AN ANALYSIS OF THE EFFECTS OF TAPE-RECORDED INSTRUCTION ON ARITHMETIC PERFORMANCE OF SEVENTH GRADE PUPILS WITH VARYING ABILITIES

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DISSERTATION

Presented to the Graduate Council of the
North Texas State University in Partial
Fulfillment of the Requirements

For the Degree of

DOCTOR OF EDUCATION

By

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Denton, Texas

August, 1968

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CHAPTER I

INTRODUCTION

Teachers are seldom satisfied with the performance of pupils assigned to them. Many are constantly searching for various ways by which they may assist pupils to improve their performance. The use of educational communications devices can serve as means for improving learning in the schools and has been explored by many people interested in research. In the face of the need for improved instruction, however, many research studies involving audio-visual devices give little evidence in suggesting improved applications of these media in the instructional process (4, 7, 11, 12). Fritz (5, p. 2) reported that "These studies . . . have repeatedly revealed no significant differences." He concluded that the conceptual role of these media could be changed from one of "supplementary" to that of "complementary," which would allow them to exercise optimal impact in the teaching-learning process.

Fritz's definition of the "complementary role" of audio-visual media in instruction is this: when any task can be performed by a technological device at least as effectively as though the teacher were doing it, it should be assigned to the device. The definition is somewhat qualified by Fritz when he says,

> The comparative advantage of such media as films, television, and tape recordings suggests that these devices be selected to provide that part of the instruction which they can perform as effectively as the teacher, and leave the teacher the task of interacting with the students in ways that lead to deeper insights into the particular unit of instruction (5, pp. 8-9).

This study was concerned with the practical application of tape-recorded instruction when understood in light of the above qualified definition.

Statement of the Problem

The problem of this study was to compare arithmetic performance scores of pupils who had been presented tape-recorded instruction with arithmetic performance scores of pupils who had received the same instruction by means of traditional teaching methods.

The study was concerned with the following sub-problems:

1. To analyze the pupils on the basis of total experimental group performance and total control group performance.

2. To analyze the subgroup performance of the three ability levels into which each group was divided.

3. To analyze the performance on the basis of sex of pupils.

Hypotheses

The following hypotheses were tested:

1. There will be no significant difference in arithmetic performance between seventh grade pupils receiving tape-recorded instruction and seventh grade pupils receiving instruction by traditional teaching procedures.

2. There will be no significant difference in arithmetic performance between seventh grade pupils with high ability receiving tape-recorded instruction and seventh grade pupils with high ability receiving instruction by traditional teaching procedures.

3. There will be no significant difference in arithmetic performance between seventh grade pupils with average ability receiving tape-recorded instruction and seventh grade pupils with average ability receiving instruction by traditional teaching procedures.

4. There will be no significant difference in arithmetic performance between seventh grade pupils with low ability receiving tape-recorded instruction and seventh grade pupils with low ability receiving instruction by traditional teaching procedures.

5. There will be no significant difference in arithmetic performance between seventh grade girls receiving tape-recorded instruction and seventh grade boys receiving tape-recorded instruction.

6. There will be no significant difference in arithmetic performance between seventh grade girls with high ability receiving tape-recorded instruction and seventh grade boys with high ability receiving tape-recorded instruction.

7. There will be no significant difference in arithmetic performance between seventh grade girls with average ability receiving tape-recorded instruction and seventh grade boys with average ability receiving tape-recorded instruction.

8. There will be no significant difference in arithmetic performance between seventh grade girls with low ability receiving tape-recorded instruction and seventh grade boys with low ability receiving tape-recorded instruction.

9. There will be no significant difference in arithmetic performance between seventh grade girls receiving tape-recorded instruction and seventh grade girls receiving instruction by traditional teaching procedures.

10. There will be no significant difference in arithmetic performance between seventh grade girls with high ability receiving tape-recorded instruction and seventh grade girls with high ability receiving instruction by traditional procedures.

11. There will be no significant difference in arithmetic performance between seventh grade girls with average ability receiving tape-recorded instruction and seventh grade girls with average ability receiving instruction by traditional teaching procedures.

12. There will be no significant difference in arithmetic performance between seventh grade girls with low ability receiving tape-recorded instruction and seventh grade girls with low ability receiving instruction by traditional teaching procedures.

13. There will be no significant difference in arithmetic performance between seventh grade boys receiving tape-recorded instruction and seventh grade boys receiving instruction by traditional teaching procedures.

14. There will be no significant difference in arithmetic performance between seventh grade boys with high ability receiving tape-recorded instruction and seventh grade boys with high ability receiving instruction by traditional teaching procedures.

15. There will be no significant difference in arithmetic performance between seventh grade boys with average ability receiving tape-recorded instruction and seventh grade boys with average ability receiving instruction by traditional teaching procedures.

16. There will be no significant difference in arithmetic performance between seventh grade boys with low ability receiving tape-recorded instruction and seventh grade boys with low ability receiving instruction by traditional teaching procedures.

Background and Significance of the Study

The discovery of a better approach to teaching is the concern of many who are engaged in educational research.

Miller (9) stated that one of the needs in the teaching of arithmetic in the elementary school is that of a continuing search for an optimum approach. Another writer (3) has implied that the primary task of professional educators is to improve the process of education as much as possible and as rapidly as possible.

There is general agreement among those interested in education that changes in and expansion of knowledge call for changes in teaching techniques. With the world's knowledge doubling every eight to ten years (3, 16), a constant evaluation of teaching methods become imperative. Soghomonian (17, p. 395) has pointed out that "Social change is taking place faster than at any time in world history." He concluded that institutions and people must change if they are to survive. To accomplish this, schools must change and teach for change. This means a drastic overhaul of the curriculum, the utilization of instructional technology, and more education per tax dollar.

Lang (8, p. 469) called attention to the need for changing teaching techniques when he stated, "Instructional technology, then, in whatever form it may appear, has specific implications for curriculum, methods of instruction, teacher manpower utilization, school finances, and philosophy."

Among the several studies made in recent years which involved the use of tape-recorded instruction, two of the studies (6, 12) found no significant difference between two methods of instruction described as "direct-detailed" and "directed-discovery." Rowlett (14, p. 7) concluded that the inconsistencies in the findings may have been due to the individual perception of method, dissimilarity of subjects, or the possible non-equivalence of learning tasks. Companion studies (10, 14, 15, 16), which compared the "direct-detailed" and "directed-discovery" methods showed significant differences in achievement, with low ability groups benefiting more from the "direct-detailed" method and the average and above average pupils receiving greater benefit from the "directed-discovery" method.

Banghert and Spraker (2) conducted an investigation of the role of group influences on creativity during mathematical problem solving to determine whether or not the subjects benefited from active participation within a group as opposed to working alone. The report was the last of a series of five research studies on group problem solving conducted at the University of Virginia under the sponsorship of the Group Psychology Bureau of the Office of Naval Research. In none of the five studies completed did the group factor make any contribution to problem solving. There seemed to be a consistent, if slight, advantage to solving problems alone.

Twyford (18) stated that, in educational research, we are conducting investigations of the most difficult type, and that all types of research are important--from the most controlled experiment to the simplest demonstration. He concluded that "We should, however, endeavor to use an experimental design to solve important problems, rather than just to get an answer."

In the search for more efficient and effective methods of directing learning activities, teachers must be both flexible and perceptive as they employ new, and, sometimes, seemingly radical instructional techniques.

Since it is generally accepted that a lack of arithmetic concepts and skills handicap an individual, not only during his school life, but throughout his adult life, this study was undertaken to determine the value of tape-recorded instruction used as a complementary aid to the teacher as plans were made to meet the needs of pupils faced with this problem.

Fritz (5, p. 31) posed the question, "In what ways and to what extent may the use of the available communications media such as television, slides, films, and tape recordings improve significantly the teaching-learning process in the schools?"

Answers to the above question, through the use of relatively inexpensive and readily available recording equipment, were sought in this study.

Definition of Terms

Complementary role. The use of taped instruction as a means of extending the effectiveness and efficiency of the classroom teacher.

Experimental Group. Pupils in the seven arithmetic classes who received tape-recorded instruction.

Control Group. Pupils in the seven arithmetic classes taught by the traditional teaching method.

High Ability Subgroup. A subgroup in which each pupil's total score on the SRA Primary Mental Abilities test was 120 or above.

Average Ability Subgroup. A subgroup in which each pupil's total score on the above mentioned test ranged from 100 to 119.

Low Ability Subgroup. A subgroup in which each pupil's total score on the above mentioned test was 99 or below.

Instruction Sheet. A handout with illustrations and practice exercises which accompanied the tape-recorded instruction used in the experimental group classes.

Taped Instruction. Instruction magnetically recorded on metallic-coated plastic tape played back to the experimental group classes accompanied by an instruction sheet.

Script Lesson. Typed instruction used to make the tape-recorded instruction committed to memory and presented to the control group classes.

Traditional teaching procedure. A term used to describe the teaching method which employs the use of lecture, demonstration, drill and practice ordinarily used in conducting classes.

Homogeneous class. A class with a high degree of similarity among its members in respect to intelligence quotient scores.

Heterogeneous class. A class with a high degree of dissimilarity among its members in respect to intelligence quotient scores.

Limitations of the Study

This study was limited to the pupils enrolled in fourteen arithmetic classes in a large metropolitan junior high school during the spring semester of the 1967-1968 school year.

A further limitation was that conclusions and inferences drawn may be applicable only to pupils enrolled in classes similar in composition to those used in this study.

Basic Assumptions

Human variables are difficult to control. However, an attempt was made to minimize the effects on the results of this study of such factors as age, sex, and personality of the teachers by planning the instruction cooperatively, utilizing the voice of each teacher an equal number of times in the preparation of taped instruction, and using the same type of equipment in the classes.

It was assumed that the time of day in which instruction was given would not affect the results significantly, since both morning and afternoon classes were used in the study. Finally, it was assumed that the reliability of the teacher-made tests, ascertained through the application of the "Kuder-Richardson Formula 21," was sufficient for the purposes of this study.

Procedures for Conducting the Study

Selection of Subjects

This study involved three hundred sixty-seven seventh grade pupils enrolled in the regular arithmetic classes in a large metropolitan junior high school during the spring semester of the 1967-1968 school year.

From a total population of three hundred ninety-six seventh grade pupils, the three hundred sixty-seven pupils represented the number of pupils who completed the program. Eventually deleted from the study were those subjects who moved from the district, changed class assignment, or failed to attend more than fifty per cent of the time during which instruction was scheduled.

Pupil class assignment had been made by the school officials prior to the initiation of the study. The total seventh grade arithmetic classes were comprised of twelve heterogeneously grouped classes and two homogeneously grouped classes. Forty-six pupils in the two homogeneously grouped classes had been assigned on the basis of high arithmetic performance and teacher recommendations. The remaining three hundred twenty-one pupils had been assigned to the twelve heterogeneously grouped classes.

By means of randomization, one high performance class and six heterogeneous classes were selected to serve as the experimental group. The remaining high performance class and six heterogeneous classes served as the control group. An equal number of classes assigned to each teacher was selected to serve in each of the two groups. The distribution was as follows:

Teacher C: Two experimental group classes and two control group classes.

Teacher L: Two experimental group classes and two control group classes.

Teacher P: Two experimental group classes and two control group classes.

Teacher W: One experimental group class and one control group class.

Equating procedure. Both the experimental and control groups as well as the subgroups were equated on the basis of mean intelligence quotient scores derived from the Primary Mental Abilities test, Battery 6-9 which was administered on October 10, 1967. (See Figure 1, below.)

