and both sexes who performed correct written computations, but only a male and a female in Group II performed written computations that were incorrect.

Comparison with NAEP Sample (Incorrect Result)

Seven percent of the 17-year-olds in the NAEP study gave 5 percent as an answer and 3 percent of the WSCC students gave the same answer. The percentage for the two groups, WSCC and NAEP, for "no response" or "I don't know" was the same (9 percent). In the category of "other unacceptable answers," 17 percent of the WSCC students were in it and 10 percent of the NAEP sample were there.

Procedures Used and Errors Made

The major error was finding 10 percent and 15 percent of $100. Seventeen percent of the students in this study did not know how to do the necessary calculations. They used division instead of multiplication. Students in Groups II, III, and IV made this type of error.

WSCC students who correctly found 10 percent and 15 percent of $100 used two different methods for finding the difference in the sale prices. Seventy-five percent of them subtracted $85 from $90, and 25 percent of them subtracted $10 from $15. Students from all groups used the first method while students from all groups, except Group III, used the second method. Twice as many females as males used the first method while twice as many males as females used the second method.

Table 16 gives the percentages of students whose problem solving protocols, work sheets, and tapes for problem three showed that their behaviors corresponded to various Check List items.

Check List Observations

Only two students, both females from Group IV, worked the problem one way then tried another way. There were students from both sexes and from Groups II, III, and IV who had trouble understanding the problem and deciding on a method to use for solving it. Twelve percent of the students in each of Groups I, II, and IV

TABLE 16

PERCENTAGES OF EIGHT STUDENTS IN EACH OF GROUPS I - IV AND 16 STUDENTS IN EACH SEX WHOSE PROBLEM SOLVING INFORMATION FOR PROBLEM THREE INDICATED BEHAVIORS CORRESPONDING TO VARIOUS CHECK LIST ITEMS

Item[a]	Group I (Hi-Math Hi-Comp)	Group II (Hi-Math Lo-Comp)	Group III (Lo-Math Hi-Comp)	Group IV (Lo-Math Lo-Comp)	Female Group	Male Group
RPA	62	62	50	50	62	50
TAW	0	0	0	25	12	0
TUP	0	12	25	37	6	31
UIA	12	37	25	25	25	25
DMS	0	12	37	37	19	25
KPO	12	12	0	12	19	0
MCE	25	25	0	25	25	12

[a]See page 70 for explanation of abbreviations.

knew the procedure but couldn't perform the calculations, and 25 percent of the students in each of those groups made a computational error. There were no students in Group III in either of those two categories.

Except for the item involving rereading the problem, fewer than one-half of the students in each group and each sex exhibited behaviors that the Check List items depicted. This could be attributed to the fact that a large percentage of students in this study answered the problem correctly.

VIII. ANALYSIS OF PROBLEM FOUR

Explanation of Problem

A car was parked in a parking lot from 10:45 in the morning until 3:05 in the afternoon. This problem required the student to find out how much it would cost, if a person were charged 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. First, one had to determine how long the car had been parked and then calculate the cost. Tables 17 and 18 give the process sequences, final results, and error types for all students for problem four.

Comparison with NAEP Sample (Correct Result)

Forty-seven percent of the 17-year-olds in the NAEP study obtained the correct answer to this problem and 62 percent of the students in this study did so. Sixty percent of those who answered the problem correctly were males and 60 percent were from Groups I and II (Hi-Math).

Table 19 gives the percentages of students who got the correct result and whose process sequences showed that their behaviors were similar to various Coding System variables. Table 20 provides the same information for students who answered the problem incorrectly.

TABLE 17

PROCESS SEQUENCES, FINAL RESULTS, AND ERROR TYPES FOR PROBLEM FOUR FOR STUDENTS IN GROUPS I AND II (HI-MATH)

Group	Sex	Student	Process Sequence[a]	Final Result	Error Type[b]
I	FEMALE	1FI	RC M3 M3 M3 M3 5	$1.35	
		2FI	RC M3 M3 W3 5	$1.35	
		3FI	RC A M2 A W3 M3 4	$1.85	II, III
		4FI	RC M3 W3 5	$1.35	
	MALE	1MI	RC M2 M3 M3 5	$1.35	II
		2MI	RC M3 W3 5	$1.35	
		3MI	RC M3 M3 M3 M3 5	$1.35	
		4MI	RC M3 P A M2 P M3 W3 M3 W2 4	$1.30	II, III
II	FEMALE	1FII	RC M3 M3 M3 5	$1.35	
		2FII	RC M2 A M3 W3 4	$0.85	II, III
		3FII	RC M3 W3 A W2 P W3 M3 5	$1.35	
		4FII	RC M3 M3 W3 5	$1.35	
	MALE	1MII	RC M3 W3 M3 W3 5	$1.35	
		2MII	RC M3 W3 5	$1.35	
		3MII	RC W3 M3 W3 W3 M3 5	$1.35	
		4MII	RC W2 P A W3 A W3 P M2 4	$1.60	II, III

[a]See page 70 for explanation of symbols.

[b]See page 50 for explanation of numerals.

TABLE 18

PROCESS SEQUENCES, FINAL RESULTS, AND ERROR TYPES FOR PROBLEM FOUR FOR STUDENTS IN GROUPS III AND IV (LO-MATH)

Group	Sex	Student	Process Sequence[a]	Final Result	Error Type[b]
III	FEMALE	1FIII	RC M3 W2 W2 4	$1.00	II
		2FIII	RC A W3 A W3 W3 4	$1.95	III
		3FIII	RC M3 M3 P A M2 M3 W3 4	$1.60	II, III
		4FIII	RC M2 W2 P M3 W3 5	$1.35	II
	MALE	1MIII	RC M3 A M3 M3 W3 4	$1.10	III
		2MIII	RC W2 P M3 M3 W3 W3 M3 5	$1.35	II
		3MIII	RC A W3 A W2 P W3 W3 A W2 M3 4	$1.86	II, III
		4MIII	RC M3 W3 5	$1.35	
IV	FEMALE	1FIV	RC W2 M3 W3 W3 W3 4	$1.60	II
		2FIV	RC M2 M3 W2 4	$1.50	II
		3FIV	IC A W3 A W2 W3 4	$2.60	II, III, IV
		4FIV	RC W3 W2 P A W2 W3 5	$1.35	II, III
	MALE	1MIV	RC M2 W3 W3 5	$1.35	II
		2MIV	RC W3 W2 W3 M3 M3 A M3 5	$1.35	II, III
		3MIV	RC M3 M3 W3 5	$1.35	
		4MIV	RC M3 W3 5	$1.35	

[a]See page 70 for explanation of symbols.

[b]See page 50 for explanation of numerals.

TABLE 19

PERCENTAGES OF STUDENTS WHOSE PROCESS SEQUENCES INDICATED BEHAVIORS CORRESPONDING TO VARIOUS CODING SYSTEM VARIABLES AND WHO ANSWERED PROBLEM FOUR CORRECTLY

Variable[a]	Group I (Hi-Math Hi-Comp) (n = 6)	Group II (Hi-Math Lo-Comp) (n = 6)	Group III (Lo-Math Hi-Comp) (n = 3)	Group IV (Lo-Math Lo-Comp) (n = 5)	Female Group (n = 8)	Male Group (n = 12)
BWC	100	100	100	100	100	100
CP	0	17	67	20	37	8
IP	0	17	0	40	25	8
MCC	100	100	100	60	87	92
MCI	17	0	33	20	12	17
WCC	50	83	100	100	75	83
WCI	0	17	67	40	37	17

[a]See page 70 for explanation of abbreviations.

TABLE 20

PERCENTAGES OF STUDENTS WHOSE PROCESS SEQUENCES INDICATED BEHAVIORS CORRESPONDING TO VARIOUS CODING SYSTEM VARIABLES AND WHO ANSWERED PROBLEM FOUR INCORRECTLY

Variable [a]	Group I (Hi-Math Hi-Comp) (n = 2)	Group II (Hi-Math Lo-Comp) (n = 2)	Group III (Lo-Math Hi-Comp) (n = 5)	Group IV (Lo-Math Lo-Comp) (n = 3)	Female Group (n = 8)	Male Group (n = 4)
BWC	100	100	100	100	100	100
CP	50	50	40	0	12	75
IP	100	100	80	33	62	100
MCC	100	50	80	67	75	75
MCI	100	100	20	33	50	50
WCC	100	100	80	67	75	100
WCI	50	50	40	100	50	75

[a]See page 70 for explanation of abbreviations.

Coding System Observations

Most of the students performed a mental and/or written computation correctly. Fewer students in Group III worked the problem correctly and of those more changed their procedures and had incorrect mental and/or written computations than students in the other groups. There were more females than males who answered the problem correctly and also changed their procedures, used an incorrect algorithm, and performed an incorrect written computation. There were fewer females than males who answered the problem incorrectly and did the three things just mentioned.

Procedures Used and Errors Made

The first task for the student in order to solve the problem was to find out how many hours the car was parked. All students knew this was to be done which accounts for the fact that everyone began with certainty. There were a variety of ways in which this information was secured. In most cases, if students could determine the number of hours, then they could determine the charge for parking.

Fifty-six percent of the students, representing all groups and both sexes, attempted to count the number of hours on their fingers. Fifty-six percent of these students correctly found the number of hours and answered

the problem correctly. Seventeen percent of these students, representing males from Groups I and IV, found the incorrect number of hours, but in some way compensated for this error and obtained the correct result to the problem. Twenty-eight percent of these students did not get the correct number of hours and did not answer the problem correctly. These represented all four groups and both sexes.

Four of the students found the number of hours from 10:45 to 12 noon and added that amount to the number of hours from noon to 3:05. These students were from all groups except Group I and from both sexes. Using this method, only two students found the correct number of hours, but the three males answered the problem correctly. The one female who tried this method was unable to find the right number of hours and also obtain the correct result.

Eighteen percent of the students gave the monetary assessment for each hour as they counted the hours. These students were from all groups and both sexes. Only one student, a Group I male, changed 3:05 to 15:05 and subtracted 10:45 from that to get the number of hours. He, unfortunately, did the problem incorrectly because he added 30 cents for the first hour instead of 35 cents.

Four students subtracted 3:05 from 10:45 and got

seven hours and 40 minutes. Both sexes were represented in the students who did this, and all groups with the exception of Group I. Two of these students multiplied 6.40 times 25 cents, one multiplied seven times 35, and the other one had trouble knowing what to charge for the 40 minutes. He finally decided to divide 25 into 40 and interpret the quotient "one" as meaning one cent for the 40 minutes.

Comparison with NAEP Sample (Incorrect Result)

Listed below are the percentages of students from WSCC and from the NAEP 17-year-old sample who made specific incorrect responses to this problem:

Incorrect Response	WSCC	NAEP
$1.60	9	9
$1.10	3	4
Other unacceptable	25	33
"I don't know" or no response	0	7

The percentages of students from this study and from the NAEP sample who gave incorrect responses of $1.60 and $1.10 were very much the same. All of the students in this study attempted to solve this problem.

Table 21 gives the percentages of students whose protocols, work sheets, and tapes indicated behaviors corresponding to various Check List items.

TABLE 21

PERCENTAGES OF EIGHT STUDENTS IN EACH OF GROUPS I - IV AND 16 STUDENTS IN EACH SEX WHOSE PROBLEM SOLVING INFORMATION FOR PROBLEM FOUR INDICATED BEHAVIORS CORRESPONDING TO VARIOUS CHECK LIST ITEMS

Item [a]	Group I (Hi-Math Hi-Comp)	Group II (Hi-Math Lo-Comp)	Group III (Lo-Math (Hi-Comp)	Group IV (Lo-Math Lo-Comp)	Female Group	Male Group
RPA	100	100	75	62	87	81
TAW	12	25	50	12	25	25
TUP	0	0	0	12	6	0
UIA	25	37	50	37	44	31
DMS	12	12	12	0	0	19
KPO	12	25	62	50	44	31
MCE	37	37	62	75	62	44

[a]See page 70 for explanation of abbreviations.

Check List Observations

All students in Groups I and II (Hi-Math) reread the problem or portions of it, and the majority of the students in the other groups did, also. There were more students in Group III who obtained an incorrect solution than the other groups. A greater percentage of the students in Group III worked the problem one way then tried another, used an incorrect algorithm, and knew the procedure but couldn't perform the calculations. However, there were no students in Group III who had trouble

understanding the problem. Only one female in Group IV had trouble understanding the problem, but there were no females and no students from Group IV who had difficulty deciding on a method for solving the problem. More students in Group IV made computational errors than students from the other groups.

General Remarks

Students had difficulty determining the number of hours and minutes from 10:45 in the morning until 3:05 in the afternoon. The idea of charging for a "fraction of an hour" was not clearly understood and how to determine this charge was another area of difficulty.

IX. ANALYSIS OF PROBLEM FIVE

Explanation of Problem

The cash price of an automobile and the basis for determining the cost, if purchased on credit, were given in this problem. The student had to find out how much more would be paid, if the car were bought on credit rather than paying cash for it. Tables 22 and 23 present the process sequences, final results, and error types for all students for problem five.

Comparison with NAEP Sample (Correct Result)

Fifty-six percent of the NAEP 17-year-olds and the same percent of WSCC students solved the problem correctly.

TABLE 22

PROCESS SEQUENCES, FINAL RESULTS, AND ERROR TYPES FOR PROBLEM FIVE FOR STUDENTS IN GROUPS I AND II (HI-MATH)

Group	Sex	Student	Process Sequence[a]	Final Result	Error Type[b]
I	FEMALE	1FI	RC M3 A W2 P W3 W3 W3 5	$430.00	II, III, IV
		2FI	RC M3 W3 W3 W3 5	$430.00	
		3FI	RC M3 W3 W3 1 4	$ 30.00	I, IV
		4FI	RC M3 W3 A W3 P W3 W3 W3 5	$430.00	III, IV
	MALE	1MI	RC W3 W3 W3 W3 5	$430.00	
		2MI	RC M3 W3 W3 W3 5	$430.00	
		3MI	RC M3 W3 W3 W3 5	$430.00	
		4MI	RC M3 W3 W2 W3 4	$350.00	II
II	FEMALE	1FII	RC W2 P M3 W3 W2 W3 W3 4	$490.00	II
		2FII	RC W3 M3 W3 W3 5	$430.00	
		3FII	RC W3 W3 W3 M2 P W3 A W3 4	$ 4.30	II, III
		4FII	RC M3 W3 W3 1 4	$ 30.00	I, IV
	MALE	1MII	RC M3 W3 W3 W3 5	$430.00	
		2MII	RC M3 W3 W3 W3 M3 M3 W3 5	$430.00	
		3MII	RC W3 W3 W3 W3 5	$430.00	
		4MII	RC W3 W2 W3 W3 4	$330.00	II

[a]See page 70 for explanation of symbols.

[b]See page 50 for explanation of numerals.

TABLE 23

PROCESS SEQUENCES, FINAL RESULTS, AND ERROR TYPES FOR PROBLEM FIVE FOR STUDENTS IN GROUPS III AND IV (LO-MATH)

Group	Sex	Student	Process Sequence[a]	Final Result	Error Type[b]
III	FEMALE	1FIII	RC W3 P M3 W3 W3 W3 W3 5	$430.00	
		2FIII	RC M3 W3 W3 W3 5	$430.00	
		3FIII	RC W3 W2 W3 W3 4	$ 90.00	II
		4FIII	RC W3 A W3 P M3 W3 W3 W3 5	$430.00	III
	MALE	1MIII	RC M3 W3 W3 W2 M2 M2 M3 5	$430.00	II
		2MIII	RC M3 W3 W3 W3 5	$430.00	
		3MIII	IC M3 A W3 A W2 4	$1132.00	II, III, IV
		4MIII	RC M3 W3 W3 W3 5	$430.00	
IV	FEMALE	1FIV	RC W3 W2 W3 W3 4	$370.00	II
		2FIV	RC M3 W3 A W3 1 4	$3320.00	I, III, IV
		3FIV	RC W3 W3 W3 W3 4	$430.00 a month	IV
		4FIV	RC W3 W3 W3 1 4	$ 30.00	I, IV
	MALE	1MIV	RU 1 4	No answer	I, IV
		2MIV	RC W3 W2 W3 W3 4	$ 30.00	II
		3MIV	RC M3 W3 W3 W3 5	$430.00	
		4MIV	RC M3 W3 W3 W3 5	$430.00	

[a]See page 70 for explanation of symbols.

[b]See page 50 for explanation of numerals.

Fifty-six percent of the WSCC students who obtained a correct result were from Groups I and II (Hi-Math) and 61 percent of them were males. There were no females from Group IV who answered the problem correctly.

Table 24 gives the percentages of students who exhibited behaviors represented by various Coding System variables and obtained the correct result after solving problem five. Table 25 presents the same information for students who obtained an incorrect result. One student, a male in Group IV, did not attempt to solve the problem; he is not included in the data of either of these tables.

TABLE 24

PERCENTAGES OF STUDENTS WHOSE PROCESS SEQUENCES INDICATED BEHAVIORS CORRESPONDING TO VARIOUS CODING SYSTEM VARIABLES AND WHO ANSWERED PROBLEM FIVE CORRECTLY

Variable[a]	Group I (Hi-Math Hi-Comp) (n = 6)	Group II (Hi-Math Lo-Comp) (n = 4)	Group III (Lo-Math Hi-Comp) (n = 6)	Group IV (Lo-Math Lo-Comp) (n = 2)	Female Group (n = 7)	Male Group (n = 11)
BWC	100	100	100	100	100	100
CP	33	0	33	0	57	0
IP	33	0	17	0	43	0
MCC	83	75	100	100	100	82
WCC	100	100	100	100	100	100
WCI	17	0	17	0	14	9

[a]See page 70 for explanation of abbreviations.

TABLE 25

PERCENTAGES OF STUDENTS WHOSE PROCESS SEQUENCES INDICATED BEHAVIORS CORRESPONDING TO VARIOUS CODING SYSTEM VARIABLES AND WHO ANSWERED PROBLEM FIVE INCORRECTLY

Variable[b]	Group I (Hi-Math Hi-Comp) (n = 2)	Grade II (Hi-Math Lo-Comp) (n = 4)	Grade III (Lo-Math Hi-Comp) (n = 2)	Grade IV (Lo-Math Lo-Comp) (n = 5)	Female Group (n = 9)	Male Group (n = 4)
BWC	100	100	100	100	100	100
CP	0	50	0	0	22	0
IP	0	25	50	20	22	25
MCC	100	50	50	20	44	50
MCI	0	25	0	0	11	0
WCC	100	100	100	100	100	100
WCI	50	50	100	40	33	100

[a]See page 70 for explanation of abbreviations.

Coding System Observations

Every student who attempted to solve the problem, began with certainty and performed at least one correct written computation. Of the students who solved the problem correctly, none of them performed an incorrect mental computation, and none of the males used an incorrect procedure or changed their procedures. The only students who obtained the correct result and used an incorrect procedure or changed their procedures were some females representing Groups I and III. There were

students from both sexes from Groups I and III who performed an incorrect written computation and obtained the right answer to problem five. The students from Groups II and IV who answered the problem correctly did not exhibit any of the behaviors just described.

All of the males who obtained an incorrect result performed an incorrect written computation as was true of all the students in Group III. There were some students representing the other groups and the females who performed an incorrect written computation and answered the problem incorrectly.

Comparison with NAEP Sample (Incorrect Result)

Listed below are the percentages of students from WSCC and the 17-year-olds of the NAEP study who made certain incorrect responses to problem five:

Incorrect Response	WSCC	NAEP
Wrong answer but correct process	25	8
$30 or attempt at (36 x 80) - 2850	9	6
$3280 or attempt at (36 x 80) + 400	3	2
Other unacceptable	3	20
"I don't know" or no response	3	9

More WSCC students knew the procedure than the NAEP sample. One male in Group IV who obtained an answer of $30 and knew the procedure is included in the category of knowing the procedure rather than obtaining an incorrect response of $30.

Procedures Used and Errors Made

Two of the students multiplied 36 by 480. One of them realized this error and changed to multiplying 36 times 80. Eighty-four percent of the students multiplied 80 by 36 and the others multiplied 80 by 12 and then multiplied the result by three. Two females from Group II subtracted the down payment from the cash price of the car then subtracted the result from the total for the 36 monthly payments. One male in Group II mentally found the difference in the two prices by getting $280 as the difference between $3000 and $3280, then $150 as the difference between $2850 and $3000, and then adding the two differences. A male in Group III subtracted the cash price from the credit price incorrectly. When he checked and found there was an error, he continued to make adjustments to the difference in an effort to get the problem to check rather than to subtract again.

Table 26 provides the percentages of students whose protocols, work sheets, and tapes showed that their behaviors were representative of the various Check List items.

Check List Observations

All the students in Group II reread the problem or portions of it. There were some students of both sexes and from each of the other groups who also reread the

TABLE 26

PERCENTAGES OF EIGHT STUDENTS IN EACH OF GROUPS I - IV AND 16 STUDENTS IN EACH SEX WHOSE PROBLEM SOLVING INFORMATION FOR PROBLEM FIVE INDICATED BEHAVIORS CORRESPONDING TO VARIOUS CHECK LIST ITEMS

Item [a]	Group I (Hi-Math Hi-Comp)	Grade II (Hi-Math Lo-Comp)	Grade III (Lo-Math Hi-Comp)	Grade IV (Lo-Math Lo-Comp)	Female Group	Male Group
RPA	37	100	62	50	75	50
TAW	25	25	25	0	37	0
TUP	37	12	12	50	44	12
UIA	25	12	25	12	31	6
DMS	0	37	25	12	25	12
KPO	12	37	25	25	25	25
MCE	25	37	37	37	37	31
UFA	0	0	0	12	0	6

[a]See page 70 for explanation of abbreviations.

problem. While solving this problem, very few students exhibited behaviors that are represented by the Check List items. Only one student, a male from Group IV, indicated any uncertainty about his answer, which was correct. Most of the students understood how to solve this problem. The errors made were basically computational.

X. ANALYSIS OF PROBLEM SIX

Explanation of Problem

This problem required the student to find the average of the summer incomes of three people if the income of each were known. The same procedure was used, the same final result was obtained, and no errors were made by all students in this study with the exception of four who represented both sexes and Groups III and IV. Table 27 presents the process sequences, final results, and error types for all students.

TABLE 27

PROCESS SEQUENCES, FINAL RESULTS, AND ERROR TYPES FOR PROBLEM SIX FOR ALL STUDENTS

Student	Process Sequence[a]	Final Result	Error Type[b]
All students except those listed below	RC W3 W3 5	$389.00	
1MIII	RC W3 W2 4	$388.33	II
2FIV	RC W3 A W2 4	$583.00	II, III
1MIV	RC W3 1 4	$1167.00	I, IV
3MIV	RC W3 W3 W3 5	$389.00	

[a]See page 70 for explanation of symbols.

[b]See page 50 for explanation of numerals.

Comparison with NAEP Sample (Correct Result)

Eighty-one percent of the students in this study worked the problem correctly, while only 66 percent of the 17-year-olds reported in the NAEP study obtained the correct result. All of the students in Groups I and II (Hi-Math) solved the problem correctly. There were more females (94 percent) than males (87 percent) who obtained the correct result. All of the students attempted to solve this problem.

Coding System Observations (Correct Result)

The only Coding System variables that could be applied to the students who obtained the correct result were that they all began with certainty and they all performed written computations correctly. Table 28 gives the percentages of students from both sexes and from Groups III and IV whose process sequences indicated that their behaviors were representative of various Coding System variables and they answered the problem incorrectly.

Coding System Observations (Incorrect Result)

All the students began with certainty, performed a written computation correctly, did not change their procedures, and did not perform a correct or incorrect mental computation. Only one student, a female from Group IV, used an incorrect procedure. She divided the sum by two

TABLE 28

PERCENTAGES OF STUDENTS WHOSE PROCESS SEQUENCES INDICATED BEHAVIORS CORRESPONDING TO VARIOUS CODING SYSTEM VARIABLES AND WHO ANSWERED PROBLEM SIX INCORRECTLY

Variable[a]	Group III (Lo-Math Hi-Comp) (n = 1)	Group IV (Lo-Math Lo-Comp) (n = 2)	Female Group (n = 1)	Male Group (n = 2)
BWC	100	100	100	100
IP	0	50	100	0
WCC	100	100	100	100
WCI	100	50	100	50

[a]See page 70 for explanation of abbreviations.

instead of by three. She was the only female who missed the problem. Two males, representing Groups III and IV, obtained an incorrect result. One of them failed to divide the sum and the other one divided by three incorrectly.