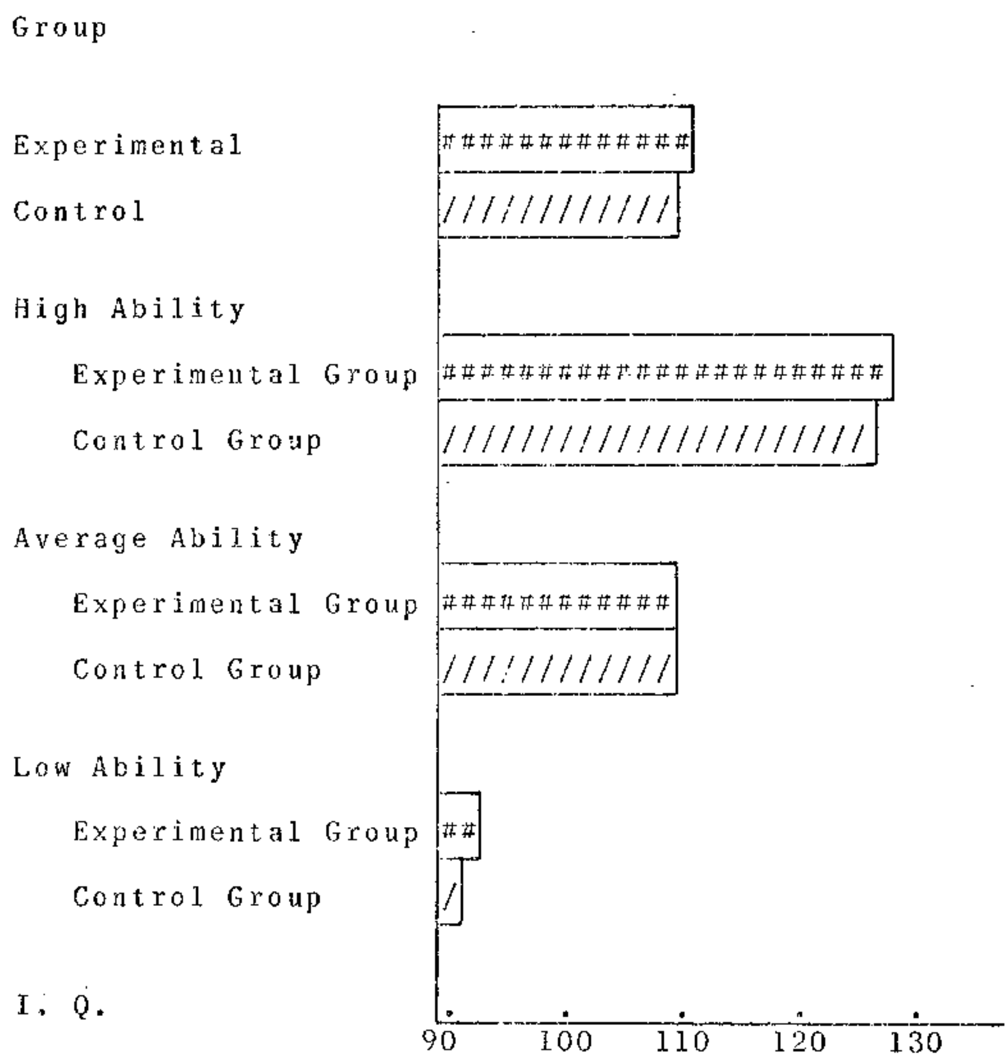

Fig. 1--A comparison of groups equated on basis of mean I. Q. scores.

Grouping procedure. As shown in Table I, one hundred eighty-two pupils from seven randomly selected classes served as the experimental group. One hundred eighty-five pupils from seven randomly selected classes served as the control group. The experimental group had eighty-four girls and ninety-eight boys while the control group had ninety-seven girls and eighty-eight boys.

TABLE I

NUMBER AND SEX OF SUBJECTS IN EXPERIMENTAL AND CONTROL GROUPS, AND HIGH, AVERAGE, AND LOW ABILITY SUBGROUPS

Sex	Experimental				Control				Total
	High	Average	Low	Total	High	Average	Low	Total	
Girls	22	51	11	84	27	56	14	97	181
Boys	23	58	17	98	17	56	15	88	186
Total	45	109	28	182	44	112	29	185	367

Both groups were divided into three ability level subgroups, shown in Table I, and were termed High Ability Subgroup, composed of pupils with I.Q. scores of 120 or above, Average Ability Subgroup, composed of pupils with I.Q. scores which ranged from 100 to 119, and Low Ability Subgroup, composed of pupils whose I.Q. scores ranged from 74 to 99. Three hundred sixty-seven pupils participated in the study.

Class assignment and intelligence quotient scores, information used in equating and determining group assignment, were obtained from appropriate school officials.

Selection of Teachers

One male and three female teachers, comprising the entire seventh grade arithmetic faculty, agreed to participate in the study. The teaching experience of the teachers ranged from two to seven years at the junior high school level. Each teacher held a valid Texas teaching certificate in the field of mathematics, and each teacher had been rated "excellent" by the principal of the school in which the study was conducted.

Each teacher, as well as the school principal, gave assurance of complete cooperation throughout the study, and with this assurance, preliminary plans for the study were begun.

Training of Teachers

A meeting was held with the participating teachers and the principal on February 12, 1968. At the meeting, an outline of the study was given, experimental and control groups class assignments made, and instruction content and sequence of topics used in the study agreed upon.

On February 19, 1968, a second meeting was held with the teachers, who were given instruction concerning the operation and use of the materials and equipment used in the study.

Each teacher practiced with the tape recorder until he was confident in his proficiency.

To assure close supervision and provide coordination to the experiment, weekly conferences were held with the participating teachers throughout the eight-week study.

Preparation of Tape-Recorded Instruction

The experimental variable used in this study was a series of eight segments of tape-recorded arithmetic instruction. Since no commercially taped lessons were available, the instruction used in this study was prepared jointly by the investigator and the four participating teachers.

At a preliminary meeting held in December, 1967, the teachers agreed to prepare a series of eight arithmetic lessons with the following titles:

1. Multiplication by Powers of Ten
2. Division by Powers of Ten
3. Adding Integers
4. Subtracting Integers
5. Understanding and Use of the Distributive Property of Arithmetic
6. Rounding Decimals
7. Solving Proportion Problems
8. Multiplication Using Scientific Notation

The content of each tape-recorded instruction was supplementary to that suggeted by the <u>Arithmetic 7 and 8</u>

<u>Teaching Guide</u>, published by the Fort Worth Public Schools, which the teachers were required to use. Since all of the subjects had had equal exposure to the concepts, it was felt that the results would satisfy the purposes of this study.

Once the topics were agreed upon, each teacher selected two of them, and wrote out in script form, lessons which required no more than fifteen minutes each for class presentation. In addition to the script lessons, the teachers prepared the instruction sheets, which the pupils used as a guide as they listened to the tape-recorded instruction. Each teacher prepared a twenty-item test which followed each tape-recorded instruction presentation.

At the February 12 meeting, copies of the eight script lessons, instruction sheets, and tests were given the teachers. After minor changes were made to the satisfaction of the teachers and the investigator, the sequence of presentation was decided upon, which was that as listed on page 16 of this report.

In an effort to minimize the effect that voice might have on the results of the study, each teacher taped the two lessons which he selected, and by means of the duplicating facilities of the school district, copies were made for the teachers. Distribution of the copies of taped instruction was made following the joint meeting of February 19, 1968.

From the teacher-made instruction sheets and tests, the director of the study prepared all copies of these instruments used in the study. The mimeographing facilities of the co-operating school were used for this purpose. Delivery of the mimeographed material was made on the day before its scheduled use.

In the interest of time, each test consisted of twenty items with a weighted value of five points for each item, and was designed as a skill or mastery test. Each teacher was provided a scoring key which was used to score each test. This method served to standardize the grading procedure. Copies of the script lessons, instruction sheets, and tests are found in Appendix A.

All taped instruction was made on Scotch Brand Magnetic Tape 1/4" x 300' on 3" reels with thirty minutes of recording time. Model 110 Audiotronics Tape Recorders, furnished by the visual aids department of the school district, were used to make each master tape and to present the taped instruction to the experimental group classes.

Method of Using Lessons

The experiment was designed to extend over a period of eight weeks with one lesson presented each week. The first five lessons were presented on different days of the week in an attempt to control the time variable. The lesson schedule was as follows:

Lesson 1: Friday, March 8, 1968

Lesson 2: Thursday, March 14, 1968

Lesson 3: Wednesday, March 20, 1968

Lesson 4: Tuesday, March 26, 1968

Lesson 5: Monday, April 1, 1968

Lesson 6: Wednesday, April 10, 1968

Lesson 7: Tuesday, April 16, 1968

Lesson 8: Monday, April 22, 1968

Through the cooperation of the building principal, all school programs and assembly meetings were rescheduled to avoid conflicts with the study schedule.

Each teacher followed the lesson procedure described below:

Experimental group classes. At the beginning of the period on the day a taped lesson was scheduled, the teacher introduced the lesson as part of the enrichment program of the school. Instruction sheets were handed out, and an announcement was made to the pupils that no questions nor comments were to be made until the test papers, which were distributed following the lesson presentation, had been collected.

The pupils then listened to the taped instruction while they followed the illustrations on the instruction sheet. At the conclusion of the lesson presentation, the test papers were distributed and time allowed for completion.

Since it was the policy of the local school district that the last twenty minutes of each class period in the seventh grade be used for supervised study, the time required for each lesson and test was limited to forty minutes. This arrangement allowed the teacher time to give instruction concerning the regular school program.

Control group classes. After memorizing the script lessons, the teachers in the control group classes presented the same instruction as that presented to the experimental group classes by tape recordings. The same instructions were given concerning questions and comments about the lesson. Identical tests were given, and the same length of time allowed as was required in the experimental group classes.

Since the control group teachers used the chalk board for illustration purposes, no instruction sheet handouts were made. Test papers were graded by the teachers and were picked up the following day by the director, who recorded the test data on forms prepared for the purpose.

The study was concluded on April 22, 1968, eight weeks after it was initiated.

Method of Estimating Test Reliability

The Kuder-Richardson Formula 21 (1, pp. 264-269), known as K-R 21, was used to estimate the reliability of the eight objective tests used in this study. Three quantities are necessary to use the formula: the mean (average score on the test), the number of items in the test, and the standard deviation. The formula is as follows:

$$\text{K-R } 21 = 1 - \frac{M(n-M)}{ns^2}$$

in which M = mean;

n = number of items;

s^2 = square of the standard deviation.

The reliability of .72 represents the cumulative reliability of the eight tests used in this study.

Treatment of Data

The tenability of the hypotheses was determined by Fisher's t technique to test the significance of difference between the two group means. The .05 level of significance was used for acceptance or rejection of the t test. The hypotheses were accepted or rejected at the .05 level of confidence.

Computation of the data in this study was made at the Computer Center, North Texas State University, Denton, Texas.

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CHAPTER II

SURVEY OF THE LITERATURE

This chapter will review some of the research studies and practices involving the use of tape-recorded instruction in several subject areas which have been conducted in recent years.

Hawk (4) conducted a study to test the relative effectiveness of auditory and printed programs for students of varying reading abilities. The problem undertaken in this study was to construct an auditory-channel program following principles of programmed learning and auditory communication, and to test the value of such a program by employing it in two classroom situations. The two arrangements for handling an auditory program were first, to have the teacher present the program recorded on tape one frame at a time from the front of the classroom, and second, to provide each student with his own tape recorder and headphones, allowing him to work independently. These two arrangements were compared to a third arrangement in which students used the self-paced visual program from which the auditory program was developed.

The effectiveness of the three program treatments was studied according to student reading ability. Students were assigned to one of three reading levels: high, average, and low. The levels were established from reading ability scores obtained on the Sequential Tests of Educational Progress Reading Test Form 3A.

Results from the study showed that students learning from the auditory program as it was presented by the teacher from a tape recorder in the group-paced situation did significantly better than either of the other groups, but more time was required by the students to complete the daily assignment. Students with high reading ability performed best with the visual program, and least well when they used their own tapes. Students with average reading ability made similar effective gains in performance in the group-paced and visual program treatments and the least effective gain in performance in the program treatment which utilized the independent study technique.

Hawk concluded that although the students using the auditory program in the group-paced situation made significantly superior gains to the other program treatments, the low efficiency of those groups casts doubt on the importance of the gains. He further concluded that students of high reading ability performed more efficiently with the visual program than with the auditory program, and that students of average reading ability performed equally efficiently with either the visual or the auditory program. The students with low reading ability performed most efficiently with the auditory program.

Stull (11) hypothesized that the provision of reading assistance would eliminate error, increase comprehension, and produce higher test scores in arithmetic when the reading assistance took the form of tape recordings.

The subjects were 838 children from the fourth, fifth, and sixth grade heterogeneously-grouped classes located in five central Pennsylvania school districts. Each school district had one class from each of the three grade levels which received auditory reading assistance. An equivalent class in each grade level in the five participating schools received no assistance.

The test used was the RASP Test developed by C. G. Corle and M. L. Coulter as part of their Reading-Arithmetic Skills Program, and consisted of four fifteen-item multiple-choice subtests which are believed to measure (a) knowledge of quantitative relationships requiring social understandings, (b) ability to recognize missing and unavailable information, (c) ability to read precisely, refusing to be misled by distractors, and (d) ability to make proper assumptions from the information given.