Comparison with NAEP Sample (Incorrect Result)

Sixteen percent of the NAEP 17-year-old sample failed to divide and only 3 percent of the WSCC sample made this error. Eight percent of the NAEP sample knew the correct process but obtained an incorrect answer while 6 percent of the students from WSCC knew the process

but got the answer wrong. The percentages of WSCC students who made errors were less than the percentages of the NAEP 17-year-olds.

Table 29 provides the percentages of students whose protocols, work sheets, and tapes indicated behaviors corresponding to various Check List items. The students in Group I did not exhibit any behaviors that were represented by the Check List items.

TABLE 29

PERCENTAGES OF EIGHT STUDENTS IN EACH OF GROUPS II - IV AND 16 STUDENTS IN EACH SEX WHOSE PROBLEM SOLVING INFORMATION FOR PROBLEM SIX INDICATED BEHAVIORS CORRESPONDING TO VARIOUS CHECK LIST ITEMS

Item[a]	Group II (Hi-Math Lo-Comp)	Group III (Lo-Math Hi-Comp)	Group IV (Lo-Math Lo-Comp)	Female Group	Male Group
RPA	12	0	25	6	12
TUP	0	0	12	0	6
UIA	0	0	12	6	0
KPO	0	12	0	0	6
MCE	0	12	0	0	6
UFA	0	0	12	6	0

[a]See page 70 for explanation of abbreviations.

Check List Observations

The female in Group IV who missed the problem indicated some uncertainty about her answer. The percentages were very small for the Check List items that were applicable. This could be attributed to the fact that students have had an opportunity to average their grades while in elementary, secondary, and post-secondary schools.

XI. ANALYSIS OF PROBLEM SEVEN

Problem seven involved finding how many people voted in an election and then determining the percent of the vote that a specific candidate received. There were three candidates, and the number of votes that each received was given. Tables 30 and 31 present the process sequences, final results, and error types for all the students in the study.

Comparison with NAEP Sample (Correct Result)

In the results reported by NAEP, 45 percent of the 17-year-olds answered this problem correctly while 47 percent of the students in this study obtained a correct result. Table 32 gives the percentages of students whose process sequences indicated that their behaviors were similar to various Coding System variables and who answered the problem correctly. Table 33 provides the same information for students who solved the problem incorrectly.

TABLE 30

PROCESS SEQUENCES, FINAL RESULTS, AND ERROR TYPES FOR PROBLEM SEVEN FOR STUDENTS IN GROUPS I AND II (HI-MATH)

Group	Sex	Student	Process Sequence[a]	Final Result	Error Type[b]
I	FEMALE	1FI	RC W3 A W1 W2 M2 4	16%	II, III
		2FI	RC W3 W3 M3 5	60%	
		3FI	RC W3 W3 M3 5	60%	
		4FI	RC W3 W3 M3 5	60%	
	MALE	1MI	RC W3 A W3 A W2 P W3 5	60%	II, III
		2MI	RC W3 W3 M3 5	60%	
		3MI	RC W3 M3 M2 M3 4	70%	II
		4MI	RC W3 W3 W3 M3 5	60%	
II	FEMALE	1FII	RC W3 W3 W3 M3 5	60%	
		2FII	RC W3 W3 M3 5	60%	
		3FII	RC W3 A W3 4	66 2/3%	III
		4FII	RC W3 W3 W3 5	60%	
	MALE	1MII	RC W3 W3 M3 5	60%	
		2MII	RC W3 A W3 P W3 M3 5	60%	III
		3MII	RC W3 W3 W3 M3 5	60%	
		4MII	RC W3 A W3 4	66 2/3%	III

[a]See page 70 for explanation of symbols.

[b]See page 50 for explanation of numerals.

TABLE 31

PROCESS SEQUENCES, FINAL RESULTS, AND ERROR TYPES FOR PROBLEM SEVEN FOR STUDENTS IN GROUPS III AND IV (LO-MATH)

Group	Sex	Student	Process Sequence[a]	Final Result	Error Type[b]
III	FEMALE	1FIII	RC W3 W3 1 4	3/5	I
		2FIII	RC W3 W3 M3 5	60%	
		3FIII	RC W3 A M2 4	20%	II, III
		4FIII	RC W3 W3 M3 A M2 4	3/5%	II, III
	MALE	1MIII	IC W3 A W2 4	66%	II, III
		2MIII	RC W3 A W3 4	66 2/3%	III
		3MIII	RC W3 A W2 1 4	No answer	I, II, III
		4MIII	RC W3 M3 5	60%	
IV	FEMALE	1FIV	RC W3 A W3 P M3 P A W2 4	66.6%	II, III
		2FIV	RC W3 A W3 4	80%	III
		3FIV	IC A W3 A W3 4	40%	III
		4FIV	RC W3 A P A W3 A M2 4	80%	II, III
	MALE	1MIV	RU A M3 A W3 A M2 4	40%	II, III
		2MIV	RC W3 A M2 4	52%	II, III
		3MIV	RC W3 1 4	No answer	I
		4MIV	RC W3 M3 M3 M3 5	60%	

[a]See page 70 for explanation of symbols.

[b]See page 50 for explanation of numerals.

TABLE 32

PERCENTAGES OF STUDENTS WHOSE PROCESS SEQUENCES INDICATED BEHAVIORS CORRESPONDING TO VARIOUS CODING SYSTEM VARIABLES AND WHO ANSWERED PROBLEM SEVEN CORRECTLY

Variable[a]	Group I (Hi-Math Hi-Comp) (n = 6)	Group II (Hi-Math Lo-Comp) (n = 6)	Group III (Lo-Math Hi-Comp) (n = 2)	Group IV (Lo-Math Lo-Comp) (n = 1)	Female Group (n = 7)	Male Group (n = 8)
BWC	100	100	100	100	100	100
CP	17	17	0	0	0	25
IP	17	17	0	0	0	25
MCC	83	83	100	100	86	87
WCC	100	100	100	100	100	100
WCI	17	0	0	0	0	12

[a]See page 70 for explanation of abbreviations.

TABLE 33

PERCENTAGES OF STUDENTS WHOSE PROCESS SEQUENCES INDICATED BEHAVIORS CORRESPONDING TO VARIOUS CODING SYSTEM VARIABLES AND WHO ANSWERED PROBLEM SEVEN INCORRECTLY

Variable[a]	Group I (Hi-Math Hi-Comp) (n = 2)	Group II (Hi-Math Lo-Comp) (n = 2)	Group III (Lo-Math Hi-Comp) (n = 6)	Group IV (Lo-Math Lo-Comp) (n = 7)	Female Group (n = 9)	Male Group (n = 8)
BWC	100	100	100	86	100	87
BWU	0	0	0	14	0	13
CP	0	0	0	29	22	0
IP	50	100	83	86	89	75
MCC	50	0	17	29	22	25
MCI	100	0	33	43	44	37
WCC	100	100	100	100	100	100
WCI	50	0	33	0	11	25

[a]See page 70 for explanation of abbreviations.

Two males, representing Groups III and IV, did not complete solving the problem. Since they started, they are included in the data of Table 33.

Coding System Observations

Of the students in this study who obtained the correct result, 80 percent were in Groups I and II. Only one student, a male in Group IV, began with uncertainty and his answer was incorrect. There was one more male than female who solved the problem correctly. Of the females whose solutions were correct, none of them changed their procedures or used an incorrect algorithm, but there were males with correct solutions who did both of these things.

Six of the females who solved the problem correctly performed only three computations while the other one used four. There was nothing consistent with the males in terms of the number of operations performed to get the correct result. For the students who worked the problem correctly, the same percentage of students in Groups I and II exhibited behaviors similar to the Coding System variables. This was also true of the students in Groups III and IV. All students performed at least one written computation correctly.

Procedures Used and Errors Made

More females (56 percent) than males (50 percent) were unable to solve the problem. The work sheets indicated that most of the students knew that they had to add the votes received by each candidate to find the total number of votes cast. It was at this point that the major error was made. Some students knew that they had to answer the question, "What percent of 200 is 120?" Some students knew they had to find a percent.

The most common error made by the students in this study was to divide 200, the total number of votes cast, by three, the number of candidates. There were two females and three males representing Groups II, III, and IV who attempted to divide 200 by three. There were two females who reduced the fraction 120/200 to 3/5. Both were from Group III. One of them considered the answer to be 3/5 and the other called the answer 3/5 percent.

A female from Group I divided 12 into 200 and considered the quotient, 16, as a percent and the answer to the problem. Two females from Group IV subtracted 120, the number of votes the candidate received, from 200. The difference, which was 80, was regarded as the percent of votes that the candidate received. A male and a female from Group IV subtracted the number of votes that the other two candidates received from the number

that the specific candidate received. The result was 40 which they called a percent and the answer to the question. There were two males who attempted to estimate the answer. They both knew that 100 votes would be 50 percent of the total. The one from Group I estimated the remaining 20 votes to be 20 percent, and he obtained 70 percent as an incorrect answer to the question. The other one from Group IV, who was the only person in Group IV to answer the problem correctly, estimated the 20 votes to be 10 percent.

The other two procedures used to solve the problem correctly were to divide 200 into 120 or 5 into 3, and to set up a proportion. All the females used the first method, and there were males who used both methods. These students were from Groups I, II, and III.

Comparison with NAEP Sample (Incorrect Result)

Listed below are the percentages of students from WSCC and from the NAEP sample who gave specific incorrect responses:

Incorrect Response	WSCC	NAEP	Incorrect Response	WSCC	NAEP
3/5	3	1	Attempt at 200/3	16	6
40%	6	5	Other unacceptable	16	25
80%	6	7	"I don't know" or no response	6	9

The percentages for each specific incorrect response were very similar for the two groups except for the attempt at dividing 200 by 3. There were many more WSCC students who used this method than the students in the NAEP study.

Table 34 states the percentages of students whose protocols, work sheets, and tapes indicated behaviors that correspond to various Check List items.

TABLE 34

PERCENTAGES OF EIGHT STUDENTS IN EACH OF GROUPS I - IV AND 16 STUDENTS IN EACH SEX WHOSE PROBLEM SOLVING INFORMATION FOR PROBLEM SEVEN INDICATED BEHAVIORS CORRESPONDING TO VARIOUS CHECK LIST ITEMS

Item[a]	Group I (Hi-Math Hi-Comp)	Group II (Hi-Math Lo-Comp)	Group III (Lo-Math Hi-Comp)	Group IV (Lo-Math Lo-Comp)	Female Group	Male Group
RPA	37	37	0	37	31	25
TAW	12	12	0	25	12	12
TUP	12	0	0	0	0	6
UIA	25	37	67	75	50	50
RSP	12	0	0	0	6	0
DMS	50	25	25	62	37	44
KPO	25	0	12	0	12	6
MCE	37	0	37	37	19	37
UFA	25	12	0	12	19	6

[a]See page 70 for explanation of abbreviations.

Check List Observations

The majority of the students in Groups III and IV used an inappropriate algorithm while 50 percent of the students of each sex made this mistake. The same number of males and females from Groups I, II, and IV worked the problem one way then tried another. Only one student, a male representing Group I, had trouble understanding the problem. Two students from Group I and one from Group III knew the procedure but couldn't perform the calculations. The other students who did not get the problem correct did not know what to do.

Males and females from all groups except Group II made computational errors. More males (37 percent) than females (19 percent) made computational errors but more females answered the problem incorrectly. With the exception of Group III, there were students from both sexes and in all groups who were uncertain about their final answer.

General Remarks

There were relatively few computational errors, when one considers the fact that more students missed the problem than answered it correctly. The difficulty was in using incorrect procedures to find the percent. Most students guessed in solving the problem because they were unfamiliar with computational procedures needed to find a percent.

XII. ANALYSIS OF PROBLEM EIGHT

Introduction

The introductory statement for problem eight referred the student to a line graph. The vertical scale for the graph indicated that the information was given in thousands of units ranging from zero to seven. The horizontal axis gave the months from January through December. The graph represented the monthly production of a company during a specific year. The problem was divided into two parts and each will be analyzed separately. The Coding System variable used in the process sequence to represent looking at the graph was "mental computation." The computation was correct if the graph were read correctly or incorrect if it were read incorrectly. The transcripts for both parts are written together, since some students read both parts before beginning to solve the first part.

Explanation of First Part of Problem

The first part of the problem required the student to find the greatest drop in production from one month to the next. This involved looking at the graph and determining where the sharpest downward trend occurred. The procedures used by the students in this study were very much the same. Table 35 presents the process

TABLE 35

PROCESS SEQUENCES, FINAL RESULTS, AND ERROR TYPES FOR THE FIRST PART OF PROBLEM EIGHT FOR ALL STUDENTS

Student	Process Sequence[a]	Final Result	Error Type[b]
All students except those listed below	RC M3 5	September to October	
3MI	RC M2 4	August to September	II
1FII	RU M3 5	September to October	
2FII	RC M2 4	September to December	II
3FII	RC M2 4	January to February	II
2MII	IRC M3 5	September to October	
4MII	RU 1 4	No answer	I, IV
1FIII	RU M2 4	January to February	II
1MIII	RC M2 4	January to February	II
3MIII	RU M2 4	February to March	II, IV
1FIV	RC M2 4	August to September	II
2FIV	RC M2 4	January to February	II
3FIV	RC M2 4	January to February	II
4FIV	RC M2 4	August to October	II
4MIV	RU M3 5	September to October	

[a]See page 70 for explanation of symbols.

[b]See page 50 for explanation of numerals.

sequences, final results, and error types for all students in the study.

Comparison with NAEP Sample (Correct Result)

Sixty-nine percent of the 17-year-olds in the NAEP study answered this part of the problem correctly whereas 66 percent of the WSCC students obtained the correct result. Table 36 gives the percentages of students whose process sequences indicated behaviors corresponding to various Coding System variables and who obtained the correct result to the first part of problem eight. Table 37 provides the same information for students who answered the problem incorrectly. There was one student, a male from Group II, who did not work the problem and is not included in the data of these tables.

Coding System Observations

Fifty-seven percent of the WSCC students who answered the problem correctly were from Groups I and II (Hi-Math) and 57 percent were males. There were more females than males and more students from Group IV than the other groups who were unable to read the graph correctly. All of the students in Group I began with certainty whether their answers were right or wrong. Of the students who obtained an incorrect result, only students in Group III began with uncertainty. Since the problem

TABLE 36

PERCENTAGES OF STUDENTS WHOSE PROCESS SEQUENCES INDICATED BEHAVIORS CORRESPONDING TO VARIOUS CODING SYSTEM VARIABLES AND WHO ANSWERED THE FIRST PART OF PROBLEM EIGHT CORRECTLY

Variable[a]	Group I (Hi-Math Hi-Comp) (n = 7)	Group II (Hi-Math Lo-Comp) (n = 5)	Group III (Lo-Math Hi-Comp) (n = 5)	Group IV (Lo-Math Lo-Comp) (n = 4)	Female Group (n = 9)	Male Group (n = 12)
BWC	100	80	100	50	89	83
BWU	0	20	0	50	11	17
MCC	100	100	100	100	100	100

[a]See page 70 for explanation of abbreviations.

TABLE 37

PERCENTAGES OF STUDENTS WHOSE PROCESS SEQUENCES INDICATED BEHAVIORS CORRESPONDING TO VARIOUS CODING SYSTEM VARIABLES AND WHO ANSWERED THE FIRST PART OF PROBLEM EIGHT INCORRECTLY

Variable[a]	Group I (Hi-Math Hi-Comp) (n = 1)	Group II (Hi-Math Lo-Comp) (n = 2)	Group III (Lo-Math Hi-Comp) (n = 3)	Group IV (Lo-Math Lo-Comp) (n = 4)	Female Group (n = 7)	Male Group (n = 3)
BWC	100	100	33	100	86	67
BWU	0	0	67	0	14	33
MCI	100	100	100	100	100	100

[a]See page 70 for explanation of abbreviations.

required the student to look at the graph to find the answer, all those who answered it correctly performed a correct mental computation while all those who got it wrong performed an incorrect mental computation.

Procedures Used and Errors Made

The most common error for WSCC students was to say that the greatest drop in production was from January to February. One can only assume that the students did not know what "greatest drop" meant. Those who said that the greatest drop was from August to October observed that the graph had a downward trend during that time. It appeared that they did not understand that the problem asked for the greatest drop in production from one month to the next month.

Comparison with NAEP Sample (Incorrect Result)

There were various incorrect responses given by the WSCC students and also the 17-year-olds in the NAEP study. Listed below are the percentages of students from the two groups who gave some specific incorrect responses:

Incorrect Response	WSCC	NAEP
January to February	16	5
August to October	3	4
Other unacceptable	12	19
"I don't know" or no response	3	3

The percentages of errors made by the WSCC students and the NAEP sample show that the students are quite similar. The greatest difference was in the response that indicated that the greatest drop was from January to February.

Table 38 shows the percentages of students whose protocols, work sheets, and tapes for the first part of problem eight showed behaviors similar to various Check List items.

TABLE 38

PERCENTAGES OF EIGHT STUDENTS IN EACH OF GROUPS I - IV AND 16 STUDENTS IN EACH SEX WHOSE PROBLEM SOLVING INFORMATION FOR THE FIRST PART OF PROBLEM EIGHT INDICATED BEHAVIORS CORRESPONDING TO VARIOUS CHECK LIST ITEMS

Item[a]	Group I (Hi-Math Hi-Comp)	Group II (Hi-Math Lo-Comp)	Group III (Lo-Math Hi-Comp)	Group IV (Lo-Math Lo-Comp)	Female Group	Male Group
RPA	50	87	50	37	75	37
TUP	0	25	12	0	6	12
DMS	25	25	12	12	25	12
MCE	12	25	37	50	44	19

[a]See page 70 for explanation of abbreviations.

Check List Observations

The students in this study exhibited very few behaviors that were similar to various Check List items when solving the first part of problem eight. There were students from Groups II and III who had trouble understanding the problem and a greater percentage of them reread the problem or portions of it. None of the students in Groups I and IV had trouble understanding the problem, but there were more students from Group IV who made computational errors.

Explanation of Second Part of Problem

The second part of this problem required the student to find the difference between the maximum and minimum monthly production for the year. First, one had to determine what the maximum and minimum productions were for the year. Then the difference had to be found by subtracting the two amounts. Determining the maximum and minimum productions was considered a mental computation, since it required the student to look at the graph and make an estimate for the two productions. In this part of the problem it was necessary to understand that the numbers given on the vertical axis (0-7) represented thousands of units rather than 0 through 7. A student could use the numbers 0 through 7 for all computations but the final result had to be given in thousands of units. When the

final result was given as a number from 0 through 7, it was coded in the process sequence, using the Coding System variables, as an incorrect procedure or algorithm used (A). This was not the only use of this variable in developing the process sequence. For the Check List items, such a mistake was considered as "not understanding the problem" since the student didn't understand how to interpret the graph which was a feature of understanding the problem.

Tables 39 and 40 give the process sequences, final results, and error types for all students in the study.

Comparison with NAEP Sample (Correct Result)

NAEP had two categories for correct results which were based on how one read the graph to determine the maximum and minimum productions for the year. The preferred category was a range from 2800 units through 3200 units. Thirty-seven percent of the students in this study gave an answer within this range whereas 18 percent of the 17-year-olds in the NAEP study were within this range. The other category was a range from 2500 through 3500, excluding 2800 through 3200. Three percent of the WSCC students and 3 percent of the NAEP sample gave answers within this range.

Table 41 gives the percentages of students whose process sequences showed that they had behaviors similar

TABLE 39

PROCESS SEQUENCES, FINAL RESULTS, AND ERROR TYPES FOR THE SECOND PART OF PROBLEM EIGHT FOR STUDENTS IN GROUPS I AND II (HI-MATH)

Group	Sex	Student	Process Sequence[a]	Final Result	Error Type[b]
I	FEMALE	1FI	RC M3 M3 W3 A 4	3 units	III
		2FI	RC M3 M3 M3 A 4	3 units	III
		3FI	RC M3 M3 M3 5	3000 units	
		4FI	RU A M2 A M2 A W3 4	2 1/2 units	II, III, IV
	MALE	1MI	RC M3 M2 M3 4	2000 units	II
		2MI	RC M3 M3 W3 5	3000 units	
		3MI	RU M3 M3 M3 M3 5	3000 units	
		4MI	RC M3 M3 M3 5	2.8 thousand units	
II	FEMALE	1FII	RU M3 M3 W3 5	2800 units	
		2FII	RC M3 M3 W3 5	3000 units	
		3FII	RC M3 M2 M3 A 4	4 units	II, III
		4FII	RC M2 M3 P M3 W3 5	2800 units	II
	MALE	1MII	RC M3 M3 W3 5	2900 units	
		2MII	RC M3 M3 W3 A 4	2 units	III
		3MII	RC M3 M3 W3 5	3250 units	
		4MII	RU 1 4	No answer	I, IV

[a]See page 70 for explanation of symbols.

[b]See page 50 for explanation of numerals.

TABLE 40

PROCESS SEQUENCES, FINAL RESULTS, AND ERROR TYPES FOR THE SECOND PART OF PROBLEM EIGHT FOR STUDENTS IN GROUPS III AND IV (LO-MATH)

Group	Sex	Student	Process Sequence[a]	Final Result	Error Type[b]
III	FEMALE	1FIII	RC M3 M3 W3 5	2975 units	
		2FIII	RC M3 M3 M3 A 4	3 units	III
		3FIII	RC M3 M3 M3 A 4	3 units	III
		4FIII	RC M3 M3 M2 A 4	5 units	II, III
	MALE	1MIII	RC M3 M3 M3 A 4	3 units	III
		2MIII	RC M2 A 4	1 unit	II, III, IV
		3MIII	RC M3 M2 W3 4	2000 units	II
		4MIII	RC M3 M3 M3 A 4	3 units	III
IV	FEMALE	1FIV	RC M3 M3 W3 5	2800 units	
		2FIV	RU A M2 4	4 1/2 units	II, III
		3FIV	RU M3 M2 W3 4	5000 units	II, IV
		4FIV	RC M3 M3 W3 5	2800 units	
	MALE	1MIV	RU 1 4	No answer	I, IV
		2MIV	RC M3 M3 M3 5	3000 units	
		3MIV	RU M3 M3 1 4	No answer	I, IV
		4MIV	RU A M2 A M3 A M2 1 4	No answer	I, II, III IV

[a]See page 70 for explanation of symbols.

[b]See page 50 for explanation of numerals.

TABLE 41

PERCENTAGES OF STUDENTS WHOSE PROCESS SEQUENCES INDICATED BEHAVIORS CORRESPONDING TO VARIOUS CODING SYSTEM VARIABLES AND WHO ANSWERED THE SECOND PART OF PROBLEM EIGHT CORRECTLY

Variable[a]	Group I (Hi-Math Hi-Comp) (n = 4)	Group II (Hi-Math Lo-Comp) (n = 5)	Group III (Lo-Math Hi-Comp) (n = 1)	Group IV (Lo-Math Lo-Comp) (n = 3)	Female Group (n = 7)	Male Group (n = 6)
BWC	75	80	100	100	86	83
BWU	25	20	0	0	14	17
CP	0	20	0	0	14	0
MCC	100	100	100	100	100	100
MCI	0	20	0	0	14	0
WCC	25	100	100	67	86	50

[a]See page 70 for explanation of abbreviations.

to various Coding System variables and who gave an answer to the second part of problem eight that was within the range of either of the acceptable categories just described. Table 42 gives the same information for students whose answers were not within the acceptable ranges. There were two students, both males from Groups II and IV, who did not attempt to work this part of the problem. They are not included in the data of these tables. Two males from Group IV did not give an answer, but they attempted to solve the problem and they are included in the data of Table 42.

TABLE 42

PERCENTAGES OF STUDENTS WHOSE PROCESS SEQUENCES INDICATED BEHAVIORS CORRESPONDING TO VARIOUS CODING SYSTEM VARIABLES AND WHO ANSWERED THE SECOND PART OF PROBLEM EIGHT INCORRECTLY

Variable[a]	Group I (Hi-Math Hi-Comp) (n = 4)	Group II (Hi-Math Lo-Comp) (n = 2)	Group III (Lo-Math Hi-Comp) (n = 7)	Group IV (Lo-Math Lo-Comp) (n = 4)	Female Group (n = 9)	Male Group (n = 8)
BWC	75	100	100	0	67	75
BWU	25	0	0	100	33	25
IP	75	100	86	50	89	62
MCC	75	100	86	75	78	87
MCI	50	50	43	75	56	50
WCC	50	50	14	25	33	25

[a]See page 70 for explanation of abbreviations.