The 441 subjects for which auditory assistance was provided listened to a tape recording of the problems and answer choices while reading the problems and answer choices silently to themselves. The 397 subjects in the control classes read and answered the problems without assistance.

Using two- and three-factor analysis of variance techniques, the data were analyzed by subtest and total test to determine the effect on the test variable upon the scores of boys, girls, and of combined boys and girls.

Stull reported that in only one instance did the investigator find evidence suggesting that provision of auditory reading assistance produced higher scores on a verbal problems test than could be obtained by children working without assistance. The one exception occurred on the subtest which measures the ability to recognize missing and unavailable information. On this subtest, the scores of auditory-assisted girls and of auditory-assisted boys and girls were significantly higher at the .01 level of confidence than the scores of unassisted girls and unassisted boys and girls.

When boys' scores were compared to girls' scores, it was found that (a) boys scored significantly higher than girls on the first and third subtests, (b) girls' scores were higher than boys' scores on the second subtest to a degree approaching the .05 level, and (c) there was no significant difference between boys' and girls' scores on the fourth subtest and on the total test. Further research in terms of the educational implications audio-instruction may have was recommended.

Lorenz (7) investigated the possibility of using audiotape recordings of live presentations to classes of college students. His study was concerned with the use of taped lectures in small colleges unable to keep up with the increase in student enrollment, and institutions with inadequate funds to provide modern instructional television.

The findings were that students who received information which had been recorded earlier in live group classes, and presented by means of tape recordings without an instructor present, achieved as well on a criterion test as students attending an identically sequenced multi-media presentation with a live instructor supplying the verbal information. Subgroups of students who had received listening training achieved significantly higher mean scores than those students who had not received listening training.

Lorenz concluded that small colleges with limited means can expose large numbers of students to their senior staff members and maintain achievement without the time-consuming repetition of multiple class presentations by using low-cost educational technology and student assistants.

A study was made by Brown (1) to examine the effects and possible values of independent work activities through the use of tape-recorded lessons in a first grade basal reading program.

Reading achievement and psychological development of students who were provided tape-recorded lessons in Grade I were compared with national norms and with students who were not provided tape-recorded lessons. The tape recordings for the experimental groups were made by the classroom teacher.

Conclusions drawn from the study were that tape-recorded lessons which provided independent work activities of a first grade basal reading program were of value in effecting high reading achievement and strong personality development.

The findings of the study suggested the following recommendations for additional research: (a) follow-up studies in subsequent grades of the pupils who were provided independent work activities as an integral part of the basal reading program in grade one through the use of tape-recorded lessons; (b) added research in which there are more participating classrooms and larger random samples; (c) added research in which the use of tape-recorded lessons is continued in subsequent grades; and (d) research in which tape-recorded lessons which are designed to accompany basal reading programs are produced by some person other than the individual classroom teacher.

In a study designed to determine the effectiveness of teaching listening skills to fourth, fifth, and sixth grade students, Fawcett (3) utilized the tape recorder to present lessons in listening and to test the students.

Analysis of co-variance and *t* tests were utilized to evaluate the effect of listening instruction on the listening skills. Results of these statistical treatments indicated that direct instruction in listening will significantly influence the results of the post-test of listening ability. Correlations with listening ability declared significant at the one per cent level were those of mental age .451, reading comprehension .585; total language .537, arithmetic concepts .540; chronological age .280, and school grade .352. Correlations ranging from .340 to .463 were found between grades in language arts and arithmetic and listening ability. These correlations were significant at the .01 level.

Fawcett concluded that the teaching of listening skills evidence significant improvement in learning, especially in the area of arithmetic and the total language arts area.

Duncan (2) investigated the relationship between listening ability and shorthand achievement of high school students. Testing was done by tape recordings to 552 third-semester high school students enrolled in Gregg shorthand courses. The coefficients of correlation obtained suggest that a relationship between listening ability and achievement in shorthand does exist, but it tends to be slight. The most substantial coefficient calculated for the total research population was .36.

A study was made by Kraner (5) in which he compared the effectiveness of two methods of listening and reading instruction in an eighth grade language arts program. Achievement gains in listening, reading, study skills and English were compared between high and low ability students exposed to a series of thirty taped lessons and a workbook. Headphones were available for each student in the experimental classes which permitted the entire class to listen to the tapes and work the corresponding exercises in the workbook. Students in the control classes received teacher-prepared lessons based on the same concepts found in the Listen and Read Program used in the experimental classes.

Differences between pretest and post-test scores in the various areas determined the amount of achievement gains. The finding was that the students in the Listen and Read Program showed significant achievement in listening comprehension, reading ability following directions, recognizing transitions, reading graphic materials, and capitalization. Both methods were effective in producing achievement gains in immediate recall, word meanings, lecture comprehension, vocabulary, reference skills, interpretation, verbal study skills, punctuation, and word usage. The Listen and Read Program was significantly more effective with low-ability students for instruction in listening comprehension, reading ability, reading vocabulary, and capitalization. Both high- and low-ability students profited equally from taped instructions in the areas of immediate recall, following directions, recognizing transitions, word meanings, lecture comprehension, reference skills, interpretation, verbal and graphic study skills, punctuation, and word usage.

In his recommendations for future research, Kraner suggested that studies be made in other subject areas in which teacher-prepared taped exercises are utilized.

Miller (8) investigated the effectiveness of two methods of teaching selected topics in a college physical science course. One method involved the use of recorded lectures only, while the second method utilized a combination of recorded lectures and discussion.

Investigation was made of the relationship of the ability to do college work, previous mathematics achievement, reading ability, and previous science achievement, as measured by standardized tests, to the learning of selected topics in a college physical science course by means of the three methods of teaching. Investigation was made of the effectiveness of teaching by each of the three methods on the ability of students to solve mathematical problems.

Two hundred thirty-six students enrolled in nine classes were used in the study. The nine groups were divided into three sections, and each section was presented with three units of study. As each unit was studied, one section acted as a control group, receiving regular classroom instruction. The two remaining sections served as the experimental sections.

The first experimental section received a series of four tape-recorded lectures accompanied by illustrations. There was no contact with the instructor. The second experimental section received two tape-recorded lectures accompanied by illustrations, followed by two discussion periods conducted by the instructor. The sections were rotated so that all students had a trial under each method of presentation.

An application of paired comparisons was used in the study. All test scores were converted to standard scores for analysis. The achievement in a unit of study for each group handled by an individual instructor was compared to the achievement of that group in each of the other units of study. Each unit of study was taught by a different method. Analysis was made to determine which of the different procedures produced the best achievement.

The study showed that the method involving two tape-recorded lectures followed by two discussion periods and the method involving regular instruction were equally effective. Scores of students in the above situations were superior to those of students taught exclusively by the use of recordings.

The study indicated that recordings are capable of reducing in part the number of hours per week that a teacher may need to spend with a given class of students. Too, there was evidence that the extreme use of recordings significantly lowers the achievement of students.

Instruction by means of an audio-tutorial method was the subject of a study reported by Livingston (6). The objectives of the study were to demonstrate the audio-tutorial teaching techniques to the university staff and to provide actual experience with the method which would allow for an accurate estimate of cost and staffing patterns if it were to be adopted.

Some of the advantages of the audio-tutorial method were reported to be that it provided for maximum use of building space, allowed greater freedom in student scheduling, allowed the student to proceed at his own pace, and recognized the student as an individual. The method provided for more staff time which could be devoted to the superior student for discussions or the direction of special projects. Another advantage reported was that the method allowed greater freedom in scheduling staff hours.

It was the conclusion of those engaged in the study that the audio-tutorial method of teaching is an effective method of teaching modern subject matter to modern students.

Rowlett (9) reported a study that compared the effectiveness of direct-detailed and directed-discovery methods.

The study showed significant superiority in the directed-discovery method which involved the use of tape-recorded instruction. Leading questions were designed to direct the student's attention to the task to be performed or problem under consideration. Subjects were left to arrive at their own solution.

In the direct-detailed method, the tape-recorded instruction provided a step-by-step procedure for the completion of an assignment. The taped instruction relating to the correct solution of problems was explicit and detailed and included the rationale and principles involved in arriving at a given solution. At the end of each problem, taped instruction provided reinforcement by stating that the problem was completed.

In this chapter, studies and practices which involved the use of tape-recorded instruction under varying conditions have been reviewed. Brief reports on significant differences in achievement and in observed advantages have been given.

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CHAPTER III

PRESENTATION OF FINDINGS

The purpose of this chapter is to present the statistical results of the analysis of the data. The analysis will be presented in the order of the sub-problems as stated in the purpose of the study. These sub-problems will be restated, and the findings that are related to each sub-problem will be presented.

Sub-Problem 1

To analyze the pupils on the basis of total experimental group performance and total control group performance.

TABLE II

SIGNIFICANCE OF DIFFERENCE BETWEEN ARITHMETIC MEAN SCORES OF TOTAL EXPERIMENTAL GROUP AND TOTAL CONTROL GROUP

Variable	Experimental Group		Control Group		*t*
	OBS = 182		OBS = 185		
	Mean	Standard Deviation	Mean	Standard Deviation	
Score	84.8700	12.7290	88.0786	11.0182	-2.5760*

*Indicates significant difference.

The following null hypothesis related to sub-problem 1 was tested:

There will be no significant difference in arithmetic performance between seventh grade pupils receiving tape-recorded instruction and seventh grade pupils receiving instruction by traditional teaching procedures.

The results of the test for significance of the difference between arithmetic score means as recorded in Table II revealed a *t* ratio of -2.5760, which was significant at the accepted level of confidence (P = .05). The hypothesis was rejected.

The findings seem to indicate that seventh grade pupils taught by traditional teaching procedures performed at a higher rate than seventh grade pupils who received tape-recorded instruction.

Sub-Problem 2

To analyze the subgroup performance of the three ability levels into which each group was divided.

High Ability Group

The following null hypothesis related to sub-problem 2 was tested:

There will be no significant difference in arithmetic performance between seventh grade pupils with high ability receiving tape-recorded instruction and seventh grade pupils with high ability receiving instruction by traditional teaching procedures.

The results of the test for significance of the difference between arithmetic score means as recorded in Table III revealed a <u>t</u> of -.0247, which was not statistically significant at the .05 level of confidence. The hypothesis was accepted.

TABLE III

SIGNIFICANCE OF DIFFERENCE BETWEEN MEAN ARITHMETIC SCORES OF EXPERIMENTAL HIGH ABILITY GROUP AND CONTROL HIGH ABILITY GROUP

Variable	Experimental Group OBS = 45		Control Group OBS = 44		t
	Mean	Standard Deviation	Mean	Standard Deviation	
Score	92.8742	6.9421	92.9073	5.4351	- .0247

The findings seemed to indicate that tape-recorded instruction and traditional instruction are equally effective with seventh grade pupils with high ability.

<u>Average Ability Group</u>

The following null hypothesis related to sub-problem 2 was tested:

There will be no significant difference in arithmetic performance between seventh grade pupils with average ability receiving tape-recorded instruction and seventh grade pupils with average ability receiving instruction by traditional teaching procedures.

The results of the test for significance of the difference between arithmetic score means as recorded in Table IV revealed a *t* of -2.4373, which was significant at the accepted level of confidence (P = .05). The hypothesis was rejected.

TABLE IV

SIGNIFICANCE OF DIFFERENCE BETWEEN MEAN ARITHMETIC SCORES OF EXPERIMENTAL AVERAGE ABILITY GROUP AND CONTROL AVERAGE ABILITY GROUP

Variable	Experimental Group		Control Group		*t*
	OBS = 109		OBS = 112		
	Mean	Standard Deviation	Mean	Standard Deviation	
Score	84.5996	11.3667	88.3059	11.1365	-2.4373*

*Indicates significant difference.

The findings seem to indicate that seventh grade pupils with average ability taught by traditional teaching procedures performed at a higher rate than seventh grade pupils with average ability who received tape-recorded instruction.

<u>Low Ability Group</u>

The following null hypothesis related to sub-problem 2 was tested:

There will be no significant difference in arithmetic performance between seventh grade pupils with low ability receiving tape-recorded instruction and seventh grade pupils with low ability receiving instruction by traditional teaching procedures.

The results of the test for significance of the difference between arithmetic score means as recorded in Table V revealed a <u>t</u> of -1.8419, which was not statistically significant at the .05 level of confidence. The hypothesis was accepted.

TABLE V

SIGNIFICANCE OF DIFFERENCE BETWEEN MEAN ARITHMETIC SCORES OF EXPERIMENTAL LOW ABILITY GROUP AND CONTROL LOW ABILITY GROUP

Variable	Experimental Group		Control Group		<u>t</u>
	OBS = 28		OBS = 29		
	Mean	Standard Deviation	Mean	Standard Deviation	
Score	73.0590	15.1669	79.8748	12.1581	-1.8419

The findings seem to indicate that tape-recorded instruction and traditional instruction are equally effective with seventh grade pupils with low activity.

Sub-Problem 3

Opposite Sex

To analyze the performance on the basis of sex of pupils.

The following null hypothesis related to sub-problem 3 was tested:

There will be no significant difference in arithmetic performance between seventh grade girls receiving tape-recorded instruction and seventh grade boys receiving tape-recorded instruction.

The results of the test for significance of the difference between arithmetic score means as recorded in Table VI revealed a _t_ of .1962, which was not statistically significant at the .05 level of confidence. The hypothesis was accepted.

TABLE VI

SIGNIFICANCE OF DIFFERENCE BETWEEN MEAN ARITHMETIC SCORES OF EXPERIMENTAL GROUP GIRLS AND EXPERIMENTAL GROUP BOYS

Variable	Experimental Group		Control Group		_t_
	OBS = 84		OBS = 98		
	Mean	Standard Deviation	Mean	Standard Deviation	
Score	85.0711	12.9856	84.6976	12.5025	.1962

The findings seem to indicate that tape-recorded instruction was equally effective with seventh grade girls and boys.

High ability group.--The following null hypothesis related to sub-problem 3 was tested:

There will be no significant difference in arithmetic performance between seventh grade girls with high ability receiving tape-recorded instruction and seventh grade boys with high ability receiving tape-recorded instruction.

The results of the test for significance of the difference between arithmetic score means as recorded in Table VII revealed a *t* of -.4416, which was not statistically significant at the .05 level of confidence. The hypothesis was accepted.

TABLE VII

SIGNIFICANCE OF DIFFERENCE BETWEEN MEAN ARITHMETIC SCORES OF EXPERIMENTAL GIRLS HIGH ABILITY GROUP AND EXPERIMENTAL BOYS HIGH ABILITY GROUP

Variable	Experimental Group OBS = 22		Control Group OBS = 23		*t*
	Mean	Standard Deviation	Mean	Standard Deviation	
Score	92.3971	6.4747	93.3304	7.3326	-.4416

The findings seem to indicate that tape-recorded instruction was equally effective with seventh grade girls and boys with high ability.

Average ability group.--The following null hypothesis related to sub-problem 3 was tested:

There will be no significant difference in arithmetic performance between seventh grade girls with average ability receiving tape-recorded instruction and seventh grade boys with average ability receiving tape-recorded instruction.

The results of the test for significance of the difference between arithmetic score means as recorded in Table VIII revealed a t of .2097, which was not statistically significant at the .05 level of confidence. The hypothesis was accepted.

TABLE VIII

SIGNIFICANCE OF DIFFERENCE BETWEEN MEAN ARITHMETIC SCORES OF EXPERIMENTAL GIRLS AVERAGE ABILITY GROUP AND EXPERIMENTAL BOYS AVERAGE ABILITY GROUP

Variable	Experimental Group		Control Group		t
	OBS = 51		OBS = 58		
	Mean	Standard Deviation	Mean	Standard Deviation	
Score	84.8452	11.5443	84.3835	11.2038	.2097

The findings seem to indicate that tape-recorded instruction was equally effective with seventh

Low ability group.--The following hypothesis related to sub-problem 3 was tested:

There will be no significant difference in arithmetic performance between seventh grade girls with low ability receiving tape-recorded instruction and seventh grade boys with low ability receiving tape-recorded instruction.

The results of the test for significance of the difference between arithmetic score means as recorded in Table IX revealed a *t* of -.4322, which was not statistically significant at the .05 level of confidence. The hypothesis was accepted.

TABLE IX

SIGNIFICANCE OF DIFFERENCE BETWEEN MEAN ARITHMETIC SCORES OF EXPERIMENTAL GIRLS LOW ABILITY GROUP AND EXPERIMENTAL BOYS LOW ABILITY GROUP

Variable	Experimental Group		Control Group		*t*
	OBS = 11		OBS = 17		
	Mean	Standard Deviation	Mean	Standard Deviation	
Score	71.4664	17.1260	74.0896	13.6528	-.4322

The findings seem to indicate that tape-recorded instruction was equally effective with seventh grade girls and boys with low ability.

Same Sex: Girls

The following null hypothesis related to sub-problem 3 was tested:

There will be no significant difference in arithmetic performance between seventh grade girls receiving tape-recorded instruction and seventh grade girls receiving instruction by traditional teaching procedures.

The results of the test for significance of the difference between Arithmetic score means as recorded in Table X revealed a *t* of -2.5950, which was significant at the accepted level of confidence (P = .05). The hypothesis was rejected.

TABLE X

SIGNIFICANCE OF DIFFERENCE BETWEEN MEAN ARITHMETIC SCORES OF EXPERIMENTAL GROUP GIRLS AND CONTROL GROUP GIRLS

Variable	Experimental Group OBS = 84		Control Group OBS = 97		*t*
	Mean	Standard Deviation	Mean	Standard Deviation	
Score	85.0711	12.9856	89.4399	9.4522	-2.5950*

The findings seem to indicate that seventh grade girls taught by traditional teaching procedures performed at a higher rate than seventh grade girls who received tape-recorded instruction.

<u>High ability</u>.--The following null hypothesis related to sub-problem 3 was tested:

There will be no significant difference in arithmetic performance between seventh grade girls with high ability receiving tape-recorded instruction and seventh grade girls with high ability receiving instruction by traditional teaching procedures.

The results of the test for significance of the difference between arithmetic score means as recorded in Table XI revealed a *t* of -.4690, which was not statistically significant at the .05 level of confidence. The hypothesis was accepted.

TABLE XI

SIGNIFICANCE OF DIFFERENCE BETWEEN MEAN ARITHMETIC SCORES OF EXPERIMENTAL GIRLS HIGH ABILITY GROUP AND CONTROL GIRLS HIGH ABILITY GROUP

Variable	Experimental Group		Control Group		*t*
	OBS = 22		OBS = 27		
	Mean	Standard Deviation	Mean	Standard Deviation	
Score	92.3971	6.4747	93.2266	5.6422	- .4690

The findings seem to indicate that tape-recorded instruction and traditional instruction are equally effective with seventh grade girls with high ability.

Average ability.--The following null hypothesis related to sub-problem 3 was tested:

There will be no significant difference in arithmetic performance between seventh grade girls with average ability receiving tape-recorded instruction and seventh grade girls with average ability receiving instruction by traditional teaching procedures.

The results of the test for significance of the difference between arithmetic score means as recorded in Table XII revealed a *t* of -2.5656, which was significant at the accepted level of confidence (P = .05). The hypothesis was rejected.

TABLE XII

SIGNIFICANCE OF DIFFERENCE BETWEEN MEAN ARITHMETIC SCORES OF EXPERIMENTAL GIRLS AVERAGE ABILITY GROUP AND CONTROL GIRLS AVERAGE ABILITY GROUP

Variable	Experimental Group		Control Group		*t*
	OBS = 51		OBS = 56		
	Mean	Standard Deviation	Mean	Standard Deviation	
Score	84.8452	11.5443	89.8859	8.4735	-2.5656*

The findings seem to indicate that seventh grade girls with average ability taught by traditional teaching procedures performed at a higher rate than seventh grade girls with average ability who received tape-recorded instruction.

Low ability.--The following null hypothesis related to sub-problem 3 was tested:

There will be no significant difference in arithmetic performance between seventh grade girls with low ability receiving tape-recorded instruction and seventh grade girls with low ability receiving instruction by traditional teaching procedures.

The results of the test for significance of the difference between arithmetic score means as recorded in Table XIII revealed a *t* of -1.4310, which was not statistically significant at the .05 level of confidence. The hypothesis was accepted.

TABLE XIII

SIGNIFICANCE OF DIFFERENCE BETWEEN MEAN ARITHMETIC SCORES OF EXPERIMENTAL GIRLS LOW ABILITY GROUP AND CONTROL GIRLS LOW ABILITY GROUP

Variable	Experimental Group		Control Group		*t*
	OBS = 11		OBS = 14		
	Mean	Standard Deviation	Mean	Standard Deviation	
Score	71.4664	17.1260	80.3529	12.6416	-1.4310

The findings seem to indicate that tape-recorded instruction and traditional instruction are equally effective with seventh grade girls with low ability.

Same Sex: Boys

The following null hypothesis related to sub-problem 3 was tested:

There will be no significant difference in arithmetic performance between seventh grade boys receiving tape-recorded instruction and seventh grade boys receiving instruction by traditional teaching procedures.

The results of the test for significance of the difference between arithmetic score means as recorded in Table XIV revealed a *t* of -1.0247, which was not statistically significant at the .05 level of confidence. The hypothesis was accepted.

TABLE XIV

SIGNIFICANCE OF DIFFERENCE BETWEEN MEAN ARITHMETIC SCORES OF EXPERIMENTAL GROUP BOYS AND CONTROL GROUP BOYS

Variable	Experimental Group		Control Group		*t*
	OBS = 98		OBS = 88		
	Mean	Standard Deviation	Mean	Standard Deviation	
Score	84.6976	12.5025	86.5781	12.3448	-1.0247

The findings seem to indicate that tape-recorded instruction and traditional instruction are equally effective with seventh grade boys.

High ability.--The following null hypothesis related to sub-problem 3 was tested:

There will be no significant difference in arithmetic performance between seventh grade boys with high ability receiving tape-recorded instruction and seventh grade boys with high ability receiving instruction by traditional teaching procedures.

The results of the test for significance of the difference between arithmetic score means as recorded in Table XV revealed a *t* of .4387, which was not statistically significant at the .05 level of confidence. The hypothesis was accepted.

TABLE XV

SIGNIFICANCE OF DIFFERENCE BETWEEN MEAN ARITHMETIC SCORES OF EXPERIMENTAL BOYS HIGH ABILITY GROUP AND CONTROL BOYS HIGH ABILITY GROUP

Variable	Experimental Group OBS = 23		Control Group OBS = 17		*t*
	Mean	Standard Deviation	Mean	Standard Deviation	
Score	93.3304	7.3326	92.4002	5.0478	.4387

The findings seem to indicate that tape-recorded instruction and traditional instruction are equally effective with seventh grade boys with high ability.

Average ability.--The following null hypothesis related to sub-problem 3 was tested:

There will be no significant difference in arithmetic performance between seventh grade boys with average ability receiving tape-recorded instruction and seventh grade boys with average ability receiving instruction by traditional teaching procedures.

The results of the test for significance of the difference between arithmetic score means as recorded in Table XVI revealed a *t* of -1.0185, which was not statistically significant at the .05 level of confidence. The hypothesis was accepted.

TABLE XVI

SIGNIFICANCE OF DIFFERENCE BETWEEN MEAN ARITHMETIC SCORES OF EXPERIMENTAL BOYS AVERAGE ABILITY GROUP AND CONTROL BOYS AVERAGE ABILITY GROUP

Variable	Experimental Group		Control Group		*t*
	OBS = 58		OBS = 56		
	Mean	Standard Deviation	Mean	Standard Deviation	
Score	84.3835	11.2038	86.7258	13.0863	-1.0185

The findings seem to indicate that tape-recorded instruction and traditional instruction are equally effective with seventh grade boys with average ability.

Low ability.--The following null hypothesis related to sub-problem 3 was tested.

There will be no significant difference in arithmetic performance between seventh grade boys with low ability receiving tape-recorded instruction and seventh grade boys with low ability receiving instruction by traditional teaching procedures.

The results of the test for significance of the difference between arithmetic score means as recorded in Table XVII revealed a *t* of -1.1434, which was not statistically significant at the .05 level of confidence. The hypothesis was accepted.

TABLE XVII

SIGNIFICANCE OF DIFFERENCE BETWEEN MEAN ARITHMETIC SCORES OF EXPERIMENTAL BOYS LOW ABILITY GROUP AND CONTROL BOYS LOW ABILITY GROUP

Variable	Experimental Group		Control Group		*t*
	OBS = 17		OBS = 15		
	Mean	Standard Deviation	Mean	Standard Deviation	
Score	74.0896	13.6528	79.4285	11.6714	-1.1434

The findings seem to indicate that tape-recorded instruction and traditional instruction are equally effective with seventh grade boys with low ability.