Coding System Observations

Sixty-nine percent of the students who answered the problem correctly were in Groups I and II (Hi-Math) while 65 percent of those who answered it incorrectly were in Groups III and IV (Lo-Math). Of the students who obtained an answer within an acceptable range, 54 percent of them were females. Of the students who obtained an answer that was not within an acceptable range, 53 percent of them were females. This occurred because of the two males who did not attempt to solve the problem. If those two were

included in the group with incorrect results, then 47 percent of the students who answered the problem wrong were females. All the females attempted to solve the problem.

All of the students in Group III began with certainty regardless of their results. For Group IV, all the students who answered the problem correctly began with certainty and all of them who answered it incorrectly began with uncertainty. For the other two groups, the majority of them began with certainty. One female in Group II changed her procedure when she realized that she had read the graph incorrectly. When she reread it, her approximations were more accurate.

All of the students who obtained answers within the acceptable ranges performed at least one mental computation correctly. There were no students in the study who performed an incorrect written computation.

Errors Made

The most common error dealt with the students ignoring the scale used for the vertical axis and considering the units of production as being some number from 0 through 7. There were students who did not know how to interpret the words "maximum" and "minimum" as they applied to this problem. As a result of not understanding the meaning of these words, they did not know how to proceed.

Comparison with NAEP Sample (Incorrect Result)

Listed below are percentages of students in this study and the NAEP study who made certain incorrect responses to this part of the problem:

Incorrect Response	WSCC	NAEP
2.8 - 3.2	19	25
2.5 - 3.5 (excluding 2.8 - 3.2)	3	4
Other unacceptable	25	35
"I don't know" or no response	12	15

The percentages of students in the two groups were very similar for the incorrect responses given.

The percentages of students whose protocols, work sheets, and tapes indicated behaviors that corresponded to various Check List items are given in Table 43.

Check List Observations

The majority of the students in each group, with the exception of Group II, had trouble understanding the problem. There were more students in Group III who had this difficulty which probably accounted for more of them using an inappropriate algorithm and making computational errors. There were more students in Group III who obtained an incorrect result. Only students in Groups I and IV had trouble deciding on a method for solving the problem. The same number of students from each group, except as previously mentioned, made computational errors.

TABLE 43

PERCENTAGES OF EIGHT STUDENTS IN EACH OF GROUPS I - IV AND 16 STUDENTS IN EACH SEX WHOSE PROBLEM SOLVING INFORMATION FOR THE SECOND PART OF PROBLEM EIGHT INDICATED BEHAVIORS CORRESPONDING TO VARIOUS CHECK LIST ITEMS

Item[a]	Group I (Hi-Math Hi-Comp)	Group II (Hi-Math Lo-Comp)	Group III (Lo-Math Hi-Comp)	Group IV (Lo-Math Lo-Comp)	Female Group	Male Group
RPA	62	50	50	50	56	50
TAW	0	12	0	0	6	0
TUP	50	37	75	62	56	56
UIA	37	25	75	25	50	31
DMS	37	0	0	37	19	19
KPO	12	25	25	0	6	25
MCE	25	25	37	25	37	19

[a]See page 70 for explanation of abbreviations.

The same number of males and females had trouble understanding the problem and deciding on a method for solving the problem. More females than males used an incorrect algorithm and made computational errors, but more males than females knew the procedure but couldn't perform the calculations.

General Remarks

One difficulty that was quite obvious was that students hastily read graphs without noting the scale to

be used in the interpretation. Again, in this part of the problem, there was some difficulty with the meaning of words. It is impossible to solve a problem if the meanings of key words in the problem are unknown. The words used in this problem were intended to be understandable by all students and especially at this age level.

CHAPTER V

SUMMARY AND CONCLUSIONS

This exploratory study was designed to analyze the records of the problem-solving procedures used by students while they solved selected consumer mathematics problems. The study was not experimental and did not assume that the sample was randomly selected. A Coding System, Check List, Error List, and Problem-Solving Questionnaire were developed. Thirty-two students were chosen from freshmen who entered Walters State Community College in Morristown, Tennessee during the summer quarter or fall quarter of 1975. They were divided into groups for various comparisons.

For the PSQ, the students were divided by sex (16 of each) for one comparison. For another comparison, they were divided based on their mathematics scores on the SCAT Test: eight females and eight males who had scores above the fiftieth percentile and the same number of each sex who had scores below the fiftieth percentile. The PSQ was completed by the students after they had solved the problems. The responses given on the PSQ gave information regarding the mathematical backgrounds, attitudes, and interests of the students.

A pilot study was conducted during the fall of 1975

using some of the consumer mathematics problems from the first assessment in mathematics conducted by the NAEP in 1972-1973. Eight of these problems were chosen to be used in this study. These eight problems represented the four categories given by NAEP: household problems; determining costs; using the concepts of average and percent; and reading and interpreting graphs and tables.

The students talked into a tape recorder as they solved these problems. Each tape was transcribed and an analysis of each problem for each student was made using the tape as well as the protocol and work sheet for that particular problem. The behaviors exhibited by the students that corresponded to the various Coding System variables, Check List items, and Error List numerals were identified.

For this part of the study, the students were divided into four groups (four females and four males in each) based on their comprehension scores on the Nelson-Denny Reading Test as well as their mathematics scores on the SCAT Test. The cut-off point for the comprehension score was the fifty-first percentile, and it was the same as before for the mathematics score. Comparisons were made among the four groups and also between the sexes relative to the Coding System variables, Check List items, and Error List numerals. There were other errors identified that were peculiar to each problem that were

not specifically stated in the Error List. These were also compared.

This study was designed to answer seven questions. These questions will be discussed in order.

I. QUESTION ONE

Statement of the Question

What were the similarities and differences in the problem-solving procedures and errors made among the following groups: Group I (Hi-Math, Hi-Comp), Group II (Hi-Math, Lo-Comp), Group III (Lo-Math, Hi-Comp), and Group IV (Lo-Math, Lo-Comp)?

Summary of the Findings (Problem-Solving Procedures)

The following are findings which relate to the differences and similarities in the problem-solving procedures. For each group, the averages of the percentages for all the problems for the behaviors represented by the various Coding System variables and Check List items were determined. The following findings are based on these averages. Among the four groups:

1. Groups I and III had the greatest average percentage (97 percent each) of students who read the problems correctly and Groups II and IV had the smallest average percentage (94 percent each) of students.

2. Group I had the greatest average percentage

(94 percent) of students who began with certainty. The remaining average percentages were: Group III--87 percent, Group II--85 percent, and Group IV--68 percent.

3. Groups III and IV had the greatest average percentage (14 percent each) of students who changed their procedures while solving the problems. An average of 12 percent of the students in Group II and 7 percent of the students in Group I exhibited this behavior.

4. Group I had the greatest average percentage (75 percent) of students who performed at least one correct mental computation. The remaining average percentages were: Groups II and III--62 percent each, and Group IV--43 percent.

5. Group II had the greatest average percentage (80 percent) of students who performed at least one correct written computation. The remaining average percentages were: Group I--73 percent, Group III--71 percent, and Group IV--64 percent.

6. Group II had the greatest average percentage (58 percent) of students who reread the problems or portions of them. The remaining average percentages were: Group I--47 percent, Group IV--46 percent, and Group III--42 percent.

7. Group IV had the greatest average percentage (30 percent) of students who had trouble understanding some of the problems. The average percentages for the

other groups were: Group III--22 percent, Group II--12 percent, and Group I--10 percent.

8. Group IV had the greatest average percentage (32 percent) of students who had trouble deciding on a method for solving some of the problems. The remaining average percentages were: Group III--25 percent, Group II--21 percent, and Group I--18 percent.

9. Group III had the greatest average percentage (21 percent) of students who knew the procedures but couldn't perform the calculations. The average percentages for the other groups were: Group I--18 percent, Group IV--17 percent, and Group II--15 percent.

10. Group IV had the greatest average percentage (5 percent) of students who were uncertain about their final answers. The remaining average percentages were: Group I--4 percent, Group II--3 percent, and Group III--1 percent.

In summary, it was found that in comparison with the other three groups, Group I had the greatest average percentage of students who read the problems correctly, began with certainty, and performed at least one correct mental computation; and had the smallest average percentage of students who changed their procedures while solving the problems, had trouble understanding some of the problems, and had trouble deciding on a method for solving some of the problems. It was also found that in

comparison with the other three groups, Group IV had the greatest average percentage of students who changed their procedures while solving the problems, had trouble understanding some of the problems, and had trouble deciding on a method for solving some of the problems; and had the smallest average percentage of students who read the problems correctly, began with certainty, performed at least one correct mental computation, and performed at least one correct written computation.

In conclusion, the major differences that existed were relative to Group I and Group IV. More students in Group I displayed characteristics of efficient problem solvers than the students in the other three groups. On the other hand, fewer students in Group IV displayed characteristics of efficient problem solvers than the students in the other three groups.

The students were similar in that none of them questioned the uniqueness of the solutions to any of the problems, and only one student tried to relate a problem to a similar problem. Every student read a problem correctly, began with certainty, performed a correct written computation, and performed a correct mental computation at least one time while solving the eight problems. Every student in Group I completed every problem and every student in Group III attempted to solve each problem.

Summary of the Findings (Errors)

The following are findings which relate to various errors. For all groups, the averages of the percentages for all the problems for the various errors were determined. The following findings are based on these averages. Among the four groups:

1. Group IV had the greatest average percentage (16 percent) of students who did not finish the problem. The remaining percentages were: Groups II and III--4 percent each, and Group I--1 percent.

2. Group IV had the greatest average percentage (29 percent) of students who did not understand some of the problems. The percentages of the other groups were: Group III--12 percent, Group II--7 percent, and Group I--5 percent.

3. Group III had the greatest average percentage (37 percent) of students who used inappropriate algorithms. The remaining percentages were: Group IV--32 percent, Group I--23 percent, and Group II--21 percent.

4. Group IV had the greatest average percentage (40 percent) of students who made at least one computational error. The percentages for the other groups were: Group III--36 percent, Group I--26 percent, and Group II--19 percent.

5. Group IV had the greatest average percentage

(28 percent) of students who performed an incorrect mental computation. The remaining percentages were: Group III--23 percent, Group I--18 percent, and Group II--15 percent.

6. Group III had the greatest average percentage (19 percent) of students who performed an incorrect written computation. The percentages for the other groups were: Group IV--18 percent, Group I--14 percent, and Group II--10 percent.

In conclusion, the major differences existed relative to the students in Group II and Group IV. On two-thirds of the errors identified, students in Group IV represented the greatest average percentage of students making those errors. On two-thirds of the errors identified, students in Group II represented the smallest average percentage of students making those errors.

Every student in Group III made a computational error and used inappropriate algorithms. Seven of the eight students from the other groups made some type of computational error and used inappropriate algorithms. Seven of the students from Group IV, six from Group III, three from Group II, and two from Group I did not understand at least one of the problems.

II. QUESTION TWO

Statement of the Question

What were the noticeable patterns established and identical skills used in the problem-solving procedures of the students in each of the four groups named above?

Summary of the Findings (Patterns)

The following noticeable patterns were found in the problem-solving procedures used by the students in the four groups:

1. In problem five, more than 50 percent of the students in Group I did the following: read the problem correctly, began with certainty, multiplied 80 by 36, added 400 to that result, then subtracted 2850 from the previous sum.

2. In problem six, more than 50 percent of the students in all groups did the following: read the problem correctly, began with certainty, added the incomes, and divided this sum by three.

3. In the first part of problem eight, more than 50 percent of the students in each of Groups I and III did the following: read the problem correctly, began with certainty, looked at the graph, and correctly located the sharpest downward trend.

Summary of the Findings (Skills)

The following skills or lack of skills were displayed by all members of the specified group:

Group I--All students obtained a solution to each of the problems. All students knew the following:

1. How to multiply 20 times 12-1/2.

2. That 250 minutes were not two hours and 50 minutes or the time 2:50 p.m.

3. How to find 10 percent and 15 percent of $100.

4. How to read the line graph in order to determine the maximum and minimum points.

5. How to read the numbers on the vertical axis of the line graph that corresponded to the maximum and minimum points.

6. How to find the difference between two numbers.

7. How to find an average.

Group II--All the students in Group II knew how to find an average.

Group III--The following observations were made in regard to all the students in Group III:

1. All of the students attempted to solve each of the problems.

2. All students knew how to find an average.

3. No students in this group subtracted the amount of the discounts on the two TV sets in problem

three to find the difference in the sale prices.

Group IV--The following observations were made in regard to all the students in Group IV:

1. No students in this group set up a proportion in problems where students from each of the other groups used that method.

2. No students in this group changed 12-1/2 to 12.5 to perform the necessary calculation in problem two.

III. QUESTION THREE

Statement of the Question

What were the similarities and differences in the problem-solving procedures and errors made by the female students as opposed to the male students?

Summary of the Findings (Problem-Solving Procedures)

The following findings relate to the differences and similarities in the problem-solving procedures. For each sex, the averages of the percentages for all the problems for behaviors represented by the various Coding System variables and Check List items were determined. The following findings are based on these averages. On the average per problem:

1. More males (97 percent) than females (85 percent) read the problems correctly.

2. More females (84 percent) than males (83

percent) began with certainty.

3. More females (18 percent) than males (5 percent) changed their procedures while solving the problems.

4. More females (62 percent) than males (60 percent) performed at least one correct mental computation.

5. More females (75 percent) than males (69 percent) performed at least one correct written computation.

6. More females (57 percent) than males (39 percent) reread the problem or portions of it.

7. More males (19.2 percent) than females (18.6 percent) had trouble understanding some of the problems.

8. More females (25 percent) than males (23 percent) had trouble deciding on a method for solving some of the problems.

9. More females (19 percent) than males (15 percent) knew the procedures but couldn't perform the calculations.

10. More females (6 percent) than males (1 percent) were uncertain about their final answers.

In conclusion, the major differences that existed between the sexes were that the males read the problems correctly more often than the females but the females reread the problems more frequently than the males. The females also changed their procedures more often and

were more uncertain about their final answers. The two sexes were very similar in the frequency with which they began with certainty, performed at least one correct mental computation, had trouble understanding some of the problems, had trouble deciding on a method for solving some of the problems, and knew the procedures but couldn't perform the calculations.

Summary of the Findings (Errors)

The following findings relate to various errors. For both sexes, the averages of the percentages for all the problems for the various errors were determined. The following findings are based on these averages. On the average per problem:

1. More males (10 percent) than females (3 percent) did not finish some of the problems.

2. More males (16 percent) than females (11 percent) did not understand some of the problems.

3. More females (32 percent) than males (24 percent) used inappropriate algorithms.

4. More females (35 percent) than males (26 percent) made at least one computational error.

5. More females (27 percent) than males (15 percent) performed an incorrect mental computation.

6. The same percentage of females and males (15 percent) performed an incorrect written computation.

In conclusion, more males did not finish the problems and did not understand the problems but more females made computational errors and used inappropriate algorithms. The sexes were similar in performing incorrect written computations.

IV. QUESTION FOUR

Statement of the Question

What were the noticeable patterns established and identical skills used in the problem-solving procedures of the female and male students?

Summary of the Findings (Patterns)

1. In problem five, more than 50 percent of the males did the following: read the problem correctly, began with certainty, multiplied 80 by 36, added 400 to that result, then subtracted 2850 from the previous sum.

2. In problem six, more than 50 percent of the females and males did the following: read the problem correctly, began with certainty, added the incomes, and divided this sum by three.

3. In the first part of problem eight, more than 50 percent of the males did the following: read the problem, began with certainty, looked at the graph, and correctly located the sharpest downward trend.

Summary of the Findings (Skills)

There were no skills displayed by all the females or all the males in solving the problems. All of the females attempted to solve each of the problems whereas all of the males did not.

V. QUESTION FIVE

Statement of the Question

Were there differences in the answers given to the problems by the students in this study and the 17-year-olds in the NAEP study?

Summary of the Findings

Listed below are the percentages of students from WSCC and the NAEP sample who obtained a correct result to each of the problems:

	Problems								
	1	2	3	4	5	6	7	8A	8B
WSCC	72	28	76	62	56	81	47	65	40
NAEP	70	35	72	47	56	66	45	69	21

Except for problems four, six, and part two of problem eight, the percentages of students from the two groups who obtained a correct result were very close. For the three exceptions, a greater percentage of students from WSCC obtained a correct result than the students in the NAEP sample. For problems where specific incorrect

responses were given, the percentages of students from the two groups who made these incorrect responses were very similar.

VI. QUESTION SIX

Statement of the Question

What were the similarities and differences in the responses given on the Problem Solving Questionnaire (PSQ) between students in Group A (Hi-Math) and Group B (Lo-Math)? (PSQ is found in Appendix B.)

Summary of the Findings

The following statements represent the attitudes of the majority of students in Group A. The majority of the students in Group B indicated that they have the opposite attitude.

1. Do not have a hard time concentrating on homework.
2. Like to discover different ways to solve the same problem.
3. Thoroughly enjoy working on mathematical games and puzzles.
4. Would rather respond slowly to a mathematics question than gamble in an answer.

It was also found that more students in Group A than Group B possessed the following characteristics:

1. Studied advanced high school mathematics courses.

2. Planned to take college mathematics courses.

3. Had special instruction in problem solving while in high school.

4. Have developed their own system for solving certain kinds of problems.

On 80 percent of the 20 questions on the second part of the PSQ, the students in the Hi-Math and Lo-Math groups had similar opinions. On 63 percent of them, they were in agreement with the statements and on 37 percent of them, they disagreed.

VII. QUESTION SEVEN

Statement of the Question

What were the similarities and differences in the responses given on the PSQ between the female and male students?

Summary of the Findings

The following statements represent the attitudes of the majority of the females, while the majority of the males have the opposite attitude:

1. Do not have a hard time concentrating on homework.

2. Like to discover different ways to solve the same problem.

3. Would rather give a wrong answer than no answer.

4. Prefer doing to thinking.

It was also found that more females possessed the following characteristics:

1. Studied advanced high school mathematics courses.

2. Had special instruction in problem solving while in high school.

3. Have developed their own system for solving certain kinds of problems.

More males planned to take college mathematics courses.

On 80 percent of 20 questions on the second part of the PSQ, the females and males had similar opinions. On 56 percent of the statements, they were in agreement and on 44 percent of them, they disagreed.

VIII. CONCLUSION

Problem solving is a topic that can be divided into many areas. The concern of this study was with one small phase which involved an analysis of the problem-solving procedures used by various groups of college freshmen while solving certain basic consumer mathematics problems.

No attempt was made to determine the characteristics of good or efficient problem solvers. However, it was found that the group that had more students who obtained the correct answer per problem for most of the problems possessed cer-

tain characteristics. They did the following things more often than students in the other groups: Read the problems correctly, began with certainty, and performed at least one correct mental computation. They did the following things less often than students in the other groups: Changed their procedures, had trouble understanding the problems, and had trouble deciding on a method for solving the problems. These students were in the Hi-Math, Hi-Comp group. It would appear that these characteristics were more conducive to obtaining correct results.

The students in the Lo-Math, Lo-Comp group had fewer students who obtained the correct result per problem on all of the problems than students in the other three groups. They also possessed certain characteristics. They did the following things less often than students in the other three groups: Read the problems correctly, began with certainty, and performed at least one mental or written computation; and more frequently did the following things than students in the other three groups: Changed their procedures, had trouble understanding the problems, and had trouble deciding on a method for solving the problems. The students in this group also made more errors per problem than students in the other three groups. Perhaps, the characteristics of this group lend themselves to making errors and obtaining incorrect results.

The females and males possessed characteristics that were very much alike in their problem-solving procedures. The percentages of each sex who obtained correct results on each of the problems were very close.

Implications for Teachers

As a result of this study, the following suggestions seem appropriate for classroom teachers. More emphasis should be placed on:

1. Interpreting the fundamental question in a statement problem before beginning to solve the problem.

2. Correctly interpreting all intermediate results and using them properly to obtain an answer to the question asked.

3. Interpreting, in light of the particular problem, when it is appropriate to round off, truncate, or express the remainder as a fraction.

4. Working with denominate numbers: (a) Subtracting a specific number of hours from a given time, e.g., four hours and 10 minutes from 5:00 p.m. (b) Determining the number of hours that have elapsed between two given times, e.g., from 10:45 a.m. until 3:05 p.m.

5. Finding a given percent of a number, e.g., 15 percent of $100.

6. Finding what percent one number is of another number, e.g., 120 is what percent of 200?

7. Determining the cost of an item if the number of monthly payments, the amount of the monthly payments, and the down payment are known.

8. Reading and interpreting a graph, e.g., to find the greatest drop in production from one month to the next.

9. Understanding how to interpret the scale on a graph, when and how to use it.

10. Interpreting words used in a mathematical problem.

Implications for Future Research

This study has posed numerous questions for future research. The following represent areas of concern:

1. The "thinking aloud" technique - Should students have practice in this technique prior to participating in a clinical study of this type?

2. Presence of an observer - Should a two-way mirror be used so that more observations can be made while the students are solving the problems? Would this keep them from being "nervous" while solving the problems?

3. The Coding System - Would another Coding System have been more sensitive to the areas of concern in the problem-solving procedures used by the students?

4. The Check List - Is the Check List a valuable

tool to use in this type study? Could the items be incorporated into the Coding System?

5. Grouping - Would other cut-off scores have provided different results? Should other type scores have been used to group the students?

6. Problem Solving Questionnaire - Should this have been administered prior to answering the questions? Would the results have been different?

More studies need to be done that would attack each of the above-mentioned areas. Replications of this study would also be valuable to see if the Coding System, Check List, Problem Solving Questionnaire, method of grouping, interviewer, and "thinking aloud" techniques are of value.

General

This study has made a small step into understanding some of the problem-solving procedures used by college freshmen to solve basic consumer mathematics problems. It is hoped that the results will in some way help teachers and pupils learn better and more efficient ways of solving problems.

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APPENDIXES

APPENDIX A

PROBLEMS USED IN THE PILOT STUDY BUT NOT IN THE FINAL STUDY

1. A housewife will pay the lowest price per ounce for rice if she buys it at the store which offers

   A. 12 ounces for 40 cents
   B. 14 ounces for 45 cents
   C. 1 pound, 12 ounces for 85 cents
   D. 2 pounds for 99 cents
   E. I don't know

2. If a city's property tax is $29.87 per $1,000 of assessed value, the tax on property assessed at $14,900 would be CLOSEST to which amount?

   A. $400
   B. $420
   C. $450
   D. $470
   E. I don't know

3. A state changes its sales tax from 3 percent to 4 percent. How much ADDITIONAL sales tax would you now pay on a new car that costs $2,760.00?

4. A door-to-door salesman receives 20 percent of the retail value of his sales as commission. What must his total retail sales be if he is to earn a commission of $60?

5. A man bought two pounds of cheese in eight-ounce packages. How many packages did he buy?

6. Curtains six feet seven inches long are needed for a set of windows. Which one of the following standard curtain lengths is CLOSEST to the length required?

   A. 66 inches
   B. 72 inches
   C. 84 inches
   D. 90 inches
   E. I don't know

7. A recipe for punch calls for equal amounts of lemonade, limeade, orange juice, and ginger ale. How many PINTS of ginger ale would be needed in order to make two gallons of this punch?

8. A gallon of asphalt paint will cover about 250 square feet of surface area. This paint is sold in gallon cans only. How many gallon cans are needed to paint a driveway 48 feet long and 10 feet wide?

9. Candidate A received 70 percent of the votes cast in an election. If 4,200 votes are cast in the election, how many votes did he receive?