CHAPTER IV

SUMMARY, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

The purposes of this chapter are to summarize the findings of the investigation, to draw conclusions based on these findings, and to make recommendations for further research pertinent to the use of tape-recorded instruction as a means of increasing the effectiveness of the classroom teacher and the improvement in learning increments.

Summary

The purpose of this study was to determine the effects of tape-recorded instruction on arithmetic performance of seventh grade pupils enrolled in a large metropolitan junior high school. The investigation was designed so that a comparison of arithmetic scores of pupils who had received tape-recorded instruction could be made with those who had been taught by the traditional teaching method.

Conclusions drawn were based on the following sub-problems:

1. To analyze the pupils on the basis of total experimental and total control group performance.

2. To analyze the subgroup performance of the three ability levels into which each group was divided.

3. To analyze the performance on the basis of the sex of the pupils.

The investigation began with a review of literature which involved the use of tape-recorded instruction. The review of the literature revealed that different methods of utilizing taped instruction had been employed in both subject matter areas and grade levels extending from grade one to the college level with varying degrees of results.

Three hundred sixty-seven seventh grade pupils participated in the study. The pupils were enrolled in fourteen regular arithmetic classes. Seven classes, composed of one hundred eighty-two pupils, were randomly assigned to serve as the experimental group while the remaining seven classes, composed of one hundred eighty-five pupils, served as the control group.

One male and three female teachers were assigned an equal number of classes in each group. A series of eight tape-recorded lessons was prepared jointly by the teachers and the director. Script lessons of the same content were presented to the classes in the control group. One lesson per week was presented for a period of eight weeks. Each lesson required from twelve to fifteen minutes for presentation, and a test was given immediately upon completion of the lesson presentation. The total time required for lesson presentation and test administration was approximately forty-five minutes. Each test consisted of twenty items with a weighted value of five points for each item.

Two lessons were taped by each teacher and duplicate copies were provided for the other three teachers. Test papers were graded by the teachers, and the results were recorded on forms prepared by the director. The mean average of the eight test scores was used in the analysis of the performance of the groups and subgroups.

These data were computed in part by the director of the study and in part by the Computer Center, North Texas State University, Denton, Texas. The statistical procedure utilized to analyze the data was the Fisher t test, with the .05 level of confidence accepted as significant.

The following results were obtained from the study.

Findings related to sub-problem 1

In analyzing the pupils on the basis of total experimental and total control group performance, the t ratio was significant at the (P .05) level of confidence. On the basis of these findings, seventh grade pupils who received instruction by traditional teaching procedures performed at a higher rate than seventh grade pupils who received tape-recorded instruction.

The hypothesis was rejected.

Findings related to sub-problem 2

In analyzing the pupils on the basis of subgroup performance of the three ability levels into which each group was divided, the *t* ratio for the high ability group was not significant. On the basis of these findings, seventh grade pupils with high ability performed equally well with tape-recorded and traditional instruction.

The hypothesis was accepted.

In analyzing the pupils on the basis of subgroup performance of the three ability levels into which each group was divided, the *t* ratio for the average ability group was significant at the (P .05) level of confidence. On the basis of these findings, seventh grade pupils with average ability performed at a higher rate when taught by traditional teaching procedures than seventh grade pupils with average ability who received tape-recorded instruction.

The hypothesis was rejected.

In analyzing the pupils on the basis of subgroup performance of the three ability levels into which each group was divided, the *t* ratio for the low ability group was not significant. On the basis of these findings, seventh grade pupils with low ability performed equally well with tape-recorded and traditional instruction.

The hypothesis was accepted.

Findings related to sub-problem 3

In analyzing the performance of pupils on the basis of different sex, the *t* ratio was not significant. On the basis of these findings, seventh grade girls and boys performed equally well with tape-recorded instruction.

The hypothesis was accepted.

In analyzing the performance of high ability pupils on the basis of different sex, the *t* ratio was not significant. On the basis of these findings, seventh grade girls and boys performed equally well with tape-recorded instruction.

The hypothesis was accepted.

In analyzing the performance of average ability pupils on the basis of different sex, the *t* ratio was not significant. On the basis of these findings, seventh grade girls and boys with average ability performed equally well with tape-recorded instruction.

The hypothesis was accepted.

In analyzing the performance of low ability pupils on the basis of different sex, the *t* ratio was not significant. On the basis of these findings, seventh grade girls and boys with low ability performed equally well with tape-recorded instruction.

The hypothesis was accepted.

In analyzing the performance of pupils on the basis of same sex, the *t* ratio was significant at the (P .05) level of confidence. On the basis of these findings, seventh grade girls taught by traditional teaching procedures performed at a higher rate than seventh grade girls who received tape-recorded instruction.

The hypothesis was rejected.

In analyzing the performance of high ability pupils on the basis of same sex, the t ratio was not significant. On the basis of these findings, seventh grade girls with high ability performed equally well with tape-recorded and traditional instruction.

The hypothesis was accepted.

In analyzing the performance of average ability pupils on the basis of same sex, the t ratio was significant at the (P .05) level of confidence. On the basis of these findings, seventh grade girls with average ability taught by traditional teaching procedures performed at a higher rate than seventh grade girls with average ability who received tape-recorded instruction.

The hypothesis was rejected.

In analyzing the performance of low ability pupils on the basis of same sex, the t ratio was not significant. On the basis of these findings, seventh grade girls with low ability performed equally well with tape-recorded and traditional instruction.

The hypothesis was accepted.

In analyzing the performance of pupils on the basis of same sex, the t ratio was not significant. On the basis of these findings, seventh grade boys performed equally well with tape-recorded and traditional instruction.

The hypothesis was accepted.

In analyzing the performance of high ability pupils on the basis of same sex, the t ratio was not significant. On the basis of these findings, seventh grade boys with high ability performed equally well with tape-recorded and traditional instruction.

The hypothesis was accepted.

In analyzing the performance of low ability pupils on the basis of same sex, the t ratio was not significant. On the basis of these findings, seventh grade boys with low ability performed equally well with tape-recorded and traditional instruction.

The hypothesis was accepted.

Conclusion

In accordance with the above list of findings of the present study, the following is concluded:

Taped arithmetic instruction can be used as a complementary aid to the classroom teacher with satisfactory results in seventh grade classes with characteristics similar to those described in this study.

Implications

As a complementary aid, taped arithmetic instruction can be used by students to make up work missed, to provide drill work for individual or small groups of students, or to assist substitute teachers not adequately oriented in the subject.

Recommendations

While the evidence gathered in the study seems to support the argument that taped instruction can be safely and satisfactorily used by the classroom teacher as a complementary aid, additional research is recommended to confirm this belief. Future research should include

1. Investigations of the same design extending over a longer period of time.

2. Studies designed to compare the performance of pupils using taped instruction and printed guide sheets with those using taped instruction and illustrations provided by means of overhead projector transparencies.

3. Studies designed to compare the performance of pupils exposed to taped instruction a different number of times each week during an experimental cycle.

4. Studies in which taped instruction is continued in subsequent grades.

5. Studies in which taped instruction is developed and produced by individuals other than the [illegible]

6. Investigations designed to measure the effects on performance when drill exercises and directions are provided by taped instruction.

7. Studies designed to measure pupil performance when make-up work is provided by means of taped instruction.

8. Studies designed to measure the arithmetic performance of pupils when taped instruction is utilized by substitute teachers.

9. Studies designed to determine the effects on attitude of pupils and teachers when taped arithmetic instruction is utilized.

10. Investigations to compare the time involved in the preparation of taped instruction with that of traditional lesson plans.

APPENDIX A

EXPERIMENTAL GROUP

SUBJECTS	SEX	I.Q.	TESTS 1	2	3	4	5	6	7	8	$\overline{X}$
C 2-1	F	116	80	75	--	95	--	95	70	65	80.0000
C 2-2	M	110	90	85	80	40	100	100	80	65	80.0000
C 2-3	F	118	100	95	100	100	100	100	100	85	97.5000
C 2-4	M	111	95	95	100	100	45	75	90	100	87.5000
C 2-5	M	100	100	95	100	75	95	--	85	90	91.4286
C 2-6	M	119	100	95	100	90	100	100	80	80	93.1250
C 2-7	M	115	100	100	100	100	--	100	--	100	100.0000
C 2-8	F	127	100	100	95	90	100	100	95	95	96.8750
C 2-9	M	116	100	100	100	55	100	100	80	95	91.2500
C 2-10	M	111	90	95	100	100	100	100	90	90	95.6250
C 2-11	M	107	95	95	100	50	75	100	75	100	86.2500
C 2-12	F	116	--	100	100	95	100	100	90	100	97.8571
C 2-13	M	95	25	65	75	55	75	95	90	65	68.1250
C 2-14	F	88	20	45	70	5	90	100	75	50	56.8750
C 2-15	M	109	95	95	100	70	95	--	95	65	87.8571
C 2-16	M	106	90	45	100	--	95	90	90	90	85.7143
C 2-17	F	128	100	100	90	45	100	100	90	100	90.6250
C 2-18	F	101	90	65	75	65	75	70	85	50	71.8750
C 2-19	F	128	100	90	100	100	95	100	90	100	96.8750
C 2-20	F	130	95	90	95	100	100	95	90	85	93.7500

SUBJECTS	SEX	I.Q.	TESTS 1	2	3	4	5	6	7	8	$\overline{X}$
C 2-21	F	114	94	94	100	80	100	100	100	35	88.1250
C 2-22	M	106	100	90	100	100	95	100	100	80	95.6250
C 2-23	F	108	80	80	90	100	95	100	100	55	87.5000
C 2-24	M	101	--	100	100	100	100	100	95	90	97.8571
C 2-25	M	91	100	60	100	100	95	75	--	95	89.2857
C 2-26	F	110	100	95	95	90	85	100	85	65	89.3750
C 2-27	M	133	100	65	100	95	80	100	90	100	91.2500

SUBJECTS	SEX	I.Q.	TESTS 1	2	3	4	5	6	7	8	$\overline{X}$
C 3-1	M	115	100	90	95	100	100	100	100	95	97.5000
C 3-2	F	123	100	100	100	100	100	100	100	100	100.0000
C 3-3	M	129	100	95	--	75	100	100	--	--	94.0000
C 3-4	F	116	95	--	90	90	80	100	100	85	91.4286
C 3-5	M	134	100	100	100	95	90	100	95	--	97.1429
C 3-6	F	145	100	95	100	100	100	100	85	100	97.5000
C 3-7	M	144	100	95	100	95	95	100	95	100	97.5000
C 3-8	F	117	100	100	100	100	--	100	100	--	100.0000
C 3-9	M	113	100	100	100	95	95	100	100	100	98.7500
C 3-10	M	131	100	100	100	90	--	100	90	100	97.1429
C 3-11	M	133	100	95	95	100	75	95	95	100	94.3750
C 3-12	F	121	100	95	100	100	100	100	100	100	99.3750
C 3-13	M	109	--	90	100	100	95	100	100	100	97.8571
C 3-14	M	121	100	100	100	100	100	100	100	100	100.0000
C 3-15	M	127	100	100	100	--	--	--	95	100	99.0000
C 3-16	M	128	95	95	--	95	95	100	100	100	97.1429
C 3-17	F	116	100	100	95	95	100	100	90	100	97.5000
C 3-18	M	126	95	100	100	100	80	--	95	100	95.7143
C 3-19	F	141	--	100	100	100	100	100	100	100	100.0000
C 3-20	F	134	100	85	100	100	85	100	85	90	93.1250
C 3-21	M	121	100	100	95	90	95	100	85	95	95.0000
C 3-22	F	133	100	95	100	100	100	100	--	100	99.2857
C 3-23	F	117	100	100	100	100	100	95	100	100	99.3750
C 3-24	M	140	100	100	85	100	100	100	95	100	97.5000