10. According to the chart below, which TWO regions of the U.S. had the largest rural populations in 1970?

U.S. Rural Population for Nine Regions in 1970

Region	Rural Population (0 = 1 million persons)
1. New England	000
2. Middle Atlantic	0000000
3. East North Central	0000000000
4. West North Central	000000
5. South Atlantic	00000000000
6. East South Central	000000
7. West South Central	00000
8. Mountain	00
9. Pacific	0000

11. According to the chart below, for which year did federal grants for education decrease from the prior year?

A. 1966
B. 1967
C. 1968
D. 1969
E. 1970
F. I don't know

Year	Expenditures (* = $500 million)
1966	**********
1967	**********
1968	**********
1969	**********
1970	**********

12. The last five years' batting averages for six baseball players and the average of the team for which they play are shown below:

	1967	1968	1969	1970	1971
Team Average:	.220	.212	.231	.224	.226
Players					
1. Lehmann	.260	.255	.295	.265	.261
2. Finley	.210	.224	.216	.221	.210
3. Hlavaty	.248	.251	.249	.246	.253
4. Heimer	.252	.255	.259	.264	.270
5. Lee	.275	.260	.290	.279	.283
6. Womer	.265	.315	.295	.304	.320

A. Which player had the most CONSISTENT batting average between 1967 and 1971?

A. Lehmann
B. Finley
C. Hlavaty
D. Heimer
E. Lee
F. Womer
G. I don't know

B. Which player's batting average agrees most CLOSELY with the batting average of his team in all five years?

A. Lehmann
B. Finley
C. Hlavaty
D. Heimer
E. Lee
F. Womer
G. I don't know

APPENDIX B

QUESTIONNAIRE ON PROBLEM SOLVING

CODE NUMBER_____ AGE_____

1. What is your father's occupation?_____

2. What is your mother's occupation?_____

3. How many people live in your home?_____
   Circle those who are living in your home:

   father mother brother(s) sister(s) others

4. What occupation do you plan to enter?_____

5. Name three occupations you might like to enter._____
   _____

6. Circle the mathematics courses that you took in high school:

   general math algebra geometry trigonometry

   senior math intermediate math other (name them)

7. Do you plan to take any mathematics courses in college?

   Yes No Undecided

8. Do you study mathematics alone? always very often

   quite often sometimes hardly ever never

9. During high school did you have any special instruction on problem solving?

   Yes No Can't remember

10. How frequently do you check your answers to mathematics problems?

    always very often quite often sometimes

    hardly ever never

11. Have you developed your own system for solving certain kinds of mathematics problems?

    Yes No

12. Does setting up a problem as neatly as possible on paper help you in solving it?

    always very often quite often sometimes

    hardly ever never

For each of the following statements put an X in the space which shows the degree to which you agree or disagree with the statement.

		Strongly agree	Mildly agree	Mildly disagree	Strongly disagree
1.	I usually guess the answer to a problem before working it out in detail.....				
2.	I would rather ask for help on a difficult problem than work on it alone.....				
3.	I would rather respond slowly to a question my math teacher has asked than gamble in my answer.....				
4.	I have always thoroughly enjoyed working on mathematical games and puzzles.....				
5.	I can tell without checking whether an answer I have gotten is correct.....				
6.	I have found that a period of silence before answering a question does not help me.....				
7.	It is more important to be able to discuss mathematical ideas than to be able to work a variety of mathematical problems.....				
8.	I would rather give a wrong answer than no answer at all.....				
9.	The most important reasons for learning math are those concerning its usefulness.....				
10.	The best way to learn how to solve math problems is to solve lots of them.....				
11.	My first choice of a subject of study in college was one concerning the foundations of mathematics.....				
12.	Frequently the answer to a problem occurs to me after I have gone on to do something else..				

		Strongly agree	Mildly agree	Mildly disagree	Strongly disagree
13.	I have a hard time concentrating on my mathematics homework.....				
14.	I like to discover several different ways to do the same problem.....				
15.	I prefer doing to thinking.....				
16.	I only raise my hand when I know I have the correct answer.....				
17.	I would rather ask for help on a difficult mathematics problem than have someone tell me the answer.....				
18.	I don't like to discuss the problems on a test after I've finished it.....				
19.	It's better to be slower and right all of the time than to be faster and right part of the time.....				
20.	I always guess on a multiple-choice test when I don't know the right answer.....				

APPENDIX C

CORRESPONDENCE

Walters State Community College
Morristown, Tennessee 37814

Developmental Studies Division December 30, 1975

(Inside Address)

Dear

This year I am teaching mathematics in the Developmental Studies Department at Walters State Community College and studying at The University of Tennessee. In connection with my studies at UT, you are one of forty entering freshmen at WSCC that is being asked to assist me in a research project.

This project will take no more than one hour of your time during the winter quarter of 1976. During the first week of the winter quarter (January 7th-9th) would you come to my office and let me know if you will be able to participate. At that time, I will explain more to you about the project.

My office is located in Room 318 of the main building. On Wednesday and Friday, my office hours are 11:00 - 12:30 and 1:30 - 2:30. On Thursday they are 3:30 - 6:00. If you cannot see me at any of those times, leave your telephone number for me and I will call you. I will also be around the gymnasium during registration on January 5th and 6th.

Hopefully you will be able to participate, and I am sure that it will be enjoyable working together. Your name will not be used in the project, and the work will not be difficult.

Very sincerely yours,
(Signed)
(Mrs.) Jacqueline Underwood

Walters State Community College
Morristown, Tennessee 37814

Developmental Studies Division

January 29, 1976

(Inside address)

Dear

During the Christmas vacation you should have received a letter from me asking you to participate in a research project. In checking my records, I notice that I have not heard from you. Hopefully, it has just been an oversight on your part or you have been unable to contact me.

Within the next week would you come to my office and let me know if you will be able to participate. At that time I will explain more to you about the project. My office is located in Room 318 of the main building. On Monday, Wednesday, and Friday my office hours are 11:00 - 12:30. On Tuesday and Thursday, they are 3:30 - 6:00. I am also there on Tuesday from 9:15 to 2:00. If you cannot see me at any of those times, leave a message with my secretary, Mrs. Loveday, in Room 203.

Hopefully, you will be able to participate, and I am sure that it will be enjoyable working together. Your name will not be used in the project, and the work will not be difficult.

Very sincerely yours,
(Signed)
(Mrs.) Jacqueline Underwood

Copy of Post Card Sent to Students Regarding the

Introductory Meeting

Walters State Community College
Morristown, Tennessee 37814
February 4, 1976

Dear

I have just received approval for conducting my research. A meeting has been scheduled for WEDNESDAY, FEBRUARY 11, 1976, at 11:15 a.m. in ROOM 321 of the main building at Walters State. If you cannot attend this meeting, try to call me, come by my office (Room 318), or leave me a note so we can arrange to have our introductory session very soon.

I look forward to seeing you on WEDNESDAY, FEBRUARY 11, at 11:15 a.m. in Room 321.

Sincerely,
(Signed)
(Mrs.) Jacqueline Underwood

Walters State Community College
Morristown, Tennessee 37814

Developmental Studies Division June 4, 1976

(Inside address)

Dear

First let me thank you for participating in my research project. I am busy now transcribing and analyzing the tape that you made.

Your cooperation was greatly appreciated. If I can be of any assistance to you, please call on me.

Again, thank you very much.

Sincerely,
(Signed)
(Mrs.) Jacqueline Underwood

APPENDIX D

TRANSCRIBED INTRODUCTORY TAPE

INTERVIEWER

I am happy that you have decided to participate in this project. Let me assure you from the beginning that your name will not be used in the study at all. You will be assigned a code number that will in no way identify you by name. I am interested in finding out how students think when they solve problems. Eight problems that represent everyday situations have been chosen to be used. Each problem is on a separate sheet of paper so that you can do all your computations on that sheet. If you need more paper, you can let me know. As you read the problem and work it, I want you to think aloud. Your words will be taped so that I can study the procedure that you have used in working each problem. Try to work each problem before giving up and saying "I don't know." So that you might understand better what I want you to do, a student has worked a problem aloud, and you will now hear him. (Give each student a copy of the problem with the student's work on it.)

STUDENT

A housewife will pay the lowest price per ounce for rice if she buys it at the store which offers (a) 12 ounces for 40 cents, (b) 14 ounces for 45 cents, (c) 1 pound, 12 ounces for 85 cents, (4) 2 pounds for 99 cents, and (e) I don't know. I will start by trying to find out what is the amount of ounces I get per the amount of money. And I will start with (a) and I will divide 40 into 12 and I will get .3. For (b) I divide 45 cents into 14 ounces and I will get .311. For (c) I will divide 85 cents into that 28 ounces which I got by adding 1 pound which is 16 ounces and 12 ounces which will equal to 28 ounces. And I divide as I said 85 into 28 to get .329. And for (d) I said 2 times 16 which is equal 16 ounces in a pound and I get 32 and I divided 99 into 32 and got .323. Now I was looking to see how the most number of ounces that I can get per cent. And I found that the .329 would be the most number of ounces I get per cent. And that came with (c) which was 1 pound 12 ounces for 85 cents and that is the answer I chose.

INTERVIEWER

Now I hope you understand exactly what I want you to do. You probably realize that this problem could be worked in other ways. So you see I am not looking for a specific way to work each of the problems. Do you have any questions? (Pause) You will need about one hour to complete the eight questions. Would you write on the other side of that sheet of paper your name, telephone number, and address for this quarter. Also list several times that you would be available to come in to do your questions. I will be in touch with you soon. Thank you so much for your interest.

APPENDIX E

TRANSCRIPTS

The transcripts are arranged so that all of the ones for each problem appear together. The code number for the student appears at the beginning of the transcript for that student. The student order for presenting the transcripts for each problem is the same. These are arranged first by group, then by sex, then by number within that sex-group. (1FI, 2FI, . . ., 1MI, 2MI . . ., 1FII, . . ., 1MII, . . ., 4MIV.)

The following is an explanation of the symbols used in the transcripts:

- \- represents a pause of less than 15 seconds.
- \# represents a pause of more than 15 seconds.
- " represents a mental computation performed by the student.
- . . . represents the oral explanation of a written arithmetic computation.
- * represents a written arithmetic computation that was not explained orally.
- ( ) remarks by the interviewer are enclosed within.

The remarks by the interviewer are comments that include such things as stating the operation being performed; stating the operation being performed and the numbers being used when it is not evident in the oral remarks by the student; and explaining numbers used later that the student did not give orally (without these numbers the procedure would be more difficult to follow).

I. PROBLEM ONE

1FI

If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? - So I find out how many calories in one ounce. I divide nine into 300 * (divided) And I get approximately 32. So in three ounces - I get - Put down 32 times three . . . (multiplied) I get 96 calories.

2FI

If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? There's 300 calories in nine ounces. So - In three ounces there would be " 100 calories because three is " One-third of nine.

3FI

If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? - 300 calories in nine ounces " 300 over three gives you * (divided) 100.

4FI

If there are 300 calories in nine ounces of a certain food, how many calories are there in three-ounce portion of that food? - (set up proportion: (300/9 equals x/3) That'd be . . . (solved for x) So there'd be 100 calories.

1MI

If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? - That's " One-third - So three into 300 * (divided) Is 100.

2MI

If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? - 300 calories - Divided by nine . . . (divided) 33.3 times three . . . (multiplied) 99.9 is the answer.

3MI

If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? - If there are 300 calories in a nine-ounce portion of a certain food, how many calories are there in a three-ounce portion? - Well three ounces would be " One-third of nine ounces, which means you would have to divide 300 calories by three * (divided) Which I would know would be 100. So there would be 100 calories in that portion of that food.

4MI

If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? - If there are 300 calories in nine ounces then three ounces should be " One-third of 300 calories. So - Set it up in a proportion. 300 calories is to x as - Three ounces - No as nine ounces is to three ounces . . . (solved for x) Answer 100 calories in a three-ounce portion of that food.

1FII

If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? # Since there are 300 calories in nine ounces of the food, you want to know how many calories there are in three-ounce portion of the food. I would # I would divide - Three - Into 300 * (divided) I get 100. # If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? I'm going to try - Divide nine, divide nine ounces into 300 to find out how many calories there are per ounce . . . (divided) 33 and one-third calories per ounce. So I

multiply 33 and one-third times three ounces - And you come up * (multiplied) With about 100. So I would say 100. So it's going to come out to 100. So 100 is right.

2FII

If there are 300 calories in nine ounces of certain food, how many calories are there in a three-ounce portion of that food? Since there are 300 calories in nine ounces and you want to find how many calories in a three ounce, you divide 300 by " Three and that will give you * (divided) 100 calories.

3FII

If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? - 300 ounces in nine ounces of a certain food. How many calories are there in a three-ounce portion of that food? You divide - You divide 300 into - You divide " Three into 300 * (divided) And you get 100 # Divide three into nine * (divided) And get three. So the answer is " 100 calories.

4FII

If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? - If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? - 300 calories be in nine ounces - 300 calories - Then three would have - Let's see - Nine ounces has 300 - Then three ounces would have " 100 calories.

1MII

If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? - I see that three ounces would be " One-third of nine ounces. So I'll multiply - 300 by one-third. I'll divide it by three * (divided) And I get 100 calories.

2MII

If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce

portion of that food? # 16 ounces equals one pound - We've got 300 calories in nine ounces - And we want to know how many calories there are in a three-ounce portion. 300 equals nine - Ounces and x will equal - The three-ounce portion # Now, I see an easy way to it if I had just read the question - By using proportion, you could say 9x will equal 900 * (multiplied equals in two equations) And x will equal * (solved for x) 100. 100 calories would be your answer, I reckon.

3MII

If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? Now how do I work this problem? 300 calories in nine ounces - How many calories are there in a three-ounce portion of that food? - Divide nine into 300 . . . (divided) Goes 33 - 33 repeating decimal - Multiply 33.3 times three . . . (multiplied) 99.9 - Calories for one ounce.

4MII

If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? - In a three-ounce portion - I take - You divide " Three into 300 . . . (divided and got 100) So - If there's 300 calories in nine ounces and in three ounces there's 100 calories.

1FIII

If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? # First of all I would divide " Three into 300 * (divided) That would be 100. Then next thing I would do would be # Next then I would divide nine into 300 and see what that would be . . . (divided and got 33 and one-third) Next I would multiply. There's 300 in nine ounces, how many in three ounces? # First thing I did was divide three into 300 would be 100. So that would be my answer - 100 calories. # No, that's not right - 33 and one-third times three would equal . . . (multiplied) That would be 100.

2FIII

If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? - Let's set this up as a simple proportion - nine is to 300 as three is to x . . . (solved for x) You get 100. So x is equal to 100 - So there's 100 calories in a three-ounce portion of that food.

3FIII

If there are 300 calories in nine ounces of a certain food, how many are there in three-ounce portions of that food? - There are 300 calories in nine ounces. How many calories are there in three-ounce portion? - Nine # If there are 300 calories in nine ounces - Nine into 300 will go . . . (divided) Be 33.

4FIII

If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? # " Looks like it's 100 calories.

1MIII

If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of the food? Since there's 300 in a nine-ounce portion, I would know that by dividing 300 into nine, no, I would know that in each " Three-ounce portion there would be 100 calories. So that 100 calories would be my answer.

2MIII

If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? - I divide 300 calories - Into nine ounces (didn't divide) # If there are 300 calories - Divide " Three into 300 * (divided) 100 - Nine ounces of a certain food. Multiply 100 times nine * (multiplied) The answer is 900.

3MIII

If there are 300 calories in nine ounces of certain food, how many calories are there in a three-ounce portion of that food? # If there are 300 calories in nine ounces of certain food, how many calories are there in a three-ounce portion of that food? - 300 over nine - I guess " 100 over three (thought of it as a proportion) So there'd be 100 calories in three ounces (reduced 300/9 to 100/3).

4MIII

If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? - You divide nine into 300 * (divided) Answer was 33 - and one-third - " Answer will be 100 calories.

1FIV

If there are 300 calories in nine ounces of a certain food, how many calories are there in three-ounce portion of that food? Nine ounce - Nine ounces of a certain food - Three-ounce portion of that food - You would - Divide. That's " One-third of nine ounces. You would divide - I guess - You divide three into 300 * (divided) And you come up with 100. Pretty simple and the answer would be 100.

2FIV

If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? So I divide three into 300 . . . (divided and got 300) It don't work - If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? # Divide three into nine. No, if there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? # Divide nine into 300 * . . . (divided) And get 33 remainder 3. # How many calories are there in a three-ounce portion of that food? - If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? Got 33 remainder three after I divided nine into 300. So there are 33 ounces in one ounce. So I divide three by 33 . . .

(multiplied) So that would be - 33 times there is * (multiplied) 99. So I divide. No, I mean multiply 99 by three . . . (multiplied) No, I'd add 99 and three . . . (added) If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? # 33 plus three # So there's 99. If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of food? 99 calories.

3FIV

If there is 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? Since there's 300 calories in nine ounces and they want to know how many calories in three ounces, I'd divide # 300 calories in nine ounces - Take " Three into 300 * (divided) Would be 100 calories - In - Three ounces.

4FIV

If there are 3000 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? # If there are 3000 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? I'm trying to figure out how to - What I would divide. If there are 3000 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? - I guess - You would divide nine - Would you divide nine into 3000 calories? How many calories are there in a three-ounce portion? - You divide three into 3000 - See I'll divide three into 3000 - It would go in . . . (started to divide) I'm not doing this right. I'm just lost # I'd say nine into 300 . . . (divided) 33 remainder three.

1MIV

If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? # Divide nine into 300 . . . (divided) 33 ounces.

2MIV

If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? # Be " One-third of 300 which would be " 100.

3MIV

If there are 300 calories in nine ounces of a certain food, how many calories are there in three-ounce portion of that food? # I can't work the problem.

4MIV

If there are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? If there are 300 calories in nine ounces of a certain food - 300 calories - In a certain food, how many calories are there in three-ounce portion of food? Three-ounce portion. There are 300 calories in nine ounces of a certain food, how many calories are there in a three-ounce portion of that food? How many calories are there in a three-ounce portion of that food? 100 will go into 300 . . . (divided and got three) Three will go into. Let's see. Nine into 300 - Will go . . . (divided and got 33 and three-ninths) How many calories are there in a three-ounce portion of that food? - 300 calories in nine ounces, how many calories are there in three ounces? Take " A third of 300. One-third of 300 is what? " There's 100 calories in three ounces. 100 calories is the answer.

II. PROBLEM TWO

1FI

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00, what time should it be put in to cook? - If a turkey weighing 12-1/2 pounds is to be done by 5:00 - You want to find out how long it would take the turkey to cook. So 12-1/2 pounds, 20 minutes a pound, you'd say 20 times 12-1/2 or . . . (multiplied) 250. So that's how many minutes. 250 minutes. So divide 250 minutes by 60 and you'll get how many hours . . . (divided) Four times (got

a remainder of 10) So you'd have to put it in four hours and " 10 minutes before 5:00, which would be - 5:00 minus 4:10 would be . . . (subtracted) So you'd put the turkey in at - Let's see # At 10 til two. Say 1:50.

2FI

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds should be done by 5:00 p.m., what time should it be put in to cook? There's 12-1/2 pounds - And 20 minutes for each pound. So I would want to multiply - 20 by 12-1/2 and I get * (multiplied) 240 plus one-half of 20 is " 10 " 250 minutes - I'm going to divide 250 minutes by 60 because that's how many minutes is in an hour * (divided) And I get four hours - And " 10 minutes. And if it's supposed to be done at 5, I have, then I'll have to put it in at * (subtracted 4:10 from 5:00 and got 12:50) 1:50 p.m.

3FI

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? You got 20 minutes. 12-1/2 pounds. So " 12.5 times 20 * (multiplied) Equals 250. 250 minutes divided by 60 for hours " (divided and got 4.17) Four hours and " 17 minutes. So five o'clock, you need four hours back. I think you subtract. I usually count it out on my fingers. It's four point - Wait, five o'clock minus four hours and 17 minutes equals * (subtracted) That doesn't work. Gives you 83 and there's no such hour. I'll count it on my fingers " 5, 4, 3, 2, get 1 o'clock - Minus 17 minutes - Still doesn't work. If I were going to cook it, I'd put it in about 12:30 just to be sure because it's going to get done on time anyway # Wow, it's 60 minus 17 " (subtracted) Put it in at " 1:43. 1:43, 2:43, 3:43, 4:43 right.

4FI

A turkey is that to be cooked 20 minutes for each pound. A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? - A turkey is to be cooked 20 minutes for each pound and if it's

12-1/2 pounds, that's 25/2 pounds and if you multiply that by - 20 minutes per pound - Oh, wait a minute. If it's 12-1/2 pounds, multiply 12 by 20 * (multiplied) Be 240 minutes - And then for the half pound it would be " 10 more minutes. So it will be " 250 minutes - And then - Divide 250 minutes by 60 minutes in an hour and * (started dividing) A turkey is to be cooked 20 minutes for each pound so 12 times 20 * (finished dividing and got 4.16) Be four hours and " 16 minutes. So you'd have to put it in at - You'd have to put it in at " 12 # Put it in at " 12:45 - Then it would be done at (counted on fingers from 12:45 to 5:00) So you put it in at " 12:44 to be done.

1MI

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? A turkey is to be cooked 20 minutes for each pound - 20 - 20 - Times " 12.5 . . . (multiplied) It'll take 250 minutes. Sixty minutes in a hour. Sixty into 250 . . . (divided and got 4.16) It'll take four hours and " 16 minutes. If it's to be done by 5 o'clock - 5 minus 4:16 . . . (started to subtract) # It'll take four hours and 16 minutes. You have to start - From - Let's see. If it takes four hours and 16 minutes, you have to start it at - 60 minus 16 . . . (subtracted) 44. Start at " 1:44.

2MI

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? 12-1/2 pounds times 20 . . . (multiplied) 250. 250 minutes divided by 60 . . . (divided) 4.166 hours - 5:00 - Minus - .16 - Divided by 60 * (divided and got 26) Three minutes * (subtracted 4:03 from 5:00) The answer at 12:57.

3MI

A turkey is to be cooked 30 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? I would know that turkey would have to be cooked for a period of, let's see - 20 times 12 * (multiplied) I know 20

20 times 12 is 240 plus 1/2 of 20 minutes would be " 10 * (added) Be 250. 250 divided by 60 for the hours, for the hours, for the minutes . . . (divided) Four and one-sixth hours. For that turkey to be done by 5:00 p.m., it would have to be put in " - At 12:50.

4MI

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? First I need to find out how long I need to cook the turkey. So if it's 20 minutes for each pound, I should multiply 20 by 12-1/2 - 12-1/2 is the same as " 12.5. So it'll be simpler to multiply so . . . (multiplied) Should be 250 minutes - There are 60 minutes - In an hour - So to change 260 minutes - 250 minutes to hours I should divide by 60 . . . (divided) Four times with 10 left over - So that'll be four hours and " 10 minutes. We want the turkey to be done at 5 p.m., so I should subtract - Four hours and 10 minutes from five hours . . . (subtracted) So it would be 12:50 - The turkey should be put in to cook at 12:50 p.m.

1FII

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is done by 5:00 p.m., what time should it be put in to cook? 20 minutes for each pound. So I would multiply 12 times 20 . . . (multiplied) And you get 240 and then you have a half a pound to be cooked for " 10 minutes. So you add them and * (added) You have 250 minutes it has to be cooked. Divide 250 by 60 because there's 60 minutes in an hour to find out how many hours there are . . . (divided) You have four and one-sixth hours. So you're gonna have it done by 5 you count the hours - 4, 3, 2, - And a sixth. And I'd put it in about - " You could - Put it in at 10 til one. Four hours and 10 minutes left over. So I'd put it in about 12:50 is my answer.

2FII

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? - It says it has to be cooked 20 minutes for each pound and the turkey is 12-1/2 pounds. You multiply 20 by 12-1/2 -

And you get * (multiplied) 250 - And it has to be done by 5 o'clock p.m. So - Since it has to be cooked 250 minutes, divide that by 60 and you get * (divided) Four and one-six hours. That's four hours and " 10 minutes. So if it has to be done by 5:00 p.m., you'd have to start it at - Subtract four minutes and 10 seconds. No - It'd have to be started at " 12:40.

3FII

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? - Cook 20 minutes for each pound - 16 ounces to a pound. A turkey weighing 12-1/2 - Is to be done by 5, what time should it be put in to cook? - 20 times 12-1/2 . . . (multiplied) 240 and - A half - Let's see - 12-1/2 pounds. Multiply 20 times 12-1/2 . . . (multiplied) 240-1/2 - 240-1/2 - So that would be - 60 into 240 * (divided) Would be four minutes. Let's see - I'm just mixed up # 20 minutes, 16 ounces to a pound - 12-1/2 pounds - Times 20 - 12.8 times 20 * (multiplied and got 2560) # I'm stuck on this one # . . . (multiplied 20 times 12-1/2) 240 - So one-half. So 240. Approximately 2:40.

4FII

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? - 20 minutes for each pound. 12-1/2 times 20 . . . (multiplied) 250 minutes and that would be * (divided 60 into 250) Four, four hours - And " 10 minutes - If it's to be done by - 5:00 it would have to be put in - At " 12:50 # 1:50 # At 12:50 p.m.