SUBJECTS	SEX	I.Q.	TESTS 1	2	3	4	5	6	7	8	$\overline{X}$
L 1-1	M	122	100	100	100	--	95	100	100	100	99.2857
L 1-2	F	121	100	95	--	10	100	95	100	60	80.0000
L 1-3	F	105	100	95	95	95	95	100	100	90	96.2500
L 1-4	M	108	100	100	85	90	95	100	95	100	95.6250
L 1-5	M	108	100	100	100	60	90	100	95	100	93.1250
L 1-6	M	99	100	80	95	75	100	100	85	100	91.8750
L 1-7	M	106	45	80	90	55	50	80	80	--	68.5714
L 1-8	F	107	--	40	75	70	70	--	95	65	69.1666
L 1-9	M	98	--	--	100	50	90	100	90	30	76.6666
L 1-10	M	120	40	85	90	35	90	95	95	20	68.7500
L 1-11	M	111	75	95	70	55	80	80	60	--	73.5714
L 1-12	F	121	100	--	85	90	95	95	95	30	84.2857
L 1-13	F	109	25	35	85	90	60	--	75	95	66.4257
L 1-14	M	124	90	95	100	50	--	100	--	100	89.1666
L 1-15	F	111	100	95	100	100	85	95	95	95	95.6250
L 1-16	M	119	100	95	95	55	100	100	95	35	84.3750
L 1-17	F	108	70	85	45	55	75	75	100	50	69.3750
L 1-18	F	115	100	100	100	90	95	100	90	80	94.3750
L 1-19	F	107	45	45	15	30	70	--	75	35	45.0000
L 1-20	F	99	95	85	95	95	100	95	90	50	88.1250
L 1-21	M	120	100	95	80	35	80	100	100	100	86.2500
L 1-22	M	122	70	100	95	95	95	100	100	100	94.3750
L 1-23	M	97	40	40	--	--	80	55	--	40	50.0000

SUBJECTS	SEX	I.Q.	TESTS 1	2	3	4	5	6	7	8	X
L 5-1	F	109	35	40	90	75	80	100	95	45	70.0000
L 5-2	F	114	100	100	100	100	60	100	100	100	95.0000
L 5-3	M	104	40	10	95	85	--	90	--	5	54.1666
L 5-4	M	87	60	--	95	85	30	60	95	70	70.7143
L 5-5	F	91	25	30	35	15	45	65	60	30	38.1250
L 5-6	M	102	80	90	--	70	20	95	65	80	71.4286
L 5-7	M	109	90	100	--	30	95	95	80	80	81.4286
L 5-8	F	121	95	30	90	85	90	100	85	45	77.5000
L 5-9	F	117	100	90	75	45	60	95	85	45	74.3750
L 5-10	M	95	100	100	65	15	60	95	100	95	78.7500
L 5-11	F	86	75	25	75	40	60	--	80	--	59.1666
L 5-12	F	123	100	100	100	90	85	95	95	60	90.6250
L 5-13	F	127	95	90	95	90	65	95	85	55	83.7500
L 5-14	M	112	100	95	100	100	90	100	100	90	96.8750
L 5-15	M	97	50	35	80	25	60	65	65	40	52.5000
L 5-16	M	106	45	95	90	35	60	20	85	35	58.1250
L 5-17	M	109	100	95	95	45	100	100	90	65	86.2500
L 5-18	M	105	25	55	70	35	75	--	70	65	56.4286
L 5-19	M	109	95	95	100	5	65	95	85	60	75.0000
L 5-20	F	98	100	100	100	85	100	95	90	55	90.6250
L 5-21	M	87	40	40	30	50	75	40	80	30	48.1250
L 5-22	F	136	100	100	100	100	70	90	95	50	88.1250
L 5-23	M	108	--	100	95	85	95	95	95	60	89.2857
L 5-24	F	103	45	50	50	55	50	75	75	60	57.5000

SUBJECTS	SEX	I.Q.	TESTS 1	2	3	4	5	6	7	8	$\overline{X}$
P 3-1	F	93	50	85	80	90	--	90	80	100	82.1429
P 3-2	M	117	75	85	100	25	85	100	90	80	80.0000
P 3-3	M	135	85	70	100	100	90	95	95	--	90.7143
P 3-4	F	117	100	95	95	100	100	100	85	100	96.8750
P 3-5	F	111	60	65	100	30	80	--	100	75	75.7143
P 3-6	M	108	90	--	100	20	90	--	90	55	74.1666
P 3-7	F	95	40	85	100	--	60	100	90	85	80.0000
P 3-8	M	130	100	100	95	40	85	--	--	55	79.1666
P 3-9	F	126	95	80	95	55	--	95	100	75	85.0000
P 3-10	M	95	65	100	100	45	75	--	75	80	77.1429
P 3-11	M	109	85	90	100	100	85	100	85	55	87.5000
P 3-12	M	104	100	95	95	80	85	100	95	55	88.1250
P 3-13	F	108	100	95	95	90	100	--	100	90	95.7143
P 3-14	F	114	100	--	100	55	80	100	75	85	85.0000
P 3-15	M	104	80	85	100	--	65	100	80	65	82.1429
P 3-16	F	101	90	80	95	45	90	95	90	95	85.0000
P 3-17	F	108	80	90	--	50	95	100	90	85	84.2857
P 3-18	F	117	90	95	100	75	95	--	90	80	89.2857
P 3-19	M	134	80	65	100	95	95	100	100	55	86.2500
P 3-20	M	97	100	70	100	90	80	70	--	90	85.7143
P 3-21	M	93	70	85	75	40	55	90	55	45	64.3750
P 3-22	F	114	70	90	95	45	100	100	100	95	86.8750
P 3-23	M	105	80	95	100	100	75	75	100	--	89.2857
P 3-24	F	115	95	85	100	45	100	--	90	95	87.8571

SUBJECTS	SEX	I.Q.	TESTS 1	2	3	4	5	6	7	8	$\overline{X}$
P 3-25	F	123	95	95	100	95	95	90	95	95	95.0000
P 3-26	M	106	90	85	100	45	85	100	95	90	87.5000
P 3-27	F	118	95	95	100	100	100	100	95	100	98.1250
P 3-28	F	118	70	95	100	50	100	--	95	50	80.0000

SUBJECTS	SEX	I.Q.	TESTS 1	2	3	4	5	6	7	8	$\bar{X}$
P 4-1	M	116	95	95	90	90	95	100	85	70	90.0000
P 4-2	F	110	90	90	100	85	80	80	--	60	83.5714
P 4-3	M	101	95	90	95	90	75	100	100	90	91.8750
P 4-4	M	117	55	60	100	35	90	100	90	45	71.8750
P 4-5	F	117	95	95	85	100	100	100	100	75	93.7500
P 4-6	M	109	100	100	100	60	85	--	85	100	90.0000
P 4-7	M	114	100	90	100	100	100	100	100	85	96.8750
P 4-8	M	103	65	70	95	90	95	75	75	55	77.5000
P 4-9	F	100	65	30	100	100	75	85	70	60	73.1250
P 4-10	M	109	90	95	100	95	90	100	65	70	88.1250
P 4-11	M	130	100	100	100	100	100	100	100	100	100.0000
P 4-12	F	120	--	75	100	--	90	100	100	100	94.1666
P 4-13	F	74	55	50	--	75	65	55	60	90	64.2857
P 4-14	M	116	--	--	--	90	45	100	70	85	78.0000
P 4-15	M	108	75	60	100	50	90	95	75	95	80.0000
P 4-16	F	116	90	70	--	50	90	100	85	45	75.7143
P 4-17	M	107	25	85	100	80	70	75	95	50	72.5000
P 4-18	F	85	50	40	100	25	45	80	70	10	52.5000
P 4-19	M	129	100	90	100	100	95	100	90	100	96.8750
P 4-20	F	98	100	85	100	80	95	85	85	--	90.0000
P 4-21	M	113	90	95	100	90	95	100	95	95	95.0000
P 4-22	M	101	75	45	55	35	85	75	90	60	65.0000
P 4-23	F	123	100	95	95	100	95	95	100	100	97.5000
P 4-24	M	103	100	95	95	50	80	100	95	40	81.8750

SUBJECTS	SEX	I.Q.	TESTS 1	2	3	4	5	6	7	8	X
P 4-25	F	113	75	85	90	50	95	95	90	70	81.2500
P 4-26	M	90	80	20	100	80	85	95	85	80	88.1250
P 4-27	M	95	95	90	85	30	70	80	70	85	75.0000

SUBJECTS	SEX	I.Q.	TESTS 1	2	3	4	5	6	7	8	$\overline{X}$
W 3-1	M	117	85	100	100	100	95	100	85	100	95.6250
W 3-2	F	103	55	95	90	100	60	100	100	55	81.8750
W 3-3	M	103	30	--	100	100	90	--	90	95	84.1666
W 3-4	F	103	35	85	85	65	80	50	75	50	65.6250
W 3-5	F	111	95	100	95	100	75	95	95	100	94.3750
W 3-6	M	97	100	95	95	100	90	95	80	95	93.7500
W 3-7	F	101	95	100	80	45	75	95	100	55	80.6250
W 3-8	M	96	50	100	90	85	60	95	30	95	75.6250
W 3-9	M	103	100	95	--	55	--	100	45	35	70.0000
W 3-10	M	104	100	100	100	--	95	90	70	20	82.1429
W 3-11	F	101	95	75	100	95	100	95	65	90	89.3750
W 3-12	F	106	100	85	85	45	80	90	75	95	81.8750
W 3-13	M	117	100	95	95	100	90	95	95	100	96.2500
W 3-14	M	119	95	90	95	85	100	95	90	85	91.8750
W 3-15	M	101	40	90	100	100	80	95	70	95	83.7500
W 3-16	F	117	--	100	--	90	95	75	90	100	92.5000
W 3-17	F	117	--	75	95	100	95	100	95	85	92.1429
W 3-18	M	111	95	100	100	--	--	100	50	95	90.0000
W 3-19	F	118	100	95	100	50	65	100	95	50	81.8750
W 3-20	F	113	100	95	100	45	95	95	85	100	89.3750
W 3-21	F	125	100	90	100	90	90	100	90	100	95.0000
W 3-22	F	114	100	100	--	80	80	95	100	100	93.5714
W 3-23	F	119	85	90	85	100	95	100	90	70	89.3750
W 3-24	M	113	75	55	70	95	80	35	75	65	62.5000

SUBJECTS	SEX	I.Q.	TESTS 1	2	3	4	5	6	7	8	X
W 3-25	F	123	100	100	100	85	95	90	90	95	94.3750
W 3-26	F	97	95	80	--	85	90	95	85	60	84.2857
W 3-27	M	96	95	70	100	55	60	55	85	70	73.7500
W 3-28	F	116	100	100	85	100	65	100	95	65	88.7500

CONTROL GROUP

SUBJECTS	SEX	I.Q.	TESTS 1	2	3	4	5	6	7	8	X̄
C 1-1	F	110	100	100	100	100	95	100	75	100	96.2500
C 1-2	M	114	95	100	100	45	95	75	90	90	86.2500
C 1-3	F	123	100	95	100	100	100	100	95	100	98.7500
C 1-4	M	110	100	80	70	95	95	100	90	100	91.2500
C 1-5	F	115	100	100	100	95	100	100	65	90	93.7500
C 1-6	F	113	90	95	90	90	100	100	80	80	90.6250
C 1-7	F	120	100	95	90	100	100	100	80	90	94.3750
C 1-8	M	113	95	90	--	100	100	100	80	--	94.1666
C 1-9	F	107	70	100	85	85	80	100	85	90	86.8750
C 1-10	M	101	100	100	100	95	100	100	95	100	98.7500
C 1-11	M	105	100	100	--	100	95	95	65	100	93.5714
C 1-12	F	133	100	100	100	95	--	100	80	100	96.4286
C 1-13	F	114	60	100	100	90	95	100	100	100	93.1250
C 1-14	M	115	85	80	100	95	100	100	80	85	90.6250
C 1-15	M	103	85	70	100	10	70	55	70	60	65.0000
C 1-16	F	121	100	100	100	95	100	100	100	90	98.1250
C 1-17	F	115	65	95	65	35	85	--	55	75	67.8571
C 1-18	M	119	100	100	100	95	85	95	85	95	94.3750
C 1-19	F	120	85	--	95	90	100	100	80	100	92.8571
C 1-20	F	111	100	95	100	100	100	100	90	100	98.1250

SUBJECTS	SEX	I.Q.	TESTS 1	2	3	4	5	6	7	8	$\bar{X}$
C 1-21	F	101	100	100	100	95	95	95	85	95	95.6250
C 1-22	F	110	95	90	75	80	85	100	85	100	88.7500
C 1-23	F	87	30	50	50	50	--	70	35	45	47.1429
C 1-24	M	122	100	100	95	100	100	100	90	95	97.5000
C 1-25	M	111	80	80	100	95	95	100	75	85	88.7500
C 1-26	F	128	95	90	--	75	90	100	85	90	81.2857
C 1-27	M	92	85	100	80	95	85	100	55	85	85.6250