1MII

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? # I see that I need to get the - How many minutes it will take to cook 12-1/2 pounds. So I multiply - " 12.5 by 20 * (multiplied) I get 250 minutes - I divide that by 60 - To get the number of hours and minutes * (divided) I get 416 and two-thirds - No, that would be 4.166 hours - Or four hours and " 10 minutes. I add that to 5 p.m. * (added) And I get - Nine hours - 9:10 p.m. So the answer is - 9:10 p.m.

2MII

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? - 20 minutes for each pound - Pound cooked. Our turkey weighs 12-1/2 pounds - And has to be done by 5:00 - So 20 times " 12.5 would equal . . . (multiplied) It's going to take you 250 minutes to cook a 12-1/2 pound turkey. So five minus - 60 - That's - That's " Four hours and " 10 minutes. So you should start at " 12:50 p.m.

3MII

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? 20 minutes for each pound. I multiply - 12-1/2 times 20 . . . (multiplied using 12.5) That's 250 minutes. Divide 250 minutes by 60 to see how many hours it takes . . . (divided) Takes four hours and " 10 minutes. - Four hours and 10 minutes for that turkey to cook - So I minus, take four hours and 10 minutes from five hours, from five o'clock . . . (subtracted) Takes 50 minutes - Wait a minute, that's not right - Start at " 12:50 - 12:50 is the answer (checked the answer).

4MII

A turkey is to be cooked 20 minutes for each pound. If a turkey weighs 12-1/2 pounds and is to be done by 5:00 p.m., what time should it be put in to cook? - First thing you do is multiply 12-1/2 - Pounds. Multiply pounds - By the minutes - No - Let me see. It cooked 20 minutes for each pound - 12-1/2 pounds is to be done by 5 p.m. What time should it be put in to cook? - You'd - 12-1/2 pounds would be your - 20 minutes - You multiply this . . . (multiplied) Equals 250 - 250 - So the time would be " 2:50 - 2:50 is the time.

1FIII

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? First of all I would multiply 12-1/2 pounds times 20 minutes . . . (multiplied) That would be 250. That'd be 250 minutes

- Two hours and 50 minutes. 250. 60 into 250 would be . . . (divided and got 4.16) That would be four hours and " 16 minutes. Turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00. Be two hours and 50 minutes. That would be - You would have to start it at - 5 o'clock minus 4:16 . . . (subtracted and got 1:84) You would have to start it at, Let's see - 1, 2, 3, 4, 5 (counted on fingers) 1:15 - 16 is - Four minus five is six, 12 minus five is 16. 15 - Four minus six. 1, 2, 3, 4 - To make that come out to 12:44.

2FIII

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? - First I'm going to multiply " 12.5 - By 20 minutes * (multiplied) It'll be 250 minutes - Then - Divide that by 60 * (divided and got 4.1) So I get four hours and " One minute - So it needs to be put in - At " 8:59.

3FIII

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00, what time should it be put in to cook? - 12-1/2 pounds - Times 20 . . . (multiplied) 250 - That can't be right # 250 - A turkey is to be cooked, a turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00, what time should it be put in to cook? - 250 # 250 # There are three 20's in 60 # (counted from one to 12) 250 # (counted three pounds per hour) Be four and a " Half hours - (counted back from 5:00) Be " 12:30.

4FIII

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? # 20 times 12 * (multiplied and got 240) * (added 30 and got 270) " (changed 270 to two hours and 70 minutes) " (took two hours and 70 minutes back from 5:00) 1:40, I believe.

1MIII

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to be cooked? So 12-1/2 pounds to be cooked 20 minutes for each pound. I'd multiply 12-1/2 by 20. Let's see . . . (multiplied and got 250) So that would be " Two hours 50 minutes and to put in on, subtract that from 5 o'clock. That would be . . . (subtracted 2:50 from 5:00) 2:10. To check that I'm going to add 2:10 to two hours 50 minutes see if I get three, I mean five . . . (added) It's finished.

2MIII

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? Multiply 12 pounds times 20 minutes * (multiplied and got 140) And you got a half a pound which will take " 10 minutes - Altogether it would take " Two hours and 30 minutes - It should be put in to start cooking at " 3:30 - No - Yeah - 3:30 p.m.

3MIII

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? - 20 minutes for each pound times 12-1/2 - is * (multiplied) 250 - Minutes - 250 minutes - Is 250 minutes - 60 minutes is " Two hours and - Two hours and 10 - Minutes. No - " Be four hours and 10 minutes - So for this to be done by 5 - You should - Start at - 12 - Should start at " 12:50.

4MIII

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? - 12-1/2 times 20 * (multiplied) 44 and 10 . . . (added) Be 54. " Five hours and 40 minutes - So it should be put in about " 11:10 a.m.

1FIV

A turkey has been cooked 20 minutes for each pound. If the turkey weighing 12-1/2 pounds is done by 5:00 p.m., what time should it be put in to cook? Be cooked for 20 minutes for each pound - You would multiply - 20 minutes for each pound - 12-1/2 pounds to be done by 5 o'clock. You should - Put 12 times 20 - 12-1/2 - " 12.05 times 20 . . . (multiplied and got 241) That'll be - Turkey should be put in - That's 241 minutes - 241 - Take that from - Let's see, 60 minutes in each hour - Times five - * (multiplied five times 60 and got 300) - So you would take that 300 away from 241 . . . (subtracted 241 from 300) Be 59 - minutes - That's wrong - Let's see - I guess it should be put in at - Minutes - 59 minutes - So that would be - Four, no, would be three - Three - 59 from 60 be " 3:59.

2FIV

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5 o'clock, 5:00 p.m., what time should it be put in to cook? A turkey is cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? I would multiply 20 by 12-1/2 . . . (multiplied) You get 240-1/2 - A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? If a turkey weighing 12-1/2 pounds is to be done by 5:00, what time should it be put in to cook? - I don't know how to do this. A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? A turkey weighing 12-1/2 pounds. Divide 12-1/2 by 20 . . . (divided 20 by 12-1/2) So it should be cooked one hour and eight minutes. Want it done by 5:00 - To get it cooked in 20 minutes for each pound. A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook. - 12-1/2 by 20. A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? For each pound it took 20 minutes to cook, so multiply. I've done done that. Be 20 minutes for each pound. Be 20 minutes for each pound # A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? 20 minutes for each pound. 20 times

12-1/2 - I multiplied 20 times 12-1/2 and I got 240-1/2. So 20 minutes for each pound. Add 20 and 12-1/2 . . . (added) 32-1/2 minutes. Should be cooked 32 - What am I doing? For each pound. A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? 20 minutes for each pound - " Two hours and 40 minutes. Should be put in, let's see two hours and 40 minutes divided by two, I mean subtracted from 200. 500 subtracted from 240 . . . (subtracted 240 from 500) Should be put in at 3:40.

3FIV

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? It said 20 minutes for each pound - So - Take 12 times 20 first of all . . . (multiplied and got 240) A half would be - Then the half would have to be - Half of a pound - Would be add " 20 minutes more on to it * (added) That's 260. 260 minutes. Then take 60 into 260 would be . . . (divided incorrectly) # I'm going to have to get this wrong. - A turkey is to be cooked 20 minutes for each pound. There's 12-1/2 pounds - Oh - Take - Try it again - 20 minutes - Times 12 . . . (multiplied) 240. And then after that be 20 . . . (added) 260 " Two hours and 60 minutes from 5:00 * (subtracted) Put it in at 2:40.

4FIV

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00, what time should it be put in to cook? - 20 times 12-1/2 . . . (multiplied) 125. It should be cooked - An " Hour and 25 minutes. That doesn't sound right, though. 12-1/2 pounds - 20 minutes - 12 times 20. Let me see. Let me try again. 20 times 12 . . . (multiplied) 240. Have " 250, maybe it should be cooked " Two hours and 50 minutes. So - Two hours would be " Four o'clock - Three o'clock and then two, not two o'clock but - 10 til - 10 til two.

1MIV

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? # I'd say 20 times 12-1/2 * (multiplied) Be 240 - And a half - So you would subtract " Two hours and 40 minutes (counted back) Should be put in at " 2:30.

2MIV

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? - I'd subtract 12 hours from 5 o'clock which would be " 4:30 a.m.

3MIV

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to be cooked? I can't do it # I can't do it.

4MIV

A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should be put in to cook? A turkey is to be cooked 20 minutes for each pound. If a turkey weighing 12-1/2 pounds is to be done by 5:00 p.m., what time should it be put in to cook? A turkey, 20 minutes for each pound. There's 12-1/2 pounds, 20 minutes per pound. See 20 times 12-1/2 . . . (multiplied) 250 minutes - 60 into 250 will go how many times . . . (divided) Four and one-sixth hours. What time should it be put in to cook? Four and one-sixth hours. One-sixth of 60 is what? " 10. Four hours and 10 minutes. So it should be put in at 1, 2, 3, 4 (counted on fingers) Be put in at 12:50. 12:50 is the answer.

III. PROBLEM THREE

1FI

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15

percent. What is the difference in the sale price at the two stores of a TV set that is regularly priced at $100? Ten percent - 10 percent of 100 to get the discount. So you take " 90 percent of 100 and at the first store - It'd be " $90. At the second store take " 85 percent of 100 and you get . . . (multiplied .85 times 100) It'd be $85. What's the difference in the sale price at the two stores? Ninety minus 85 will give you the difference . . . (subtracted) $5 difference. What's the difference in the sale price? $5.

2FI

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15 percent. What is the difference in the sale price at the two stores of a TV set that is regularly priced at $100? Well, if it's priced at $100 and one offers a 10 percent discount then they're offering a * (multiplied) $10 discount. If one offers a 15 percent discount, they're offering * (multiplied) $15 as a discount. So there's a " $5 difference in sale price at the two stores.

3FI

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15 percent. What is the difference in the sale price at the two stores of a TV set that is regularly priced at $100? Ten percent of 100 is " $10 and 15 percent of 100 - 10 percent would be $10 and half 10 percent be $5, would be " $15. I hope. So the difference between the two is " $5 cause if you only get $10 off on one and 15 on the other, it's $5.

4FI

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15 percent. What is the difference in the sale price at the two stores of a TV set that is regularly priced at $100? What is the difference in the sale price? - The set's $100 - And - One offers a 10 percent discount. You multiply by .10 * (multiplied) That'll give you a $10 discount. So that TV will be " $90. And then the - Other store gives a 15 percent discount. So you multiply $100 by .15 . . . (multiplied and checked) They offer $15. So it'd be - That TV would be " $85. So the difference would be " $15.

1MI

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15 percent. What is the difference in the sale price at the two stores of a TV set that is regularly priced at $100? Televisions are on sale at two stores. One offers a 10 percent discount while the other offers - A 15 percent discount - 10 percent of 100 is " Is " 90 - So 15 percent of 100 - That'll be - 15 - 150 divided by 100 . . . (divided) Be 15 - 100 minus $15 * (subtracted) Is $85. So 90 minus 85 * (subtracted) Is 5.

2MI

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15 percent. What is the difference in the sale price at the two stores of a TV set that is regularly priced at $100? One hundred dollars times 10 percent * (multiplied) $10. One hundred dollars times 15 percent * (multiplied) $15. Difference in the sale price $15 minus $10 * (subtracted) $5.

3MI

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15 percent. What is the difference in the sales price at the two stores of a TV set that is regularly priced at $100? Two sets on sale at two stores. One offers a 10 percent discount while the other offers a 15 percent. What is the difference in the sales price at the two stores of a TV set? Well I know that 10 percent of 100 is " $10 and 15 percent is " $15. So the difference in the sale prices would be " $5. One would be " $85 and the other would be " 90.

4MI

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers a 15 percent discount. The difference in the sale price at the two stores of a TV set that is regularly priced at $100 - Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15 percent. What is the difference in the sale price at the

two stores of a TV set that is regularly priced at $100? I need to find what each sells at a 10 percent discount - And at a 15 percent discount. Then subtract the difference - $100 times 10 percent . . . (multiplied) So that'll be 10. So 100, $10 from $100 * (subtracted) Will leave $90 - Likewise, if 10 percent discount will knock off $10 from a price, then the other will knock off " $15 from a price of 100. So the price at the second store will be " $85 - Subtract the 10 percent from the 15 percent, it'll leave the - 85 from 90 - Which will be " $5. The difference being $5 in the price of the store that offers 10 percent discount and the 15 percent discount in TV's costing $100.

1FII

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15 percent. What is the difference in the sale price at the two stores of a TV set that is regularly priced at $100? First we should find how much 10 percent of $100 is . . . (multiplied) That would be $10. - Wait a minute - That's the same as 100 times 10 . . . (multiplied) Then I got 1000 which is not right - I think that 10 percent of $100 is $10. That's right - 15 percent, you want to find out what 15 percent of $100 is * (multiplied) Really - It'd - Be around $15, I think. Let's see - (checked multiplication) It's $15. So - You would subtract $10 from $100 and get * (subtracted) $90. Ten percent discount which is $10 off so you'd have $90 on one television set. The other one you'd subtract 100, I mean, $15 from $100 * (subtracted) You would have $85. Would be how much the second TV set would cost. So the difference, what is the difference in the sale price at the two stores? So the difference is really just * (subtracted) $5.

2FII

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15 percent. What is the difference in the sale price at the two stores of a TV set that is regularly priced at $100? - First store offers a 10 percent discount and that's * (multiplied) $10 off at the first store. The next store offers a 15 percent discount - And that's * (multiplied) $15 - The difference in the sale price, the first one would cost " $90 because of the 10 percent discount

which is $10 and the second one would cost " $85. So the difference would be " $5.

3FII

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15 percent. What is the difference in the sale price at the two stores of a TV set that is regularly priced at $100? - 10 percent times 100 * (calculated) That'll be $1.10 - 15 percent of 100 * (calculated) Be $1.15 - So it'll be " 5 cents.

4FII

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15 percent. What is the difference in the sale price at the two stores of a TV set that is regularly priced at $100? - 10 percent of $100 - Would be equal to - (multiplied) $10 off the regular price - And 15 percent would be . . . (started to multiply) 10 percent of 100 - One-tenth off of the regular price. One-tenth times 100 would be $10 - 3/20 times 100 would be . . . (multiplied) $15. The difference in the prices would be * (subtracted) $90 and " $85. The difference in the prices would be $5.

1MII

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers a 15 percent discount. Which is the difference, what is the difference in the sale price at the two stores of a TV set that is regularly priced at $100? - I - Will find 10 percent of $100 so I multiply. .1 times 100 * (multiplied) And get $10. Subtract that from 100 * (subtracted) And get $90. That is the sale price of the first set - The second set I'll - Take 15 percent of $100. Multiply 100 by .15 * (multiplied) And get $15. So I subtract 15 from 100 to get the sale price * (subtracted) And find that it's $85 - So to get the difference I'll subtract $90 from $85 * (subtracted 85 from 90) And get $5 for the difference - In the price.

2MII

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15 percent. What is the difference in the sale price at the two stores of a TV set that is regularly priced at $100? - 10 percent of $100 will be " $10 marked off. So you would get - At one store you would get the TV for " $90. The other store, it would be 15 percent off # So 15 percent of 100 - 15 percent of 100 is * (multiplied) $15. So at the other store you would get the TV at " $85. And what is the difference in the sale price at the two stores of a TV set that is regularly priced at $100? The difference would be " $5.

3MII

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15 percent. What is the difference in the sale price at the two stores of a television set that is regularly priced at $100? - Set this up as a proportion - x is to 100 as - 1 is to 10 . . . (solved for x) The answer is 10. Same, do this again - Be x is to 100 as 15 is to 100 . . . (solved for x) That equals 15. That is how much the percentage is. What is the difference in the sale price at the two stores of a TV set that is regularly priced at $100? - You'd minus 10 from 15 - Cause that's what the difference - That's what the - That's how much you get off the sale price. That equals - (subtracted) 5 - You have $5 difference.

4MII

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15 percent. What is the difference in the sale price at the two stores of a TV set that is regularly priced at $100? So - Take - What is the sale price? So you divide 10 into 100 and get . . . (divided) 10. That means that the TV at 10 percent off would have cost " $110 - And the one at 15 percent off would have cost - You take the 15 into 100 and that goes . . . (divided with difficulty) $15.10 - That'll be " $115.10 - If it's 15 percent off.

1FIII

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15 percent. What is the difference in the sale prices at the two stores of a television set that is regularly priced at $100? Let's see. I would take 100 and take 10 percent of that . . . (multiplied) That'd be $10 off of that one. It'd be " $90. And the next one would be 15 percent. Which would be more - Discount. Which would be . . . (multiplied) $15 off of it. That would be " $85. What is the difference in the sale price at the two stores of a TV set that is regularly priced at 100? That would be " $5 difference in the sale price.

2FIII

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers a 15 percent. What is the difference in the sale price at the two stores of a TV set that is regularly priced at $100? - Television sets are on sale at two stores. One offers a 10 percent discount while the other offers a 15 percent. What is the difference in the sale price at the two stores of a TV set that is regularly priced at $100? Take 100 - Multiply by .01 * (multiplied) And you get $10. So the one that offers a 10 percent discount it would be " 90. Then take 100 and multiply it by .15 * (multiplied and got 15) And the one that offers it for 15 percent discount would be " 85 - I subtracted - 15 from 100 - So the difference would be - Subtract 85 from 90. It would be " $5.

3FIII

Television sets are on sale at two stores. One offers a 10 percent discount while the other stores offers a 10 percent. What is the difference in the sale price at the two stores of a TV set that is regularly priced at $100 - Be $100 times 10 - One offers a 10 percent discount while the other offers 15 percent. What is the difference in the sale price of a TV set that is regularly priced at $100? - Be 100 times .10 . . . (multiplied) Be $10. Be " 90 - And - Take 10 from 100 and come up with 90 - Take 100 times .15 . . . (multiplied) Be $15 and take 100 minus 15 " Be $85. The difference in the sale price at the two stores is " $5.

4FIII

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15 percent. What difference in the sale price at the two stores of a TV set that is regularly priced at $100? Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15 percent. What is the difference in the sale price at the two stores of a TV set that is regularly priced at $100 # The price is $100. Fifteen percent discount and 10 percent discount # 100 percent minus 10 percent is * (subtracted) 90 percent. One hundred percent minus 15 percent is * (subtracted) 85 percent # * (multiplied $100 times .90 and got $90; multiplied $100 times .85 and got $85) That'd be " $5.

1MIII

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15 percent. What is the difference in the sale price at the two stores of a TV set that is regularly priced at $100? To get this I would divide the percentages of 10 and 15 into 100 to find my answer . . . (divided) 10 into 100. Ten, that would equal $10 savings, no 10 cents savings, 1 dollar savings. Fifteen into 100 * (divided) That would equal 6, 60 cents, 6 dollar savings. So there's the answer $1 and $6. Fifteen percent, 6 dollars; 1 dollar that'd be 10 cents, no.

2MIII

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15 percent. What is the difference in the sale price at the two stores of a TV set that is regularly priced at $100? - Subtract 10 percent from 100 * (subtracted 10 from 100) And get 90 and 15 from 100 * (subtracted) Be 85. The difference is " $5.

3MIII

Television sets are on sale at two stores. One offers 10 percent discount while the other offers 15 percent. What is the difference in the sales price at the two stores of a TV set that is regularly priced at

$100? - 10 percent - Of - 10 percent of 100 is * (divided) $10. Fifteen percent of 100 is * (divided) Six - 6. - Let's see 6.6 - So the difference at the - Shoot, I don't know.

4MIII

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15 percent. What is the difference in the sale price at the two stores of a TV set that is regularly priced at $100? That'd be a $5 difference (gave the answer quickly and there was no written computation).

1FIV

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers a 15 percent discount. What is the difference in the sale price at two stores if a TV set is regularly priced at $100? - 100 - 10 percent would be 10 - 10 percent of 100 is " 10. So that would be * (subtracted) $90 and 15 percent of 100 " Is " 85. So that'd be " $5 difference.

2FIV

Television sets are on sale at two stores. One offers a 10 percent discount while the others offers 15 percent. What is the difference in the sale price at the two stores of a TV set that is regularly priced at 10, I mean at $100? Ten percent off $100 " is " $90. Fifteen percent off $100 " Is " $85 - So the difference is " $5.

3FIV

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15 percent. What is the difference on the sale price of the two TV sets if regular priced - At a dollar? # 10 percent discount on a dollar would equal " 10 - Cents - Off would be " 90. Excuse me, $100. Be " $90 - And 15 percent would be " $80 - What is the difference in the sale price at the two stores of a TV set that is regularly priced at a dollar? - $10.

4FIV

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15 percent. What is the difference in the sale price at the two stores of a TV set that is regularly priced at $100? Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15 percent. What is the difference in the sale price at the two stores of a TV set that is regularly priced at $100? I would take 100 and try to find out how to get 10 percent of 100 - So I guess I would divide - Divide - No you wouldn't divide 10 into 100. Maybe you would put 100 over one times one-tenth . . . (multiplied) 10 times. One hundred over one times one-fifteenth . . . (started to multiply) No, no 10 into 100 goes 10. I did the first one wrong. I'm starting all over again. Ten times one is 10 and one equals 10. Oh, it comes out the same way. Fifteen into 100 . . . (divided with difficulty and got 6) What is the difference in the sale price? - I would say " 5 percent.

1MIV

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15 percent. What is the difference in the sale price at the two stores of a set that is regularly priced at $100? # I don't know how to do this one.

2MIV

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers a 15 percent. What is the difference in the sale price at the two stores of a TV set that is regularly priced at $100? Let's see, 10 percent of $100 would be " $10 and 15 percent - Of $100 would be " $15 and you'd subtract 10 from 15 * (subtracted) Which would leave you $5. The answer would be $5.

3MIV

Television sets are on sale at two stores. One offers a 10 percent discount while the other offers 15 percent. What is the difference in the sale price at the two stores of a TV set that is regularly priced at $100? # One offers a 10 percent discount # I still can't do this either.

4MIV

Television sets are on sale at two stores. Televisions are on sale at two stores. One offers a 10 percent discount while the other offers a 15 percent discount. What is the difference in the sale price at the two stores of a TV set that is regularly priced at 100? What is the difference in the sale price at the two stores of a TV set that is regularly priced at 100? Ten percent discount of 100 would be " $10. Which would be " $90 at one store. While the other store had the 15 percent discount - Which leaves " $15 off of that. Fifteen dollars off that would give the other store " $85. What is the difference in the sale price at the two stores? The difference between the two is " $5. Five dollars is the difference between the two. One store sells 90 - First one does, and second store sells it at $85. So the difference is $5.

IV. PROBLEM FOUR

1FI

A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? - For a car parked from - A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction - 35 cents for the first hour. Car parked from 10:45 in the morning til 3:05 - You want to find how many hours, how long it was parked there so you would say 10, from 10:45 until 3:05 is (counted on fingers) 10, 11, 12, 1, 2, 3 - No # From 10:45 til 11:45 is one hour, 11:45 to 12:45 is two hours, 12:45 to 1 is three hours, to 2:45 is four hours " Four hours - And 20 minutes is how long it was there. So, if a parking lot charges 35 cents for the first hour. For the first hour, that'd be 35 cents for the first hour and 25 cents for each additional hour or fraction. So that'd be three times 25 " Or 75 and 20 minutes would be another. So it'd be " 100 - Or $1.00. So he gets charged " $1.35.

2FI

A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an

hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? 10:45 to 3:05 - Must calculate how many that is (counted on fingers) That's " Four hours - And 20 minutes. So if it's - 35 cents for the first hour, one hour would be 35 cents plus - If it's 25 cents for each additional hour or fraction - There's three additional hours - So you put say 25 three times - Plus there's a fraction of an hour, so you'd still say 25. So you add up this and you get . . . (added) $1.35 is your answer. So it'd cost $1.35 to park your car for four hours and 20 minutes in that parking lot.

3FI

A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? - Thirty-five cents for the first hour - 25 cents for additional hours. So out of 10:45 to 3:05 (counted on fingers) 10, 11, 12, 1 - 11, 12, 1, 2, 3. That's five hours - 10:05 to 3:05. That'll be five hours and charge you for " Six anyway. So that'd be 35 plus six times 25 and six 25's are * (multiplied) $1.50 and 35 is " $1.85, which is too much for parking.

4FI

A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? Charges 35 cents for the first hour - It's parked from 10:45 - To 3:05 - And it charges 35 cents for the first hour. From 10:45 to 11:45 - It charges 35 cents - And 25 cents for each additional hour - To 12:45 - To 1:45 - To 2:45 - To 3:45 - To 3:05. Be 25 for that and 25 for that hour - 25 cents from 11:45 to 12:45 - 25 cents from 12:45 to 1:45 - 25 cents from 1:45 to 2:45 - And then it says - 25 cents for each additional hour or fraction of an hour. 2:45 to 3:05 would be 25 more cents - So you add all those together and you get . . . (added) $1.35 - Is the answer.

1MI

A parking lot changes 35 cents for the first, charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? - 10:45 to 11:45 is one, to 12:45 is two, to 1:45 is three, to 2:45 is four, to 3:45 is five. So he was in there four hours. Let's see " Four hours and 40 minutes. Let's see, a parking lot charges 35 cents for the first hour and 25 cents for three hours and 40 minutes - 25 cents for each additional hour. So that's four hours. Be four times 25. It's " A dollar " $1.35.

2MI

A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? - 10:45, 11:45, 12:45, 1:45, 2:45, 3:45 - (counted the hours) " Five hours. He'll be charged 35 for the first hour and 25 for four hours - 35 and 25 and 25 and 25 and 25 is * (added) 135. $1.35.

3MI

A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning til 3:05 in the afternoon, how much money should be charged? - A parking lot charges 35 cents for the first hour and 25 cents for each additional hour - So I would have to calculate the number of hours and fraction of hours - And decide. 10:45, 11:45, 12:45, 11:45, 12:45, 1:45, 2:45, 3:45 - 2:45. That's (counted on fingers) There will be " Four hours and 20 minutes. Now the first hour is 35 cents so that leaves three hours and 20 minutes. The first hour is 35 cents - That leaves three hours and 20 minutes, which would be three times 25 " 75 plus 25 cents for the additional fraction. Be " A dollar " $1.35.

4MI

A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an

hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? First I need to find out how long the car set there before finding out - How much it cost - From 10:45 to 11:45 is one hour. From 11:45 to 12:45 is two hours. From 12:45 to 1:45 is three hours - From 1:45 to 2:45 is four hours - From - Wait a minute - Can't do it that way - 10:45 - I subtract - " 13:05 - From 10:45. I subtract 13 - Wrong, wrong, 12 hours - So it'll be 12 plus three. From " 15 hours and five minutes I subtract 10 hours and 45 minutes . . . (subtracted) Four hours and 20 minutes. The car was parked for four hours and 20 minutes. At 35 cents for the first hour - Plus - Four fractions of an hour - Which would be " A dollar. Come to a total of * (added) $1.30. The money that should be charged for the parking lot was $1.30.

1FII

A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? Parked from 10:45 in the morning until 3:05 in the afternoon. Find out how many hours that would be. So from 10:45, 11:45, 12:45, 1:45, 2:45. That's four hours. Then til three would be four hours. From 2:25 until 3:00 that's 15 minutes, til 3:05, that's 20 minutes. That's " Four hours and 20 minutes - So first hour would be 35 cents. That leaves you three hours and 20 minutes. So 25 cents for each additional hour or fraction of an hour. So for three hours and 20 minutes, that would be three hours and the other fraction so that would be 25 cents for each. So that would be four, so it'd be " A dollar. So it'd be a dollar charge for that. So it'd be $1 plus 35 " $1.35. That's how much should be charged.

2FII

A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? - First find out how many hours the car is parked. It's parked from 10:45 - Until 3:05 - Which would be # (counted on fingers) " Three hours and - 10 minutes. If it charges 35 cents for the first hour so you take 35,

25 cents for each additional hour. First hour is taken away which is 35. That leaves two hours and 10 minutes. So the two hours that are left, 25 cents for each hour is " 50. Be * (added) 85 cents.

3FII

A parking lot charges 35 cents for the first hour, that's 60 minutes, and 25 cents for each additional hour or fraction of an hour. If a car parked from 10:45 - Put that down, in the morning until 3:05 in the afternoon, how much money should they be charged? 10:45 - Is 15 til 11 so - 11, 12, 1, 2, 3 (counted on fingers) So that'd be " Four hours and 20 minutes - So - 35 cents for the first hour - 35 times - So it'll be three hours left - And 20 minutes - For a car parked - How much money should be charged? Twenty-five cents for each additional hour. Twenty-five times three . . . (multiplied) Be 75 cents. So 75 cents. Twenty-five times 20 * (multiplied) Would be # 50 cents - That'd be 25 cents - So that'll * (added) Be a dollar. Be " $1.35 - Because for the first hour - And 25 cents for the next three hours be 75 cents and 25 cents for the 20 minutes - So that would be an hour, $1.35.

4FII

A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? Let's see from 10:45 in the morning will be - 10, 11, 12, 1, 2 - Would be " Four hours and - Four hours and - 15, 20, 20 minutes - And 35 cents for the first hour - 25 cents for each additional hour or fraction of an hour. So it'd be " 75 cents for the additional three hours and 25 cents for the fraction. So it should be . . . (added) $1.35.

1MII

A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? First I'll find out how much time has elapsed between 10:45 and 3:05 - Let's see from 10:45 - To 2:45 -

There's " Four hours - Time elapsed. I subtract 3:05 from - 2:45 from 3:05 * (subtracted 45 from 65) I get 20 minutes - So - That means that four hours and 20 minutes have elapsed - Since 35 cents is to be charged for first hour take .35 and take off one hour which leaves three hours and 20 minutes. Twenty-five cents for each additional hour - 25 times three * (multiplied) I get 75 cents and for the additional hour another 25 for the fraction of an hour, another 25 cents so I get " $1.00 - Add that to 35 cents for the first hour * (added) And get $1.35 for the answer.

2MII

A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? Car is parked from 10:45 til 3:05 - That is the time of " Four hours and 20 minutes. Since the parking lot charges 35 cents for the first hour, 35 for the first hour, 25 for each additional hour or fraction of an hour - So he parked 35, it'd be 35 cents for the first hour plus 25 for the second hour plus 25 for the third hour and plus 25 for the fourth hour plus 25 cents for the fraction of the last hour - Which equals . . . (added) Would be $1.35.

3MII

A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or a fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? - I must find how much time is there - 12:00 - 12:00, 10:45 * (subtracted 10:45 from 12:00) One hour and 15 minutes from 10:45 to 12:00. 3:05 - From 12:00 is " Three hours and five minutes. So three hours and five minutes - Plus one hour and 15 minutes equals * (added) Four hours and 20 minutes - The first hour cost 35 cents. Strike one hour - Have three hours and 20 minutes. That is four - That is the same thing as four hours because it's a fraction of the hour counts 25 percent also, 25 cents also. So 25 times four * (multiplied) Gives you 100 or a dollar. So it'll cost " $1.35 - To park there for four hours and 20 minutes.

4MII

A parking lot charges 35 cents for the first hour and 25 for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? Twenty-five percent, 25 cents - For an hour - That's 35 cents for the first hour. Car parked from 10:45 in the morning until 3:05 in the afternoon. First thing I do, I take the 10:45 and subtract it from 3:05 and see how much time difference they are . . . (subtracted) That means 12 hours and 60 minutes - Or 13 hours - No be 12 hours and - I don't know about this problem - It's parked at 10:45 in the morning until 3:05 in the afternoon. You got to find how much time there is. So in order to do that I've got to subtract - No add - No I guess I'll have to subtract - 3:05 from the 10:45 . . . (subtracted) Seven hours and 40 minutes - I got the seven hours and 40 minutes. For the first hour of this - I'll take off an hour and that'll make six hours and 40 minutes and that leaves a price of 35 cents. Then for the next - Six hours and 40 minutes I multiply 6.40 times 25 cents . . . (multiplied) 160 Golly, whew - I got - 160 - That'll be - 25 cents times - Nope (checked multiplication) I got that 160 - Couldn't be 160 - So 160 - No, $1.60 is it - Is the answer.

1FIII

A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? A parking lot charges 35 cents for the first hour and that would be til 11:45 equal to 35 cents. Twenty-five cents for each additional hour. That would be (counted on fingers) 12:45, 1:45, 2:45 - 2:45 - 2:45. That would be " Three hours - 11:45 to 12:45, 12:45 - Let's see, 12:45 to 1:45, 2:45 - 2:45. Four * (multiplied four times 25) That'd be 75 cents. How much money should be charged? * (added 75 and 35) $1.00.

2FIII

A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged?

- Now first, a parking lot charges 35 cents for the first hour and 25 cents for each additional hour - And the car is parked from 10 until three. 10:45 until 3:05. So first I subtract - 3:05 from 10:45 * (subtracted) And get 7:40. And the first hour it will be 35 cents. So one hour from 7:40 leaves 6:40. So 25 cents for each additional hour. Multiply that 25 cents by 6:40 and you get * (multiplied .25 times 6.40) $1.60 - So $1.60 plus 35 cents * (added) Is $1.95.

3FIII

A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the afternoon until 3:05 in the afternoon, how much money should be charged? Thirty-five for 10:45 to 11:45 (counted on fingers) " Four for " $1 - And 35 cents - 35 for the first hour and - 25 # Be five hours " 1.25 plus 35 . . . (added) Be 1.60.

4FIII

A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? Thirty-five cents for the first hour and 25 cents for each additional hour or fraction of an hour # (counted number of hours) * (multiplied 25 times five and got 75) * (added 35, 75, and 25 and got $1.35).

1MIII

A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? 10:45 a.m. from 3:05. That would be 10 to 12 would be two, take five from three, that would make it charge for " Four hours parking. Four hours parking, 75 plus 35 equals . . . (added) $1.10 four hours parking.

2MIII

A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an

hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? - Gotta find out how long he's been there - From 10:45 to 3:05 in the afternoon is - Two hours, five hours - Subtract 3:05 from 10:45 * (subtracted) In the morning he got " An hour and 15 minutes and the evening's " Three hours and five minutes. He's been there * (added) Four hours and 20 minutes. The first hour is 35 cents and then - The three hours, three times 25 cents * (multiplied) Is 75 - And 25 cents for a fraction of an hour and he's been there 25 more cents. So it'll be " $1.35.

3MIII

A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked at 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? - The first one should be - To get the time difference - So - I would - The time difference is * (subtracted 305 from 1045) 7:40 - Seven hours and 40 minutes - The first hour would be only 35 cents - And for each additional hour 25 cents. So - That'd be 6:40 and 25 minutes for each one you would - Divide . . . (tried to divide 25 into 640) Be best to start this one over - We - Parking lot is from 10:45 to 3:05. Be seven hours and 40 minutes. The first hour is 35 cents. So - 35. Six hours and 40 minutes - For each additional hour be 25 cents - Six times 25 . . . (multiplied and got 150) * (added 150 and 35) For the hours you have 1.85. Now you got 40 minutes left - Be a fraction, so you have 25 cents into 40 * (divided and got one) Roughly be 1.80 - " $1.86 for seven hours and 40 minutes.

4MIII

A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money would be charged? - The first hour the car be parked. A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? # 10:45 to 11:45 be 35 cents. 12:45 - 25 cents - 1:45 - 25 cents -

2:45 - 25 cents - 2 to 3:05 - An additional 25 cents . . . (added) $1.35 by your answer.

1FIV

A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? From 10:45 in the morning until 12:00. That would mean . . . (subtracted 10:45 from 12:00) That's 1:55 - And then from 3:05 - From - Plus - That's 3:05 hours from 12 - And then from 1:55 . . . (added 3:05 and 1:55) So that's four hours and - 60 minutes - Which is five hours - And 35 cents for the first hour - And five, that's four times 25 is . . . (multiplied five times 25) That's 1.25 - 35 cents plus 1.25 . . . (added) Be $1.60.

2FIV

A parking lot changes 35 cents for the first hour, a parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? Be 10:45, 11:45, 12:45, 1:45, 2:45, 3:05. That's 1, 2, 3, 4, 5. That's five hours - " Five hours and 20 minutes. Thirty-five cents for the first hour and 25 cents for each additional hour or fraction of an hour. Be 35 cents and then four more. That'd be " A dollar and 25 cents. Be $1.35 - And then counting over for the 20 minutes it will be two dollars, wait, $1.35, add 25 cents onto that . . . (added) Be $1.50. No, oh yeah, $1.50.

3FIV

A parking lot charges 35 cents for the first hour and 25 cents for additional hours or fraction of an hour. For a car parked at 10:45 in the morning until 3:05 in the afternoon, how much time would you charged? 10:45. Take 10:45 and 3:05 and subtract * (subtracted 3:05 from 10:45) Seven hours and 40 minutes and - 35 cents for each hour. Thirty-five cents times seven . . . (multiplied and got 2.35) And then for the additional hour, a quarter . . . (added) $2.60.

4FIV

A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? Thirty-five cents until 11:45 and - Then you would say 25 cents until 12:45 and - 25 cents til 1:45 - 25 cents til 2:45 - Then - You would say - See it wouldn't be quite that. I'll add these up first . . . (added and got 110) Now I'll try to figure out how to get the difference. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? I'll subtract 3:05 from 2:45 . . . (subtracted) No, I'll do it the other way . . . (subtracted) 60 minutes. So that would be an hour. So you would add 25 cents to it and it would be . . . (added) Be $1.35.

1MIV

A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? " Five hours and 40 minutes. For first hour. Say 25 times four . . . (multiplied) It'll be a dollar * (added) $1.35.

2MIV

A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? - Let's see I'd go - Add the hours from 10:45 to 3:45 - To 3:05 - Let's see, 10:45 to 12:00 * (subtracted and got 1:15) And then I would - Let's see, I'd subtract 10:45 from 12:00, then I would - Subtract 3:05 from 12:00 * (subtracted) # Whew, I'm trying to decide whether - To add the hours from 12 to 3:05. Be 3:05 or 3:55 - So I'd 3:55 to 1:15 . . . (added) Be four hours and 70 minutes or five hours and 10 " Be five hours and 10 minutes at 35 cents an hour - Or 35

cents for first hour. Be 35 and 25 times four be " $1 - And 10 minutes would be - Do we have to get this exactly correct? (Interviewer responded: Close to it anyway) Be $1.35.

3MIV

A parking lot changes, charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? Let's see. Thirty-five cents for first hour and 25 cents # (mumbles something) # I need to figure out how many hours between 10:45 and 3:05. From 10:45 to 11:45 will be one hour, which will be 35 cents for the first hour. 12:45 be 25 cents for second hour. From 12:45 to 1:45 will be 25 cents for another hour. From 1:45 to 2:45 will be 25 cents for another hour. From 2:45 to 3:05 will be - Let's see # Be from 2:45 to 3:05 will be - 50, 60 be (mumbles something) # Add up 35 for the first hour, 25 for the second, 25 for the third, 25 for the fourth, 25 for the fifth which will give you * (added) Which will give you $1.35.

4MIV

A parking lot charges 35 cents for the first hour and 25 cents for each additional hour or fraction of an hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? A parking lot charges 35 cents for the first hour and 25 cents for the additional hours, additional or fraction of hour. For a car parked from 10:45 in the morning until 3:05 in the afternoon, how much money should be charged? 10:45 to 3:05. How many hours? 10:45 to 3:05. That would be 10:45, 11:45, 12:45, 1:45, 2:45 (counted on fingers) Four hours. 2:45 - 15, 20 minutes " Four hours and 20 minutes. That's how many hours they was parked. Four hours and 20 minutes. Thirty-five cents for first hour. That would leave three hours and 20 minutes left over. Twenty-five cents for the next, for each additional hour. So it'd be 25 and 25 and 25 plus the fraction or a fraction of an hour. Twenty-five. Be 25 for the fraction. So the answer would be . . . (added) Be $1.35 is the answer.

V. PROBLEM FIVE

1FI

A new automobile can be bought for cash for $2850 or on credit with a down payment of $400 and $80 a month for three years. How much MORE would a person pay by buying on credit rather than by buying the car for cash? A new automobile can be bought for cash for $2850 or on credit with a down payment of $400 and $80 a month for three years. How much MORE would a person pay by buying on credit - So you want to find out how much it would cost him to buy on credit. So for a month of three years - It'd be - A month for three years - In three years there's " 36 months. So $480 for 36 months would be . . . (multiplied and got 172.80) So he pays - 172.80 - For three years - No, I'm working it wrong. With a down payment of 400 - Oh, I get it. A down payment of $400 - And 80 a month. So it'd be 36 months for three years. So 80 times 36 . . . (multiplied) So that'd be 2880 - Plus your $400 for the first down payment . . . (added) So he's paying $3280 on credit. You'd subtract, it can be bought for cash for 2850 . . . (subtracted) So he has to pay, how much more would a person pay by buying on credit - $430 more on credit than cash.

2FI

A new automobile can be bought for cash for $2850 or on credit with a down payment of $400 and 80 a month for three years. How much MORE would a person pay by buying credit rather than by buying the car for cash? Since the down payment's $400, we'll add that to the amount that you get by multiplying $80 times " 36 since 36 months are the amount of months in three years. So we'll do that - $80 times 36 . . . (multiplied) That's 2880 is how much you would pay on the installment plus the $400 that you pay as a down payment * (added) Would be 3280. That's how much you pay - If you buy it on credit - 3280. And subtract - That, subtract the amount that you'd buy for cash, which would be 2850 and you'd get * (subtracted) $430. So you would pay - $430 more if you bought the car - On credit than on cash.

3FI

A new automobile can be bought for cash for 2850 or on credit with a down payment of 400 and $80 a month for three years. How much MORE would a person pay by buying on credit rather than by buying the car for cash? You go, cash rate of 2850 - And $80 a month for three years will be $80 for " 36 months. That's $80 times 36 * (multiplied) 2880. So you subtract 2850 from that. You're paying " $30 more.

4FI

A new automobile can be bought for cash for $2850 or on credit with a down payment of $400 and $80 a month for three years. How much MORE would a person pay by buying on credit rather than by buying the car for cash? - It's gonna cost 2850 for cash - The down payment of $400 - And $80 a month for three years. Now 80 times " 12 months will be * (multiplied) $960 plus the 400 for the down payment * (added) 1360 - So if you subtract the original 2850 - From 1360, you get . . . (started to subtract) No, wait a minute - $80 a month - That's how much it cost - With a down payment of $400 - And $80 a month for three years. Oh, three years. So it'll be 960 - Times three . . . (multiplied) So add - 2880 to 400 - And you get * (added) 3280. And then subtract what it really cost - 2850 * (subtracted) You get $430. So he would spend 430 more dollars by buying it on credit.

1MI

A new automobile can be bought for cash for $2850 or on credit with a down payment of $400 and $80 a month for three years. How much MORE would a person pay by buying on credit rather than buying the car for cash? A new automobile can be bought for cash for $2850 or on credit with a $400 down payment. Four hundred dollars and $80 a month for three years. Twelve times three . . . (multiplied) 36. Thirty-six times 80 . . . (multiplied and got 2880) plus $400 . . . (added) That's $3280 - How much more would a person buy by paying on credit rather than buying the car for cash? - 3280 minus 2850 . . . (subtracted) 430.

2MI

A new automobile can be bought for cash for $2850 or on credit with a down payment of $400 and $80 a month for three years. How much MORE would a person pay by buying on credit rather than buying the car for cash? - $80 times three years " 36 months . . . (multiplied) 2880 plus $400 down payment . . . (added) 3280 minus 2850 . . . (subtracted) Answer $430.

3MI

A new automobile can be bought for cash for $2850 or on credit with a down payment of $400 and $80 a month for three years. How much MORE would a person pay by buying on credit rather than buying the car for cash? There's 12 months in a year and three times 12 is " 36. Thirty-six times 80 is . . . (multiplied and got 2880) For 36 months times $80 plus the $400 down payment is * (added) $3280. Subtract 2850 from that . . . (subtracted) Person would pay $430 more buying on credit.

4MI

A new automobile can be bought for cash for $2850 or on credit with a down payment of $400 and $80 a month for three years. How much MORE would a person pay for buying on credit rather than buying the car for cash? I know how much the car would cost for cash. So I know he'd have to pay $400 down - I know he'd have to pay $80 a month for three years. That would be " 36. Three years and 12 months to the year would be 36. So I multiply 36 by $80 . . . (multiplied) It would cost 2880 plus $400 down payment . . . (added) 3200. Now from that I'm going to subtract $2850 . . . (subtracted) It'll cost $350 - To buy the car on credit rather than pay cash.

1FII

A new automobile can be bought for cash for $2850 or on credit with a down payment of $400 and $80 a month for three years. How much MORE would a person pay by buying the car for cash? A new automobile can be bought for cash for $2850 or on credit with a down payment of $400 and $80 a month for three years. I multiply $80 times three * (multiplied) $160. Add $400 to it - That's wrong # Multiply $80 times " 12 to find out

how much money they would be paying a year - And you come up with . . . (multiplied) $960 a year and multiply that times three cause they have it for three years . . . (multiplied) So it'd be $2940, then add $400 to it * (added) So they would be paying $3340. So you subtract $2850 from $3340 and you get . . . (subtracted) So it'd be a difference of $490.

2FII

A new automobile can be bought for cash for $2850 or on credit with a down payment of $400 and $80 a month for three years. How much MORE would a person pay by buying on credit rather than by buying the car for cash? - The automobile was bought on credit for 2850 with a down payment of 400. So subtract $2850, subtract 400 from that * (subtracted) You get 2450, which has to be paid for the next three years. You have to pay $80 for three years. Eighty dollars a month for three years, so that would be " 36 months. Multiply 80 by 36 months and you get * (multiplied) $2880. So subtract from that the 2450 * (subtracted) And you get $430 more which has to be paid.

3FII

A new automobile can be bought for cash for 2850 (had difficulty reading the numeral) or on credit with a down payment of 400 and 80 a month - 80 a month for three years. How much MORE would a person pay by buying on credit rather than by buying the car for cash? Four hundred down - 400 from 2850 * (subtracted) So you'd have remaining 2450 to pay - For three years - If you pay 80 a month. Twelve times three would be * (multiplied) 36 months - 36 months 80 * (multiplied) Be 2880 - So it'd be " $28.80 a month. No, wait a minute # 80 times - 36 * (multiplied) So 36 months - 30 a month - 36 months - Be 2880. Subtract 2450 * (subtracted 24.50 from 28.80) So you're paying $4.30 more on credit.

4FII

A new automobile can be bought for cash for $2850 or on credit with a down payment of $400 and $80 a month for three years. How much MORE would a person be buying on credit rather than by buying the car for cash? -

Cash it can be bought at 2850 - Or on credit with a down payment - We have $400 for the down payment - And $80 a month for three years would be " 36 months - Times $80 . . . (multiplied) 2880 minus 2850 would be * (subtracted) 30 more dollars.

1MII

A new automobile can be bought for cash for $2850 or on credit down a down payment of $400 and $80 a month for three years. How much MORE would a person pay by buying on credit rather than buying the car for cash? - I'll take the down payment of $400 and add that to - " 36 months times $80 - Multiplying 36 times 80 I get * (multiplied) I get $2880. Add that to the down payment of $400 * (added) I get $3280. I subtract $2850 from that to get the difference in the prices * (subtracted) And I find that the difference is - $430.

2MII

A new automobile can be bought for cash for $2850 or on credit with a down payment of $400 and $80 a month for three years. How much MORE would a person pay by buying on credit rather than buying the car for cash? The price of the car for cash is $2850. If you buy it on credit you have to pay a down payment of $400 as your first payment and $80 a month for three years " 12 months in a year. Twelve times 80 will be * (multiplied) $960 a year which will be three times this for three years * (multiplied) For three years your $80 payments will be $2880 - Which will be, you have to add $400 onto this which is your first initial payment, which will be * (added) Total cost of this car will be $3280 on credit. The difference would be " 280 plus " 150 - Which is * (added) $430. You would have to pay $430 more if you bought the car with installment on the installment plan.

3MII

A new automobile may be bought for cash for $2850 or on credit with a down payment of $400 and a $80 a month for three years. How much MORE would a person pay by buying the car for cash? There's 12 months in a year. You multiply three times 12 * (multiplied) Is 36. Multiply 80 times 36 . . . (multiplied and got 2880)

That's $2080 - In payments plus $400 * (added) $3280 - On credit. Minus that - Minus the cash price and how much it cost on credit * (subtracted) There's a difference of $430.