SUBJECTS	SEX	I.Q.	TESTS 1	2	3	4	5	6	7	8	$\overline{X}$
C 5-1	M	117	100	95	80	85	100	100	95	90	93.1250
C 5-2	M	98	100	95	100	95	90	95	90	95	95.0000
C 5-3	M	129	95	100	100	95	100	100	75	100	95.6250
C 5-4	F	112	80	100	100	85	100	95	85	85	91.2500
C 5-5	F	111	90	80	95	100	100	90	90	95	93.7500
C 5-6	F	110	70	--	--	75	95	100	95	100	89.1666
C 5-7	F	127	95	85	100	85	100	100	90	100	94.3750
C 5-8	F	110	100	100	95	100	100	100	95	100	98.7500
C 5-9	F	136	90	100	45	--	100	100	90	100	89.2857
C 5-10	M	89	95	65	95	95	100	95	95	100	92.5000
C 5-11	M	113	85	100	100	95	95	100	100	100	96.8750
C 5-12	F	109	100	100	95	100	95	100	100	100	98.7500
C 5-13	F	100	95	100	80	--	100	100	85	100	94.2857
C 5-14	M	109	80	95	100	100	85	100	90	85	91.8750
C 5-15	M	96	80	95	75	95	60	95	75	85	81.2500
C 5-16	M	124	100	100	85	100	100	100	100	85	96.2500
C 5-17	F	126	95	100	95	85	80	95	95	95	92.5000
C 5-18	M	124	100	100	100	95	95	--	95	100	97.8571
C 5-19	F	104	75	85	90	90	95	100	90	100	90.6250
C 5-20	F	104	95	75	85	95	100	90	90	100	91.2500
C 5-21	M	107	95	95	85	45	30	55	80	--	69.2857
C 5-22	F	108	80	90	75	95	100	--	95	100	90.7143

SUBJECTS	SEX	I.Q.	TESTS 1	2	3	4	5	6	7	8	X̄
L 2-1	F	88	95	95	85	70	50	100	65	90	81.2500
L 2-2	F	92	85	100	95	100	75	95	100	90	92.5000
L 2-3	F	87	90	90	70	65	100	100	85	75	84.3750
L 2-4	M	101	100	90	--	45	--	100	--	85	84.0000
L 2-5	M	118	20	15	75	45	70	50	80	25	47.5000
L 2-6	M	110	95	95	90	100	85	90	90	40	85.6250
L 2-7	M	119	100	90	100	55	85	95	90	55	83.7500
L 2-8	F	109	95	95	95	65	95	100	85	75	88.1250
L 2-9	M	107	100	95	--	95	100	100	100	55	92.1429
L 2-10	M	122	100	95	100	100	55	85	90	95	90.0000
L 2-11	F	118	95	80	95	80	70	100	80	20	77.5000
L 2-12	M	102	95	90	100	100	85	75	90	65	87.5000
L 2-13	F	116	90	95	100	100	75	--	90	90	91.4286
L 2-14	F	109	100	100	100	95	75	95	90	80	91.7650
L 2-15	F	100	15	75	45	75	65	75	80	30	57.5000
L 2-16	M	124	100	--	100	100	100	100	75	80	93.5714
L 2-17	F	114	95	90	95	95	100	100	95	100	96.2500
L 2-18	F	104	75	85	15	55	90	95	90	65	71.2500
L 2-19	M	87	50	80	85	75	60	95	75	45	70.6250
L 2-20	F	109	100	95	90	95	75	100	100	95	93.7500
L 2-21	M	104	100	100	100	50	75	75	30	75	75.6250
L 2-22	F	102	--	45	60	70	65	65	95	50	64.2857
L 2-23	F	122	100	100	95	100	100	100	100	100	99.3750
L 2-24	M	103	95	65	100	50	90	85	90	95	83.7500

SUBJECTS	SEX	I.Q.	TESTS 1	2	3	4	5	6	7	8	$\overline{X}$
L 2-25	M	106	90	90	80	70	100	100	100	70	87.5000
L 2-26	M	118	95	75	95	100	85	100	90	100	92.5000
L 2-27	M	102	60	30	--	20	15	95	10	30	37.1429

SUBJECTS	SEX	I.Q.	TESTS 1	2	3	4	5	6	7	8	X̄
L 3-1	F	116	95	95	100	--	--	--	100	100	98.0000
L 3-2	M	103	80	80	100	90	100	85	90	--	89.2857
L 3-3	M	133	100	100	90	85	95	100	90	95	94.3750
L 3-4	F	111	100	--	85	90	100	95	90	95	93.5714
L 3-5	M	111	100	95	100	40	100	100	100	95	91.2500
L 3-6	F	121	95	90	90	90	95	95	95	85	91.8750
L 3-7	F	144	100	85	90	100	100	100	95	100	96.2500
L 3-8	F	132	--	100	100	80	100	90	90	95	93.5714
L 3-9	F	112	100	100	70	75	90	95	90	100	90.0000
L 3-10	F	148	100	90	95	90	95	100	95	75	92.5000
L 3-11	F	114	100	100	100	95	100	100	100	100	99.3750
L 3-12	F	121	100	100	95	100	100	95	100	100	98.7500
L 3-13	F	124	100	95	90	85	100	70	--	--	90.0000
L 3-14	F	109	90	100	90	95	95	95	95	95	94.3750
L 3-15	F	124	100	95	90	90	--	--	100	100	95.8333
L 3-16	F	123	100	95	100	--	80	95	95	100	95.0000
L 3-17	M	124	100	95	95	85	100	95	100	70	92.5000
L 3-18	F	124	85	90	65	35	100	100	80	75	78.7500
L 3-19	M	132	100	95	100	95	95	95	100	95	96.8750
L 3-20	M	128	100	100	100	100	100	90	95	100	98.1250
L 3-21	M	116	100	100	100	100	100	100	100	90	98.7500
L 3-22	M	135	100	--	100	80	100	95	80	75	90.0000
L 3-23	F	115	95	95	95	90	95	95	85	85	91.8750
L 3-24	F	111	100	100	100	100	90	95	95	100	97.5000

SUBJECTS	SEX	I.Q.	TESTS 1	2	3	4	5	6	7	8	$\overline{X}$
L 3-25	M	133	100	95	85	100	100	100	90	90	95.0000
L 3-26	F	113	95	90	100	100	90	95	75	100	94.3750
L 3-27	M	129	95	90	90	50	80	95	95	50	80.6250
L 3-28	M	105	100	70	100	95	85	90	75	100	89.3750

SUBJECTS	SEX	I.Q.	TESTS 1	2	3	4	5	6	7	8	$\overline{X}$
P 2-1	F	111	85	--	85	85	100	95	85	90	88.1429
P 2-2	M	106	55	15	90	55	65	65	30	15	48.7500
P 2-3	F	110	100	100	100	90	100	90	100	80	95.0000
P 2-4	F	102	75	65	90	85	80	95	90	--	82.8571
P 2-5	F	91	95	95	90	70	65	95	80	95	85.6250
P 2-6	F	129	100	95	100	100	80	85	95	95	93.7500
P 2-7	M	104	100	95	100	100	100	100	100	70	95.6250
P 2-8	F	104	60	85	95	90	95	85	85	95	86.2500
P 2-9	M	115	100	85	95	50	85	95	95	65	83.7500
P 2-10	F	117	100	90	95	55	85	100	90	80	86.8750
P 2-11	M	96	35	65	100	65	90	80	30	--	66.4286
P 2-12	F	115	90	80	95	95	75	95	80	85	86.8750
P 2-13	M	108	100	100	100	100	95	100	85	95	96.8750
P 2-14	F	124	100	95	100	100	100	95	100	95	98.1250
P 2-15	F	113	100	75	95	95	100	100	90	100	94.3750
P 2-16	M	86	70	50	100	70	70	10	15	15	50.0000
P 2-17	F	112	100	100	100	100	100	100	100	100	100.0000
P 2-18	M	98	70	80	90	95	80	70	55	35	71.8750
P 2-19	M	102	100	100	95	95	95	100	90	70	93.1250
P 2-20	F	118	100	95	100	100	--	100	90	100	97.8571
P 2-21	M	108	90	95	100	95	90	90	100	100	95.0000
P 2-22	F	134	--	100	100	100	100	100	--	--	100.0000
P 2-23	F	127	100	95	95	10	90	95	95	55	79.3750
P 2-24	M	109	90	95	100	90	100	100	75	80	91.2500

SUBJECTS	SEX	I.Q.	TESTS 1	2	3	4	5	6	7	8	$\overline{X}$
P 2-25	M	117	100	100	100	95	100	100	95	100	98.7500
P 2-26	M	130	100	95	100	85	90	100	80	100	93.7500
P 2-27	F	109	90	95	100	90	90	100	95	95	94.3750

SUBJECTS	SEX	I.Q.	TESTS 1	2	3	4	5	6	7	8	$\overline{X}$
P 6-1	F	106	80	95	90	65	90	60	90	55	78.1250
P 6-2	M	110	90	100	95	80	100	--	90	100	93.5714
P 6-3	F	93	90	65	100	55	95	95	90	70	82.5000
P 6-4	F	111	100	95	95	100	70	90	80	80	88.7500
P 6-5	F	93	70	95	90	80	85	95	60	60	79.3750
P 6-6	M	111	100	90	95	45	80	95	80	65	81.2500
P 6-7	M	90	100	95	95	100	95	75	70	65	86.8750
P 6-8	F	108	100	95	100	95	95	95	95	95	96.2500
P 6-9	M	119	100	90	--	100	100	100	95	100	97.8571
P 6-10	F	135	100	95	100	--	100	100	100	100	99.2857
P 6-11	F	96	95	95	95	80	85	85	95	85	89.3750
P 6-12	F	113	100	100	95	60	100	100	95	95	93.1250
P 6-13	F	91	60	85	90	95	95	85	--	100	87.1429
P 6-14	M	99	90	85	100	45	85	100	85	70	82.5000
P 6-15	M	110	100	95	100	95	95	100	90	100	96.8750
P 6-16	F	75	95	80	95	80	70	45	90	75	78.7500
P 6-17	F	91	70	65	--	80	50	40	15	75	56.4286
P 6-18	M	114	100	100	95	100	90	95	90	60	91.2500
P 6-19	M	110	80	100	95	45	85	90	95	70	82.5000
P 6-20	F	97	95	95	100	90	80	--	85	95	91.4286
P 6-21	M	89	80	100	90	40	80	95	90	45	77.5000
P 6-22	M	121	90	95	95	100	--	100	95	85	82.5000
P 6-23	M	97	100	90	70	70	100	100	100	65	86.8750
P 6-24	M	89	95	80	100	80	85	80	95	40	81.8750

SUBJECTS	SEX	I.Q.	TESTS 1	2	3	4	5	6	7	8	$\overline{X}$
P 6-25	F	111	85	100	90	95	95	95	90	85	91.8750
P 6-26	M	106	95	90	100	75	95	80	80	70	85.6250
P 6-27	M	107	100	85	90	90	75	100	85	65	86.2500

SUBJECTS	SEX	I.Q.	TESTS 1	2	3	4	5	6	7	8	$\overline{X}$
W 4-1	F	123	90	90	95	95	85	100	90	100	93.1250
W 4-2	M	98	100	85	100	100	100	100	60	100	93.1250
W 4-3	M	108	95	95	95	90	70	100	90	100	91.8750
W 4-4	F	92	80	60	80	95	55	100	--	--	78.3333
W 4-5	F	107	95	85	100	90	100	85	100	90	93.1250
W 4-6	M	105	100	80	--	85	90	75	90	100	88.5714
W 4-7	F	87	85	100	80	80	--	100	90	100	90.7143
W 4-8	M	103	--	20	95	45	60	55	45	50	52.8571
W 4-9	M	107	90	80	--	100	95	90	100	50	86.4286
W 4-10	F	108	100	100	100	85	80	100	75	90	91.2500
W 4-11	F	118	80	95	90	--	90	100	95	95	92.1429
W 4-12	M	112	100	100	100	90	80	100	100	60	91.2500
W 4-13	M	93	60	40	95	90	70	95	50	55	69.3750
W 4-14	F	113	100	90	--	50	95	100	95	45	82.1429
W 4-15	M	125	90	90	90	80	75	95	90	100	88.7500
W 4-16	F	107	95	100	85	--	75	95	90	50	84.2857
W 4-17	M	107	100	100	95	95	95	100	100	100	98.1250
W 4-18	M	108	100	95	100	95	100	100	95	100	98.1250
W 4-19	F	112	95	95	80	95	65	100	90	95	89.3750
W 4-20	M	116	100	90	100	--	100	100	95	100	97.8571
W 4-21	F	122	100	90	95	100	100	95	80	100	95.0000
W 4-22	M	104	90	75	95	80	85	100	70	95	86.2500
W 4-23	M	100	90	70	100	100	95	100	85	65	88.1250
W 4-24	M	121	100	100	100	90	75	90	65	80	87.5000

SUBJECTS	SEX	I.Q.	TESTS 1	2	3	4	5	6	7	8	$\overline{X}$
W 4-25	M	108	80	85	100	--	90	85	60	90	84.2857
W 4-26	F	127	100	80	100	80	90	--	95	75	88.5714
W 4-27	M	104	100	100	--	100	--	95	80	95	95.0000

APPENDIX B

Lesson 1

AREA: MULTIPLICATION

SKILL: Multiplication by Powers of Ten

In recent days you have had occasion to multiply or divide by powers of ten. Some of you solved your examples by annexing zeros and then pointing off the correct number of decimal places.