4MII

A new automobile can be bought for cash for $2850 or on credit with a down payment of $400 and $80 a month for three years. How much MORE would a person pay by buying on credit rather than by buying the car for cash? - So I - Take - I subtract - I take $80 a month for three years. For three years, 12 months would be . . . (multiplied) So it'll be 36 - Months - $80. I'll take this $80 and multiply it by the months. Thirty-six months . . . (multiplied) 2780 is my answer. So that would be # $2850 or on credit. That's how much the car is worth - With a down payment of $400 and $80 for three years. So the $80 for three years - A month for three years would come out to $2780 plus your $400 for your down payment would make it . . . (added) 3180 is how much you would buy for on credit - So I take the credit - How much more would a person pay by buying on credit rather than by buying the car for cash? So I'll take the 3180, that's how much they paid for the credit and then the original price of the car is 2850. By buying on credit I subtract the 2850 from 3180 . . . (subtracted) So $330 is how much money he could have saved - Rather than buy it for cash.

1FIII

A new automobile can be bought for cash for 2850 or on credit with a down payment of 400 and $80 a month for three years. How much MORE would a person pay by buying on credit rather than buying the car for cash? - Or on credit with a down payment of $400. Down payment's $400 and $80 a month for three years. Eighty times three . . . (multiplied) $960 for a year, times three years would be . . . (multiplied) They would by paying 2880 plus $400 which was the down payment . . . (added) That would be 3280 - On cash it would be 2850. Subtract that from that . . . (subtracted) That would be $430 more.

2FIII

A new automobile can be bought for cash for $2850 or on credit with a down payment of $400 and $80 a month

for three years. How much MORE would a person pay by buying on credit rather than buying the car for cash? Going to pay $400 down payment and 80 a month for three years. There's 12 months in a year. Three 12's are " 36 - So multiply 36 - There's three years, so multiply 36 - It's $80 a month - Multiply that by 80 * (multiplied) You get 2880. So that would be - 2880 and then 400 plus that because you paid 400 down payment . . . (added) That'll be 3280 total that you pay when you buy - It on credit. So subtract 2850 from that . . . (subtracted) So you would be paying $430 more by buying it on credit.

3FIII

A new automobile can be bought for cash for $2850 or on credit with a down payment of $400 and $80 a month for three years. How much MORE would a person pay by buying on credit rather than by buying the car for cash? - $400 and then, let's see - 12 times three * (multiplied) Is 36 - 36 times $80 . . . (multiplied and got 2540) And times 400 . . . (added) Then we'd subtract 2940 from that 2850 and come out * (subtracted) Come out with 90. Ninety more dollars - He would be paying 90 more dollars - If he would buy on the credit plan.

4FIII

A new automobile can be bought for cash for $2850 or on credit with a down payment of $400 and $80 a month for three years. How much MORE would a person pay by buying on credit than by buying the car for cash? Four hundred dollars - $80 a month for three years. There's 12 months in a year. Be 12 times 80 * (multiplied) Be 960 and then it's 24 months in a year. Be 24 months for three years. Three years - So it must be 80 times 24 * (multiplied) " 36 months * (multiplied 36 times 80 and got $2880) * (added $400 and $2880 and got $3280) * (subtracted $2850 from $3280 and got $430).

1MIII

A new automobile can be bought for cash for 2850 or on credit with a down payment of 400 and 80 a month for three years. How much MORE would a person pay on credit rather than by buying the car for cash? To get this I would take and multiply " 36 by 80 and add 400

. . . (performed operations) And now I get the sum total of 3280. I would subtract 2850 from that. That would be the difference . . . (subtracted) I got 130. Add that to 2850 to see if my total's right * (added) It's not right though . . . (added) So the person would pay " 180 more dollars " 330 more dollars. Let's see * (added 2850 and 330) That's not right. That would be four " 430, $430.

2MIII

A new automobile can be bought for cash for $2850 or on credit with a down payment of $400 and $80 a month for three years. How much MORE would a person pay by buying on credit than by buying the car for cash? Down payment's $400 and three years would be " 36 months times $80 a month * (multiplied) That's 2880 plus your 400 as down payment * (added) Be 3280 - If you paid cash for it, it'd be 2850. Subtract 2850 from 3280 * (subtracted) Be paying 430 more dollars.

3MIII

A new automobile can be bought for cash for 2850 or on credit with a down payment of $480 a month for three years. How much MORE would a person pay by buying on credit rather than buying the car for cash? - Three years - Three times 12 will be " 36 months - 36 months times 480 would be * (multiplied) It'll be 17 hundred 200 - 1720 - Let me check this over again . . . (multiplied) 17280 - You would say - (subtracted 1728 from 2850) 1132.

4MIII

A new automobile can be bought for cash for $2850 or on credit with a down payment of $400 and eighty hundred dollars, $80 a month for three years. How much MORE would a person pay by buying on credit rather than buying the car for cash? - $400 - 80 times " 36 - Would be . . . (multiplied and got 2880) Add $400 to $2880 * (added) 3280 - Subtract 2850 from that . . . (subtracted) That's $430 - Difference.

1FIV

A new automobile can be bought for cash for $2850 or on credit with a down payment of 400 and $80 a month for three years. How much MORE would a person pay by buying on credit rather than buying the car for cash? Four hundred dollars and $80 a month for three years. Twelve months in a year. Twelve times three . . . (multiplied) 36 months times $80 . . . (multiplied and got 2820) $400 plus 2820 . . . (added) $3220 minus $2850 . . . (subtracted) Be $370.

2FIV

A new automobile can be bought for cash for $2850 or on credit with a down payment of $400 and $80 a month for three years. How much MORE would a person pay by buying on credit rather than by buying the car for cash? The cash is 2850. The down payment of $400 and $80 a month for three years. So it'll be 80 times " 36. Eighty dollars a month for three years . . . (multiplied) I got from multiplying 80 times 36, I got 2880 and $440 on to that . . . (added) So the answer is $3320.

3FIV

A new automobile can be bought for cash for $2850 or on credit with a down payment of $400 and $80 a month for three years. How much MORE would a person pay by buying it on credit rather than buying for cash? # Four hundred down - Put this over here. Eighty dollars a month for three years. Twelve times three * (multiplied) Is 36 - Times 80 . . . (multiplied) 2880 - Plus the $400 down payment . . . (added) $3280. Now subtract $2850 from that . . . (subtracted) $430 a month (wrote 4.30).

4FIV

A new automobile can be bought for cash for $2850 or on credit with a down payment of $400 and $80 a month for three years. How much MORE would a person pay by buying on credit rather than buying the car for cash? - Put the down payment down and keep it in line and then $80 a month. Then you would take 12 and multiply it by three . . . (multiplied) Then you would multiply - 80 times 36 . . . (multiplied and got 2880) Then you take

the $2850 and the 2880 and subtract the 2850 from that . . . (subtracted) So you would be paying 30 more dollars.

1MIV

A new automobile can be bought for cash for $2850 or on credit with a down payment of $400 and $80 a month for three years. How much MORE would a person pay by buying on credit rather than by buying the car for cash? # I don't know how to work that problem.

2MIV

A new automobile can be bought for cash for $2850 or on credit with a down payment of $400 and $80 a month for three years. How much MORE would a person pay by buying on credit rather than buying the car for cash? Let's see. First I'd add the down payment $400 and then I would - Three times 12 - Three years, so it'd be three times 12 * (multiplied) Which will be - 36 months - Be a 36 month period. So I'd multiply 80 by 36 * (multiplied) Which would be $2480. So this $2480 would be added on to the down payment of $400 * (added) Which would be $2880. Then I would subtract how much it would be bought for with cash which is $2850 and the difference would be * (subtracted) $30 - This is your answer, I would say.

3MIV

A new automobile can be bought for cash for $2850 or on credit with a down payment of $400 and $80 a month for three years. How much MORE would a person pay by buying on credit rather than by buying the car for cash? You would take, you would multiply 80 a month by " 36 months, which would be three years * (multiplied) Which would give you $2880 and add 400 down on it * (added) Which would give you $3280. Then subtract 2850 from 3280 * (subtracted) Which would give you a difference of $430, I think.

4MIV

A new automobile can be bought for cash for $2850 or on credit with a down payment of $400 and $80 a month for three years. How much MORE would a person pay by

buying on credit rather than buying the car for cash? A new automobile can be bought for cash for $2850 or on credit with a down payment of $400 and $80 per month for three years. There's " 36 months in a year, in three years, three years, 36 months. There's $80 per month plus the 400. Eighty dollars - 400 for three years. Thirty-six times 80 would be . . . (multiplied) Be 2880 plus the $400 which would equal . . . (added) The total of $3280 is what you'd be paying for the car if you bought it on credit. How much more would the person pay by buying on credit rather than buying the car for cash? Subtract 2850 from $3280. You get . . . (subtracted) So you have $430 difference between the two. Four hundred thirty dollars is the answer. You'd be paying $430 more for the car if you bought it on credit.

VI. PROBLEM SIX

1FI

Last summer Todd earned $205, Charlotte earned $562, and Dale earned $400. What is the average of their summer income? To get the average, add all three together . . . (added and got 1167) Then you divide by three would be . . . (divided) So their average income was $389.

2FI

Last summer Todd earned $205, Charlotte earned $562, and Dale earned $400. What is the average of their incomes - During the summer? To get the average we will have to add these 205, 562, 400 * (added) And we get 1167. If my math's right. Let me check it - That's right. Since there's three people earning these incomes, we'll have to divide 1167 by three in order to get - The amount - That is their average . . . (divided) So their average income is $389.

3FI

Last summer Todd earned $205, Charlotte earned 562, and Dale earned 400. What's the average of their summer incomes? You add them all together * (added) 1167. Divide that by three * (divided) That's $389.

4FI

Last summer Todd earned $205, Charlotte earned $562, and Dale earned $400. What is the average of their summer incomes? First we add them altogether - 205, 562, 400 * (added) And get $1167. Then divide that by three and get . . . (divided) Their average is $389.

1MI

Last summer Todd earned $205, Charlotte earned 562, and Dale earned 400. What is the average of their summer incomes? Two hundred five plus 562 plus 400 . . . (added and got 1167) Divide by three . . . (divided) Average is 389.

2MI

Last summer Todd earned $205, Charlotte earned $562, and Dale earned $400. What is the average of their summer incomes? Two hundred five, 562, 400 . . . (added) 1167 divided by three . . . (divided) $389.

3MI

Last summer Todd earned $205, Charlotte earned $562, and Dale earned 400. What is the average of their summer incomes? Add the incomes together and divide by three . . . (added) It's 1167 divided by three . . . (divided) Their average income is $389.

4MI

Todd earned $205, Charlotte earned $562, and Dale earned $400, smart girl. What is the average of their summer incomes? To do this I should add them altogether and divide by three. Two hundred five dollars plus $562 plus $400 would be . . . (added) Their sum total is $1167. Divide this by three . . . (divided) The average - Summer earning income was $389.

1FII

Last summer Todd earned $205, Charlotte earned $562, and Dale earned $400. What is the average of

their summer incomes? I would add the three totals of money . . . (added) And get $1167. Take $1167 and divide it by three because there are three people . . . (divided) Be $389.

2FII

Last summer Todd earned $205, Charlotte earned 562, and Dale earned $400. What is the average of their summer incomes? Add $205, 562, and 400 * (added) And you get 1267, no, 1167. Multiply that by three * (divided by three) And you get $389, the average.

3FII

Last summer Todd earned $205, Charlotte earned 562, and Dale earned 400. What is the average of their summer incomes? - Five hundred sixty-two, 400, 205 * (added) Be 1167. Three, which is all of them put together, into 1167, the sum of all three . . . (divided) So the average is 389.

4FII

Last summer Todd earned $205, Charlotte earned $562, and Dale earned $400. What is the average of their summer incomes? Two hundred five plus 562 plus 400 . . . (added) Divided by three . . . (divided) So the average is $389.

1MII

Last summer Todd earned $205, Charlotte earned $562, and Dale earned $400. What is the average of their summer incomes? I'll take the - Three totals - The three incomes and add them together. Add 205 plus 562 plus 400 * (added) And I get $1167. I divide that by three to get their average * (divided) And get $389. So their average income for the summer was $389.

2MII

Last summer Todd earned $205, Charlotte earned $562, and Dale earned $400. What is the average of their summer incomes? The average of their summer incomes would be $205 plus $562 plus $400 - That would

add up to be * (added) $1167 altogether. And the average would be three divided into this . . . (divided) Their average would be $389 for each of them.

3MII

Last summer Todd earned $205, Charlotte earned $562, and Dale earned $400. What was their average of their summer incomes? Add - The three incomes together * (added) $1167. Divide it by three because there are three people * (divided) $389 - Average.

4MII

Last summer Todd earned $205, Charlotte earned $562, and Dale earned $400. The average of their summer incomes? What is the average of their summer incomes? - So you got to average these three numbers - So I got to add $400, $205, and $562 and come out with answer of . . . (added) $1167. That's what I got by adding all three of those. So I got to divide three cause there's three prices - There's three people, anyway three different things. I'm going to average the three people into $1167 . . . (divided) So it's $389 average - For the summer of their incomes.

1FIII

Last summer Todd earned $205, Charlotte earned $562, and Dale earned $400. What is the average of their summer incomes? Two hundred five, 562, 400 - Add those up . . . (added) Would be 1167. Average would be - Divide that by three . . . (divided) Average of the summer incomes would be 389.

2FIII

Last summer Todd earned $205, Charlotte earned 562, and Dale earned $400. What is the average of their summer incomes? Take $205 that Todd earned, 562 that Charlotte earned, and the 400 that Dale earned and add those together . . . (added) And you get $1167. - And you divide that by three because there's three people. To get an average you divide . . . (divided) So their average is $389.

3FIII

Last summer Todd earned $205, Charlotte earned $562, and Dale earned $400. What is the average of their summer incomes? Two hundred five dollars plus $562 plus $400 equals * (added) $1167 - Divided by three . . . (divided) Their average - The average of their summer incomes - Would be - $389.

4FIII

Last summer Todd earned $205, Charlotte earned 562, and Dale earned 400. What is the average of their summer incomes? Two hundred five, 562, and 400 . . . (added) That comes out 1167 and there was three of them so three into 1167 . . . (divided) Average is $389.

1MIII

Last summer Todd earned $205, Charlotte earned $562, and Dale earned $400. What is the average of their summer incomes? To get the average you, I'll have to add Todd, Charlotte's, and Dale's totals, total income together . . . (added) That gives me the total of 1167. To find the average, divide that by the number of persons who have the income, which is three into 1167 . . . (divided) The average would be $388.33.

2MIII

Last summer Todd earned $205, Charlotte earned $562, and Dale earned $400. What was the average of their summer incomes? You add all - Three amounts together. Two hundred five, 562, and 400 * (added) Come up with 1167. And divide it by three * (divided) Their average is $389 each.

3MIII

Last summer Todd earned 205, Charlotte earned 562, and Dale earned 400. What is the average of their summer incomes? - You would add all three of them up, which would be 205, 562, and 400, add them up . . . (added) Total incomes would be 1167. And you divide this by - Three to figure out the average . . . (divided) So the total average of their incomes, summer incomes will be $389.

4MIII

Last summer Todd earned $205, Charlotte earned $562, and Dale earned $400. What is the average of their summer incomes? Add 205, 562, and 400 . . . (added) Come up with $1167 - Divide it by three . . . (divided) Average income would be $389 - Average.

1FIV

Last summer Todd earned $205, Charlotte earned $562, and Dale earned $400. What is the average for their summer incomes? Two hundred five plus 562 plus 400 . . . (added and got 1167) Divide it by three . . . (divided) So their average is $389.

2FIV

Last summer Todd earned $205, Charlotte earned $562, and Dale earned $400. What is the average of their summer incomes? I add $205 and $562 and $400 . . . (added) 1167. So I divide that by two . . . (divided) Average is - Wait - Last summer Todd earned $205, Charlotte earned $562, and Dale earned $400. What is the average of their summer incomes? I divide that - Last summer Todd earned $205, Charlotte earned $562, and Dale earned $400. What is the average of their summer incomes? - So I divided two by 1167 * (divided) and get $583.

3FIV

Last summer Todd earned $205, Charlotte earned 562, and Dale earned 400. What is the average of their summer incomes? Add them all up, first of all and the total would be . . . (added) $1167 and three into that . . . (divided) It'd be 389 - Would be the average.

4FIV

Last summer Todd earned $205, Charlotte earned $562, and Dale earned $400. What is the average of their summer incomes? Take $205 and $562 and $400 . . . (added and got 1167) Then you divide three in 1167 . . . (divided) So the average would be 389.

1MIV

Last summer Todd earned $205, Charlotte earned 562, and Dale earned $400. What is the average of their summer incomes? - Two hundred five, 562, 400 . . . (added) 1167.

2MIV

Last summer Todd earned $205, Charlotte earned $562, and Dale earned $400. What is the average of their summer incomes? First I'd add the three - Totals. Todd's 205, Charlotte's 562, and Dale's 400. Then I would add them . . . (added) And I come up with a total - Of 1167 and divide by three . . . (divided) Which would be $389.

3MIV

Last summer Todd earned $205, Charlotte earned 562, and Dale earned 400. What is the average of their summer incomes? You'd add $205, $562 * (added) Which will give you $767 plus $400 - (added) Which will give you $1167 and divide it by three . . . (divided) Which would give you an average of $389.

4MIV

Last summer Todd earned $205, Charlotte earned $562, and Dale earned $400. What is the average of their summer incomes? Last summer Todd earned $205, Charlotte earned $562, and Dale earned $400. You add the three up first . . . (added) Total 1167. Divide 1167 by three, by the three people . . . (divided) The answer is $389. Their income is $389.

VII. PROBLEM SEVEN

1FI

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percent of the total number of votes did Joe receive? First you want the total number of votes. You add 120, 50, and 30 to get the total *

(added) 200 total votes. So if he received 120 votes - What percent of the total number of votes did Joe receive? If he got 120 votes - So you just divide - 120 into 200 . . . (divided but never got an answer) - In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 - So the total number of votes was 200 - So I'm just going to say - Strike out those last two zeroes. I'll just take 12 into 20 . . . (divided with difficulty and got 16) I'm going to say " 16 percent.

2FI

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percentage of the total number of votes did Joe receive? - First of all I'm going to add the votes to see how much - They all get together * (added) And they got 200 votes altogether. If Joe received 120 votes could take - Divide 200 which is the total that they received into his amount which is 120 . . . (divided and got .60) So he got " 60 percent of the total number of votes.

3FI

In a school election with three candidates, Joe received 120 votes, Mary 50 votes, and George 30 votes. What percent of the total number of votes did Joe receive? First thing you do is add them altogether . . . (added) All my years of algebra they never taught me to do percent - 200 into 120 * (divided) " 60 percent.

4FI

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percent of the total number of votes did Joe receive? Joe received 100 votes, Mary received 50 votes, and George received 30 votes - Add them together * (added) There were 200 votes cast altogether. And - So what percent - Of 200 - What percent of 200 is - 120 # So you divide 200 into 120 - I think, I don't know * (started to divide) If you wanted to find out - 10 percent of 200 - Then you'd multiply 200 by .10. So if you wanted to find - You divide 120 by 200 * (divided and got .6) So it

would be 6 percent - Is that right? - I believe it's 6 percent. Maybe it's 60 percent " 60 percent.

1MI

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percent of the total number of votes did Joe receive? There were 120, 50, 30 votes cast. That's . . . (added) 300 votes - 200 votes. Two hundred votes - 120 is what percent of 200? One hundred into 120 . . . (divided) 1.2 - Times - 200 . . . (multiplied) 24 percent. No - Wait - 1.2 - Times 200 . . . (multiplied) # Joe received 120, Mary received 50, George received 30 . . . (added votes) 200. What percent of 200 is 120? Two hundred over 120 times 100 over x . . . (said times but meant equals) * (solved for x) 60 percent.

2MI

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percent of the total number of votes did Joe receive? One hundred twenty votes, 50 votes, and 30 votes add together . . . (added) 200 divided into 120 . . . (divided and got .60) " 60 percent.

3MI

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percent of the total number of votes did Joe receive? Add all the votes together * (added) They equal 200 exactly - I know what percentage - Is out of the whole - Be so nice - Let me think - How do I do that? - 120 - Put 120 over here - Figure this out in my head. I know he earned at least 50 percent. One hundred of 200 would be 50 percent. Then I'll have to take, there's 100 left - 20 percent - Joe earned 50 percent with his 100 cause he has 120 and 70 percent, I mean " 20 percent of the next 100, so that would be " 70 percent. Joe got 70 percent of the vote. Let me check that out.

4MI

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percent of the total number of votes did Joe receive? To do this I should add all the votes together - Then - Work for a percentage. One hundred twenty votes plus 50 votes plus 30 votes - Would be * (added) 200 votes - Now set it up as a ratio. One hundred twenty divided by 200. So it can be percentage, so I put it in 100 - Percent and over 100 percent I should put x cause that's what I'm solving for - Cross multiply - First I cancel out . . . (reduced the fraction 120/200) Now I cross multiply . . . (solved for x: 3/5 equals x/100) Joe received " 60 percent of the votes - To check - 200 times .60 should give me - Joe's votes . . . (multiplied) To check be 120.

1FII

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percent of the total number of votes did Joe receive? Add the three votes together . . . (added) 200 votes together. What percent did Joe receive? Joe had 120 votes # Joe received 120 votes and there's 200 in the total. I would - Put 120 over 200 - And break it down into a smaller fraction . . . (reduced) Get three-fifths. Change to decimal. Divide five into three . . . (divided) You get .60 and I would say that Joe received " 60 percent of the votes.

2FII

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percent of the total number of votes did Joe receive? - First find the total of votes. One hundred-twenty for Joe plus 50 for Mary and 30 for George equals * (added) 200 votes. If Joe received 120 votes - Then - Divide - 200 into 120 * (divided) And get " 60 percent. So Joe received 60 percent of the 200 votes.

3FII

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30. What percent of the total number of votes did Joe receive? * (added the votes) Altogether there were - 200 votes. He received * (divided 200 by three) 66 and two-thirds, I guess - Percent.

4FII

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percent of the total number of votes did Joe receive? The total number of votes is 120 plus 50 plus 30. So it'd be . . . (added) 200 votes. One hundred-twenty over 200 will be equal to . . . (reduced) Three-fifths times 100 . . . (multiplied) He got 60 percent of the votes.

1MII

In a high school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percent of the total number of votes did Joe receive? I'll add the three candidates' votes together. That would be 120 plus 50 plus 30 * (added) And I get 200 votes - So I know that Joe received 120 of those. So I'll divide 200 into 120 to find the percentage that Joe got * (divided and got .60). And I find that he got " 60 percent.

2MII

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percent of the total number of votes did Joe receive? Joe received 120 votes, Mary 50 votes, and George only received 30 votes - So all the votes together would be * (added) 200 votes together. One hundred-twenty votes - Would be a little over 50 percent and - 200 votes # Same thing as 12 into 20 - Will go - (started to divide) Doesn't help any - Joe received 120, Mary received 50, George received 30. Total votes were 200 cast. George received, Mary received - One-fourth of the votes. She received 25 percent. George received - Oh, Joe received 120 of the 200 * (divided 120 into 200) 1.66 would be the fractional

- Vote. Be the fraction. Let's see. Be 50 percent # Total amount would be 200 votes. Joe received 120. So he's gonna receive 50 and # 200 votes was the maximum number of votes - So Joe had to receive # That's simple - 120 - 120 into 200 into 120 is * (divided) .60 - So Joe received " 60 percent of the votes.

3MII

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percent of the total number of votes did Joe receive? - In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percent of the total number of votes did Joe receive? - Let's find out the total votes. One hundred-twenty plus 50 plus 30 * (added) Is 200 - 120 - Set up a proportion. One hundred-twenty is to 200 as x is to 100 . . . (solved for x) You come up with 60. Answer is " 60 percent.

4MII

On a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percent of the total number of votes did Joe receive? I got to add all these votes together - 120, 50, 30 . . . (added) 200 - That's how much of the people votes. So I'll take the three into 200 and I'll get . . . (divided) 66 and two-thirds percent of the total number of votes. Joe received 66 and two-thirds.

1FIII

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percentage of the total number of votes did Joe receive? Let's see. You add 120, 50, and 30 . . . (added) 200 votes altogether. How many did Joe receive? He received 120. So it'll be 120 over 200 which would be - He received . . . (reduced fraction) When you reduce that to three-fifths. Three-fifths of 120 be three-fifths.

2FIII

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30. What percent of the total number of votes did Joe receive? First - Add them altogether to find out how many votes there were total . . . (added) There were 200 votes - You want to find out what number Joe received. So you take the total and divide it into 120, the number of votes Joe received . . . (divided and got .6) So he received 60 - .6 - Put into percentage - Would be, multiply by 100 and get " 60 percent of the votes.

3FIII

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percent of the total number of votes did George receive? One hundred-twenty plus 50 be 170 plus 30 . . . (added) Be 200 - 200 - 120 votes - 80. He received " 20 percent of the votes.

4FIII

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percent of the total number of votes did Joe receive? Total number was 120 plus 50 plus 30 * (added) The total vote was 200 - Joe received 120. One hundred-twenty is what percent of 200? One hundred-twenty equals n times x percent of 200 * (wrote 120/200, reduced it to 3/5) " (wrote 3/5 percent as answer).

1MIII

In a school election with three candidates, Joe received 120 votes, Mary received 50, and George received 30. What percent of the total votes did George receive? I would add the totals together * (added votes) Divide it by three. Would be what the percent would be . . . (divided 200 by three) He got " 66 percent of the votes.

2MIII

In a school election with three candidates, Joe received 120 votes, Mary received 50, and George received 30. What percent of the total numbers of votes did Joe receive? Add the 120, the 50, and the 30 together * (added) Altogether there were 200 votes cast - # With three people - Into 200 * (divided) He received 66 and two-thirds of the vote.

3MIII

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percent of the total number of votes did Joe receive? - Add these up * (added votes) And you have 200. So 200 votes. Altogether it was 200 votes. So to figure out Joe's - Percentage - You go into his votes - 120. So it'll be 120 into 200 - And you'll get . . . (tried to divide) I'll pass on this one.

4MIII

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percent of the total number of votes did Joe receive? - Add 120, 50, and 30 * (added) Come out with - 200 votes in all - 120 of 200 would be " 60 percent of the votes.

1FIV

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percent of the total number of votes did Joe receive? One hundred-twenty plus 50 plus 30 . . . (added) That will be 200 votes all total - 200 - Votes all total. Find the percent - There are three voters . . . (divided three into 200 and got 66.6) That's not right - There's 200 percent total and - 200 percent total votes - And - That means he got 120 votes. Half of 200 would be 100. So he got over 100 percent - 50 percent, I mean - And - Half of that - So he got about - Tie would come out to about 66.66 - Three into 200 would go about . . . (divided) 66.6 percent.

2FIV

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percent of the total number of votes did Joe receive? I add 120 by 50 by 30 . . . (added) 200 votes in all. Subtract 200 from 120 . . . (subtracted 120 from 200) He got 80 percent of the votes.

3FIV

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What's the percent total number of votes did Joe receive? - 50 and 30 . . . (added) Would be 80. He got 120 * (subtracted 80 from 120 and got 40) # How would you do that? # He received 40 percent more, I guess - I don't know.

4FIV

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percent of the total number of votes did Joe receive? - Find the total number of votes. One hundred-twenty and 50 and 30 . . . (added) So there were 200 votes # Joe got 120 - What percent of the votes did Joe receive? # Divide three into 200 * (started to divide but quit) No - Divide 120 into 200 . . . (divided and got one with remainder 80) So he got " 80 percent of the votes.

1MIV

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes and George received 30 votes. What percent of the total votes did Joe receive? # " (added Mary's and George's votes and got 80) 120 minus 80 * (subtracted) Would be " 40 percent of the votes.

2MIV

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percent of the total number of

votes did Joe receive? - Whew, first I would - Add the total votes - Which would, total was " 200 - So Joe received 120 - Which would be about " 52 percent. Fifty-two percent.

3MIV

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percent of the votes total number of votes did Joe get? - Joe received 120 votes - You'd add up 120 votes plus 50 votes plus 30 votes * (added) To find out how many people voted. And I don't know how to do this problem.

4MIV

In a school election with three candidates, Joe received 120 votes, Mary received 50 votes, and George received 30 votes. What percent of the total number of votes did Joe receive? Joe received 50 votes. No, Joe received 120 votes. Mary received 50 votes, and George received 30 votes. What percent of the total number of votes did Joe receive? Add them up . . . (added) 200 votes altogether. If George received 120 votes, how much percent is that? Joe received 120 votes out of 200 altogether. He received over half of them. Let's see. Ten percent of 200 - 50 percent would be " 100. Another 10 percent would be, 10 percent of 200 would be " 20. It'd be " 60 percent. Joe received 60 percent of the votes. The answer is 60 percent.

VIII. PROBLEM EIGHT (PARTS A AND B)

1FI

The graph on the opposite page shows the monthly production of Company X during 1971. The greatest drop in production from one month to the next occurred between what two months? The graph on the opposite page shows the monthly production of Company X during 1971 (looked at graph) The greatest drop in production from one month to the next - The greatest drop in production was from September to October. The difference between maximum and minimum monthly production during 1971 was approximately how many units? So you take the highest

point (looked at graph) which was in July and take the lowest (looked at graph) Which was in January, the first of the year - In July it was at 6000 and in January it was - 3200 - The difference between those was how many units? - So let's just say that it was 6000 and this one in January was 3200. So the difference . . . (subtracted and got 2800) So it's approximately - 2 - No - Approximately - Three units - Almost three units.

2FI

The graph on the opposite page shows the monthly production of Company X during 1971. The greatest drop in production from one month to the next occurred between what two months? Let me look at the graph (looked at graph) The greatest drop in production (looked at graph) Kept going up til six - Then it dropped to one-half - Oh, that's between - September and October because that's a big drop. That's more than a whole drop, so it's September and October - The second question on this problem is: The difference between the maximum and the minimum monthly production during 1971 was approximately how many units? I'm going to look at the minimum production (looked at graph) Which was January and it was about three and a third. I'll write that down - January - Three and one-third and that's the minimum. The maximum, I'd say, was - In - Let's see, that's July and it was about six and one-third - So that's about three units difference.

3FI

The graph on the opposite page shows the monthly production of Company X during 1971. The greatest drop in production from one month to the next occurred between what two months? Production drop (looked at graph) That's September and October. You can see that - Right off. September the production started out almost 6000 and by the beginning of October it dropped four. Oh, it's much more than any of the rest of them. The difference between maximum and minimum, that's most and less (looked at graph) In July, July was their peak. They produced 6000 units (looked at graph) January was their low. They produced 3000. Three thousand from 6000 is " 3000 and that's the end of it.

4FI

The graph on the opposite page shows the monthly production of Company X during 1971. The greatest drop in production from one month to the next occurred between what two months? The greatest drop in production from one month to the next occurred between what two months? (looked at graph and commented on the rise and drop between consecutive months) Be between September and October. The difference between maximum and minimum monthly production during 1971 was approximately how many units? The difference between maximum and minimum monthly production - The maximum production - During 1971 was approximately how many units? - The difference between maximum production - And minimum production - Oh, monthly - Maximum monthly production. The maximum monthly production would have been (looked at graph and found the difference between production from one month to the next month) So that was the maximum. So it would have been five and one-half to, say, six and three-fourths - That's maximum - The minimum monthly production (looked at graph) About six and three-fourths to four and one-half or four and one-fourth - So - The difference between those two # So it'd be the difference between six and three-fourths and four and one-fourth . . . (subtracted) Two and one-half.

1MI

The graph on the opposite page shows the monthly production of Company X during 1971. The greatest drop in production from one month to the next occurred between what two months? (looked at graph) # September to October. The difference between maximum and minimum monthly monthly production during 1971 was approximately how many units? - Between maximum and minimum monthly production - Was approximately how many units? (looked at graph) # The least was 3500 - And the most was (looked at graph) 5500 . . . (subtracted 3500 from 5500) Be 2000.

2MI

The graph on the opposite page shows the monthly production of Company X during 1971. The greatest drop in production from one month to the next occurred between what two months? (looked at graph) September to October. The difference between maximum and minimum monthly production during 1971 was approximately how many units?

The difference between maximum and minimum monthly production during 1971 was approximately how many units? Three thousand units. I got that - Be 6000 approximately minus 3000 * (subtracted).

3MI

The graph on the opposite page shows the monthly production of Company X during 1971 (looked at graph) The greatest drop in production from one month to the next occurred between what two months? (looked at graph) Occurred between August and September - Let me check that to make sure (looked at graph) That's true. The difference between maximum and minimum monthly production during 1971 was approximately how many units? The difference between maximum and minimum monthly production during 1971 was approximately how many units? What the heck does that mean? The difference between maximum and minimum monthly production during 1971 - Oh, was approximately how many units? (looked at graph) Your minimum was about three and one-third and your maximum - Let's see (looked at graph) The maximum was about six and one-third. I'd say about three units (looked at graph) Oh, thousand - I would say 3000 units (looked at graph) Let me check that out. Looks about the same. I'd say 3000 units.

4MI

The graph on the opposite page shows the monthly production of Company X during 1971 (looked at graph) Monthly production of 1000 units - 1000 of units - 1971 thousands of units, January, February, etc. - 1, 2, 3, through 7. A. The greatest drop in production from one month to the next occurred between what two months? (looked at graph) The sharpest drop in the graph - Is between - September and October. Therefore, monthly production dropped sharpest during this time - The answer is September - To October. B. The difference between maximum and minimum monthly production during 1971 was approximately how many units? (looked at graph) The minimum was - 3.2 thousand units. The maximum was six thousand units - Having a difference of " 2.8 thousand units. The difference was approximately - 2.8 thousand - Units difference.

1FII

The graph on the opposite page shows the monthly production of Company X during 1971. The monthly production of Company X during 1971. A. The greatest drop in production from one month to the next occurred between what two months? The greatest drop in production from one month to the next occurred between what two months? (looked at graph) The greatest drop. I'd say it occurred between September and October because it dropped from (looked at graph) about six to four. B. The difference between maximum and minimum monthly production during 1971 was approximately how many units? The difference between maximum and minimum monthly production during 1971 was approximately how many units? Maximum (looked at graph) Maximum was six and maximum was about 6000 units and minimum was about, I'd say around 3000. Little over about 32000 (said 32000 but wrote 3200) So I'd say 6000 minus about 32000 and you get . . . (subtracted) 2800 units. That's around 2000 units or 3000. Could be 3000 units. Twenty-eight hundred units.

2FII

The graph on the opposite page shows the monthly production of Company X during 1971. (looked at graph) A. The greatest drop in production from one month to the next occurred between what two months? (looked at graph) The greatest drop occurred - During - The month of October through December. So the greatest drop occurred between the months of September and December. The difference between maximum and minimum monthly production during 1971 was approximately how many units? (looked at graph) The maximum was 6000 units and the minimum was about 3000 units * (subtracted) So the difference would be 3000.

3FII

The graph on the opposite page shows the monthly production of Company X during 1971. The greatest drop in production from one month to the next occurred between what two months? (looked at graph) The greatest drop in production from one month to the next - Occurred between what two months? - (looked at graph) I guess it'd be from January to February. The difference between maximum and minimum monthly production during 1971 was approximately how many units? (looked at graph) There

was three units, maximum (looked at graph) Six - I'd say four. Three from seven is four. Seven was the most - And so the difference was four.

4FII

The graph on the opposite page shows the monthly production of Company X during 1971 (looked at graph) The greatest drop in production from one month to the next occurred between what two months? (looked at graph) The greatest drop in production from one month to the next - Occurred between what two months? (looked at graph) Between September and October. The difference between maximum and minimum monthly production during 1970 was approximately how many units? - Between during 1971. The difference between maximum and minimum - (looked at graph) The difference between maximum and minimum monthly production during 1971 was approximately how many units? The minimum was about - 32000 and the maximum was 6000 - No, wait - 3200 - The minimum was 3200 and the maximum was 6000. So the difference is . . . (subtracted) Difference is 2800 units.

1MII

The graph on the opposite page shows the monthly production of Company X during 1971. The greatest drop in production from one month to the next occurred between what two months? (looked at graph) The greatest drop - So I look for the steepest decline between two months in a one year and I can see immediately that it is between September and October - When it dropped from about six to four and a half. So the answer is from September to October. B. The difference between maximum and minimum monthly production during 1971 was approximately how many units? (looked at graph) I see the maximum occurred at - July and August when they produced a little over six, a little over 6000 units - I call it 6200 units (looked at graph) I see the lowest production - Was in January when they produced approximately 3000 - 3300 units. So I'll take 6200 and subtract from that 3300 * (subtracted) And get 2900 units.

2MII

The graph on the opposite page shows the monthly production of Company X during 1971. A drop in production

from one month to the second occurred between the two months? (looked at graph) The greatest drop in production from one month to the next occurred between what two months? The greatest drop would be - It's going up here, up, up, up - Greatest drop would be between - September and October. The difference between maximum and minimum monthly production during '71 was approximately how many units? The difference between maximum and minimum monthly production during 1971 was approximately how many units? (looked at graph) Thousands - Of units - The maximum was (looked at graph) Six. The minimum was (looked at graph) 3.4 - Units - So the difference between the maximum and minimum monthly production would be * (subtracted) 2.6 units.

3MII

The graph on the opposite page shows the monthly production of Company X during 1971. The biggest drop in production from one month to the next occurred between what two months? The greatest drop in production from one month to the next occurred between what two months? (looked at graph) The greatest drop in production - September and October - The difference between maximum and minimum monthly production - The difference between maximum and minimum monthly production during 1971 was approximately how many units? (looked at graph) They came into '71 - At - 3250 units. The max in '71 was in July and it was about - 6500 units. Difference is about * (subtracted) 3250 units.

4MII

The graph on the opposite page shows the monthly production of Company X during 1971. The greatest drop in production from one month to the next occurred between what two months? The difference between maximum and minimum monthly production during 1971 was approximately how many units? (looked at graph) I can't do this one - No, I've never had this in high school. I can't do this one.

1FIII

The graph on the opposite page shows the monthly production of Company X during 1971 (looked at graph) The greatest drop in production from one month to the next

occurred between what two months? The greatest drop in production from one month (looked at graph) The greatest drop in production - Let's see, the greatest drop in production was between what two months? (looked at graph) It was between January and February - The difference between maximum and minimum monthly production during 1971 was approximately how many units? (looked at graph) Maximum was 6000 and minimum was (looked at graph) Minimum was 3025. The difference between, subtract . . . (subtracted) 2975 would be the difference.

2FIII

The graph on the opposite page shows the monthly production of Company X during 1971. The greatest drop in production from one month to the next occurred between what two months" (looked at graph) The graph shows the monthly production of Company X during 1971. The greatest drop in production from one month to the next occurred between what two months? (looked at graph) The greatest drop in production occurred between September and October - Because that's when it goes down - It had went up (looked at graph) Before then. The difference between maximum and minimum monthly production during 1971 was approximately how many units? Between (looked at graph) The maximum was - A little over six and the minimum was - A little over three - So the difference was about " Three units.

3FIII

The graph on the opposite page shows the monthly production of Company X during 1971. A. The greatest drop in production from one month to the next occurred between what two months? (looked at graph) September to October. The difference between maximum and minimum monthly production during 1971 was approximately how many units? # The difference between maximum and minimum monthly production during 1971 was approximately how many units? (looked at graph) Maximum was six, minimum was three " Three units.

4FIII

The graph on the opposite page shows the monthly production of Company X during 1971. The greatest drop in production from one month to the next occurred between

what two months? Greatest drop in production (looked at graph) September and October - The difference between maximum and minimum monthly production during 1971 was approximately how many units? The difference between maximum and minimum production during 1971 was approximately how many units? (looked at graph) The maximum production was in July and the minimum - Was January # " (read from graph and calculated five).

1MIII

The graph on the opposite page shows the monthly production of Company X during 1971. A. The greatest drop in production from one month to the next occurred between what two months? (looked at graph) Between January and February. The difference between the maximum and monthly production during 1971 was approximately how many units? (looked at graph) Between three point possibly two at 6.2, possibly 3.01. From approximately 3.2 units as lowest to 6. units as the highest " Three units.

2MIII

The graph on the opposite page shows the monthly production of Company X during 1971. A. The greatest drop in production from one month to the next occurred between what two months? (looked at graph) That's from September through October. B. The difference between maximum and minimum monthly production during 1971 was approximately how many units? (looked at graph) One.

3MIII

The graph on the opposite page shows the monthly production of Company X during 1971 (looked at graph) The greatest drop in production from one month to the next occurred between what two months? (looked at graph) First drop was in - January - The last drop - Was from October to November - October, November, December - The greatest drop - Would be - The greatest drop was - Between - January (looked at graph) I don't know that. So it'd be - Greatest drop in production from one month to the next occurred between what two months? Be November - To December because - Oh, boy - Be February and March. The greatest drop in production from one month to the next occurred between

what two months? (looked at graph) It would be between - February - And March. B. The difference between maximum and minimum monthly production during 1971 was approximately how many units? The difference between maximum and minimum monthly production during 1971 was approximately how many units? (looked at graph) The maximum was about six - 6000 units - And the minimum - Was 4000 - Subtract * (subtracted) Be 2000 units.

4MIII

The graph on the opposite page shows the monthly production of Company X during 1971. A. The greatest drop in production from one month to the next occurred between what two months? (looked at graph) Be between September and October - The difference between maximum and minimum monthly production during 1971 was approximately how many units? (looked at graph) The difference between maximum and minimum monthly production during 1971 was approximately how many units? (looked at graph) Be three and one-fourth - To six and one-fourth - Approximately " Three units.

1FIV

The graph on the opposite page shows the monthly production of Company X during 1971. The greatest drop in production from one month to the next occurred between what two months? (looked at graph) The greatest drop in production from one month to the next occurred between what two months? (looked at graph) From one month to the next, greatest drop - Here's an increase - I'll list in September because its a thousand. From August to September. The difference between the maximum and minimum monthly production during '71 was approximately how many units? (looked at graph) December was end in 1971. Between the maximum and minimum monthly production - During '71 was approximately, in '71 it was July (looked at graph) And it was about - 6000 units - That was the maximum (looked at graph) The difference between - And - During '71 - It was in January and it was about 3.2 - About 32000 units, 3200 - 6000 minus 3200 . . . (subtracted) So it'll be 2800.

2FIV

The graph on the opposite page shows the monthly production of Company X during 1971. A. The greatest

drop in production from one month to the next occurred between what two months? B. The difference between maximum and minimum monthly production during 1971 was approximately how many units? The graph on the opposite page shows the monthly production of Company X during 1971 (looked at graph) The greatest drop in production from one month to the next occurred between what two months? (looked at graph) The greatest drop between what two months is in January and February. The difference between maximum and minimum monthly production during 1971 - Wait - B. The difference between maximum and minimum monthly production during 1971 was approximately how many units? (looked at graph) Approximately - The maximum and minimum monthly production during 1971 was approximately how many units? So I turn over here. So the average looks to be about four and one-half (looked at graph) So I put down four and one-half. The answer is four and one-half.

3FIV

The graph on the opposite page shows the monthly production of Company X during 1971 (looked at graph) A. The greatest drop in production from one month to the next month occurred between what two months? (looked at graph) January to February - Because it's got more whatever you call it. The difference between the maximum and minimum monthly production during '71 was approximately how many units? I don't know (looked at graph) The difference between maximum and minimum monthly production during '71 was approximately how many units? (looked at graph) The difference between maximum and minimum monthly production during 1971 was approximately how many units? (looked at graph) I guess you take - 0, 1, 2, 3, 4, 5, 6, 7 - (read numbers on left margin of graph) I guess that's the units - The highest on the graph is 6000. So it'd be 5000, I guess. Six thousand - 1000 . . . (subtracted 1000 from 6000) Is 5000.

4FIV

The graph on the opposite page shows the monthly production of Company X during 1971 (looked at graph) A. The greatest drop in production from one month to the next occurred between what two months? (looked at graph) Looks like - From August to October. B. The difference between maximum and minimum monthly production during

1971 was approximately how many units? (looked at graph) # The maximum was about 6000 units - And the minimum was about 3200. To get the difference you would subtract . . . (subtracted) The difference was approximately 2800 units.

1MIV

The graph on the opposite page shows the monthly production of Company X during 1971 (looked at graph) A. The greatest drop in production from one month to the next occurred between what two months? (looked at graph) # It would be between September and October - It would be five and one-half minus three and one-half. The difference between maximum and minimum monthly production during 1971 was approximately how many units? (looked at graph) # I don't know how to work that problem.

2MIV

The graph on the opposite page shows the monthly production of Company X during 1971. The greatest drop in production from one month to the next occurred between what two months? (looked at graph) Between September and October. The difference between maximum and minimum monthly production during 1971 was approximately how many units? (looked at graph) One thousands of units - From three up to six - Let's see it goes from 3000 to 6000. Be " 3000 units.

3MIV

The graph on the opposite page shows the monthly production of Company X during 1971. The greatest drop in production from one month to the next occurred between what two months? (looked at graph) Between September and October. The difference between maximum and minimum monthly production during 1971 was approximately how many units? (looked at graph) # Maximum was (looked at graph) # Six - Hundred, thousand units and the minimum was about 30 - 1 - 2 - 3000 units. I don't know.

4MIV

The graph on the opposite page shows the monthly production of Company X during 1971. A. (looked at graph) The greatest drop in production from one month to the next occurred between what two months? The graph on the opposite page shows the monthly production of Company X during 1971. The greatest drop in production from one month to the next occurred between two months. The greatest drop in production from one month, the greatest drop in production from one month to the next occurred between two months. The greatest drop in production from one month to the next occurred between what two months? The greatest drop in production from one month to the next. Oh, yes (looked at graph) From September to October. From September to October is the answer to A. That's the greatest drop in production. September to October. B. The difference between maximum and minimum monthly production during 1971 was approximately how many units? - The difference between maximum and minimum monthly production during 1971 was approximately how many units? Maximum production - And minimum production. What's maximum and what's minimum? Maximum and minimum. I know what it means. See - It could mean the drop in production. I'll just go ahead and do that. I don't know what it is. The difference between maximum and minimum monthly production during 1971 was approximately how many units? Maximum and minimum production, minimum monthly production (looked at graph) Started dropping during August and leveled off at October. Started dropping in August and leveled off in October. The maximum production would would been at - During May and June would be the best production. Would be the maximum production. Between two months - January, February jumped from three and one-fourth to about four. Then it leveled off. Be about two-thirds production. Leveled off to about one-fourth and up again from about one-half, about one-half and went up again. Looks like another half and climbed steadily. I don't know how to work this problem.

VITA

Jacqueline Martin Underwood was born in Knoxville, Tennessee, on March 23, 1934 to Ralph and Anna Lou Martin. She attended the public schools of Sheffield and Marion, Alabama, and Sevierville, Chattanooga, and Knoxville, Tennessee. In 1951, she graduated from Austin High School in Knoxville as valedictorian of her class.

She received the B. S. degree from Knoxville College in 1955 with a double major in mathematics and biology, as well as completing requirements for Tennessee teacher certification in these two areas. In 1962, she received the M. S. degree from The University of Tennessee with a major in Science Education. She participated in a National Science Foundation Academic Year Institute in 1963-64 which was held at The University of Tennessee. At the completion of the summer portion of this institute, she received the M. M. degree.

She has also studied at Vanderbilt University (1967--National Science Foundation Summer Institute), Columbia University (1969--U. S. Office of Education Summer Institute), and IBM (1970 and 1971--Special Summer Program).

Jacqueline Martin Underwood taught at Schutz School in Alexandria, Egypt; Vine Junior High School in

Knoxville; The University of Tennessee (exchange teacher and part-time instructor); Walters State Community College in Morristown (part time and full time); and Knoxville College (assistant professor). She has taught in the Upward Bound and Try New Things Projects at Knoxville College. She was Director and Instructor in an Academic Year Institute for Elementary School Teachers which was sponsored by the U. S. Office of Education and was a cooperative program between Knoxville College and The University of Tennessee.

For four summers, 1965-1968, she participated in the National Urban League Summer Faculty Fellowship Program. She worked in the area of computer programming for IBM in Lexington, Kentucky; U. S. Steel in Pittsburgh, Pennsylvania; ALCOA in Alcoa, Tennessee; and General Electric in Huntsville, Alabama. She has conducted classes for children to acquaint them with various games and activities used in mathematics and in the general area of thinking.

In 1974, she returned to The University of Tennessee to work toward the Doctor of Education degree with emphasis in mathematics education. She received a grant from the U. S. Office of Education to study for two years toward this degree.

She is a member of the National Council of

Teachers of Mathematics, Tennessee Mathematics Teachers Association, Phi Delta Kappa, Alpha Kappa Alpha Sorority, Alpha Kappa Mu National Honor Society, Shiloh United Presbyterian Church, and numerous other civic and social organizations. She has served on the boards of several organizations.

She is the mother of two children, Paul, Jr. and Carla. They reside in Knoxville, Tennessee.