This method is slow and cumbersome. Mathematics is a science in which speed is almost as important as accuracy.

Today, you are going to learn a method of multiplying by 10, 100, 1000, and so on, or by powers of ten so that it can be done accurately and almost instantaneously, or at least in a matter of seconds.

You will not be allowed to ask questions or make comments during this class period, so listen carefully to the explanations and directions as they are given to you.

Refer to the instructional sheet that has been given to you when you are directed to do so.

There will be a short test for you to take at the end of this lesson.

Look at Entry A on the instruction sheet.

Most of you are already familiar with the term, exponent, or power of a base. The exponent tells the number of times the base is multiplied by itself. For example, 10^1 tells you there is only one ten; 10^2 tells you there are two tens, or 10x10 or 100; 10^3 tells you there are three tens, of 10x10x10, or 1000; 10^4 tells you there are four tens, or 10x10x10x10, or 10,000.

Do you see that the exponent names the number of zeros in the numeral? 10^1 tells you there is one zero in the numeral; 10^2 tells you there are two zeros in the numeral; and 10^3 tells you there are three zeros in the numeral.

Now you are ready to learn the short method of multiplying by powers of ten. You must remember that every whole number has a decimal point, though it is seldom written. For instance, where is the decimal point in the numeral 175? (Pause) Yes, it is understood to be after the last digit, five.

You will have no difficulty in seeing the decimal point in a decimal fractional numeral.

You will also need to think about this: that when any whole number or fractional number is multiplied by ten or any power of ten, it will increase in value, therefore, you will move the decimal point to the right. You will learn the number of places to the right of the original decimal point that will be correct to move the point. The number of zeros in the power of ten is the clue.

Look at Entry B on the instruction sheet. The first move the decimal point one place to the right, you must annex one zero making the product 20. The second item is 100x0.02 or two hundredths. Since there are two zeros in 100, the decimal point is moved two places to the right making the product 2. Do you see that the third item, 10^2x0.02 is the same as item 2? The exponent 2 tells you that 10^2 means 10x10 which is 100 and has two zeros following the digit one. The fourth item is 1000x0.24 or twenty-four hundredths. Since there are three zeros in 1000, the decimal point is moved three places to the right, making the product 240. Do you see why a zero has to be annexed to the 24? Item five is the same as item four since 10^3 is 10x10x10 or 1000. Of course the product is also 240. Item six, 1000x0.25 or twenty-five thousandths, requires moving the decimal point how many places to the right? (Pause) Yes, three places, making the product 25. Item seven is 10^4x0.025 or twenty-five thousandths. What is the product? (Pause) You should have 250. In item eight, what is the product of 10^6x0.000001, or one millionth? (Pause) The product will be one. Write only the digit, one, with no zeros before or after the digit. Item nine. What is the product of 10^3x8.8, or eight and eight-tenths? (Pause) The product is 8,800. Item ten. What is the product of 10^1x14.3, or fourteen and three-tenths? (Pause) Yes, the product is 143.

Be sure to omit zeros in front of whole numbers. They are not needed, and it looks rather odd to see a whole number preceded by zeros.

Now look at Entry C. Think what the product should be. When I give the answer, check yourself for accuracy. If the response you made mentally is not correct, try harder to get the rest of them right.

Item 1. 10x8.9 or eight and nine-tenths. (Pause) The product is 89.

Item 2. 100x5.056, or five and fifty-six thousandths. (Pause) The product is 505.6.

Item 3. 1000x2.941, or two and nine hundred forty-one thousandths. (Pause) You should have 2,941.

Item 4. 10^1x1.68. The product is 16.8.

Item 5. 10^2x0.008. The product is 0.8.

Item 6. 10^3x3.64. The product is 3,640.

What do you notice about the relationship between the number of zeros in the second factor and the number of decimal places in the product? With each additional zero in the second factor, there is one less decimal place in the product. In the example 10^1x3.14, or three and fourteen hundredths, there is one less decimal place in the product than in the second factor, since the product is now 31.4. In the example 10^2x3.14, there are two less decimal places in the product than in the second factor because the exponent 2 tells you to move the decimal point two places to the right. The product is now 314.

Look at Entry D on the instruction sheet as I read it to you.

Item 1. 10×0.1468 is 1.468.

Item 2. 100×0.1468 is 14.68.

Item 3. 1000×0.1468 is 146.8.

Item 4. $10{,}000 \times 0.1468$ is 1,468.

Item 5. $10^1 \times 146$ is 1,460.

Item 6. $10^2 \times 146$ is 14,600.

Item 7. $10^3 \times 146$ is 146,000.

Item 8. $10^4 \times 146$ is 1,460,000.

You can see, that to find the product of a power of ten and any other factor, you can simply rewrite the numeral and move the decimal point one place to the right for each zero in the power of ten.

How many places to the right should you move the decimal point when multiplying by 100 or 10^2? (Pause) Yes, two places. When multiplying by 1000 or 10^3? (Pause) Yes, three places. When multiplying by 10,000 or 10^4? (Pause) Yes, four places.

Now you are ready to take a short test on this lesson. Take your time. Think about the information given to you and you will do well.

When you have finished, raise your hand and I will collect your paper. Do not leave your seat until all papers have been collected.

INSTRUCTION SHEET #1

SKILL: Multiplication by powers of ten.

As you listen to the directions and explanations of the lesson on multiplying by powers of ten, look at each item as reference is made to it.

A. 10^1 is 10 10^2 is 100

10^3 is 1000 10^4 is 10,000

B. 1. 10x2 = 20
2. 100x0.02 = 2
3. 10^2x0.02 = 2
4. 1000x0.24 = 240
5. 10^3x0.24 = 240
6. 1000x0.025 =_______
7. 10^4x0.025 =_______
8. 10^6x0.000001 =_____
9. 10^3x8.8 =_______
10. 10^1x14.3 =_______

C. 1. 10x8.9 is__________
2. 100x5.056 is________
3. 1000x2.941 is_______
4. 10^1x1.68 is_______
5. 10^2x0.008 is______
6. 10^3x3.64 is_______

D. 1. 10x.1468 is 1.468
2. 100x.1468 is 14.68
3. 1000x.1468 is 146.8
4. 10,000x.1468 is 1468
5. 10^1x146 is 1,460
6. 10^2x146 is 14,600
7. 10^3x146 is 146,000
8. 10^4x146 is 1,460,000

TEST #1

Math Seven Date____________ Period______

Name__________________________ Teacher______________________

SUBJECT: Multiplication by Powers of Ten

Give the products in each of the following examples:

1. 100 x 2.74 is____________
2. 10 x 32 is ____________
3. 1000 x 6.753 is__________
4. 10,000 x 0.4135 is_______
5. 100 x 16 is ____________
6. 1000 x 278 is____________
7. 10^4 x 0.036 is _________
8. 10^3 x 32 is_____________
9. 10^2 x 4.04 is___________
10. 10^1 x 38.95 is__________
11. 10^3 x 5.098 is__________
12. 10^4 x 3.1416 is_________

By what power of ten must each of these be multiplied to result in the product to the right?

______ x 3.25 is 325

______ x 0.015 is 15

______ x 92.3 is 923.

______ x 3.14 is 3140

______ x 0.01 is 1

______ x 0.001 is 1

______ x 0.725 is 725.

______ x 1.251 is 12,510

Lesson 2

AREA: DIVISION

SKILL: Division by Powers of Ten

On page 61 of our math textbook is a stated problem reading:

"A basswood tree yields about 16,100 board feet of lumber. The wood is worth about $35.00 per 1000 board feet. What is the value of 11 average basswood trees?"

Some of you did not find it a simple matter to divide by 1000 and therefore computation was slow and unsure.

Today you will learn to divide rapidly and accurately by powers of ten.

Remember, there will be no questions nor comments during this instruction period. Listen carefully to all explanations and directions. There will be a test at the end of the lesson. Refer to the sheet of instructions when directed to do so.

Now let's finish the stated problem introduced at the beginning of the lesson. Look at Entry A on the instruction sheet.

The equation is: $N = [(16{,}100 \div 1000) \times 35]11$.

There are several variations of the equation, but in every case you must find the number of thousand board feet in 16,100 board feet. To divide 16,100 by 1000, move the decimal point 3 places to the left of the dividend. This gives a quotient of 16.1. Now, multiply 16.1 (the number of thousand board feet) by 35 (the value of 1000 board feet). This product is \$563.50. Then multiply \$563.50 by 11 to find the cost of 11 basswood trees. The total value of the 11 trees is \$6,198.50.

Look at Entry B on the instruction sheet for a quick review of the powers of ten. 10^1 means there is ONE 10; 10^2 means there are TWO tens, or 10 x 10 or 100; 10^3 means there are THREE tens, or 10 x 10 x 10 or 1000; 10^4 means there are FOUR tens, or 10 x 10 x 10 x 10 or 10,000 and so on. The exponent tells the number of zeros that follow the digit one.

Also, remember that in every whole number, there could be a decimal point written after the last digit.

When a numeral is divided by a power of ten, it must decrease in value; therefore, the decimal point is moved to the left. The number of zeros in the power of ten will indicate the number of places to the left that the decimal point must be moved. It may be necessary to annex zeros in front of the numeral in order to have enough places.

You can see this if you now look at Entry C, Item 1, 13 ÷ 10. Since 10 has only one zero, the decimal point is moved one place to the left. The quotient is 1.3, or one and three tenths. In Item 2, 13 ÷ 100, the decimal point is moved two places to the left since 100 has two zeros. The quotient is 0.13, or thirteen hundredths. Notice Item 3, 13 ÷ 1000. Since 1000 has three zeros, the decimal point is moved three places to the left. The quotient is 0.013, or thirteen thousandths. In Item 4, $3.5 \div 10^1$, the power of ten tells you there is one zero which means that the decimal point is moved one place to the left. The quotient is 0.35 or thirty-five hundredths. The fifth item is $2.42 \div 10^2$. The exponent tells you there are two zeros in the power of ten, so the decimal point is moved two places to the left. The quotient is 0.0242 or two hundred forty-two ten-thousandths. Item 6 in Entry C shows $117.2 \div 10^3$. The exponent tells you to move the decimal point three places to the left making the quotient read 0.1178 or one thousand one hundred seventy-eight ten-thousandths.

What do you notice about the relationship between the number of zeros in the divisor and number of places in the quotient? With each additional zero in the divisor, there is one more decimal place in the quotient. For example, if 3.14 or three and fourteen hundredths is divided by 10^1 or 10, the quotient has one more decimal place than the dividend. In this case, the quotient is 0.314 or three-hundred fourteen thousandths. If 3.14 or three and fourteen hundredths is divided by 10^2, there will be two more decimal places in the quotient than in the dividend, making the quotient read 0.0314 or three-hundred fourteen ten-thousandths.

In Entry D, you are to find the quotients mentally. Solve them one at a time, then as I read the answer, check yourself for accuracy.

Item 1. 1.8 or one and eight tenths divided by 10^1 is (pause) 0.18 or 18 hundredths.

Item 2. 0.06 or six hundredths divided by 10^2 is (pause) 0.0006 or six ten-thousandths.

Item 3. 2.1 or two and one tenth divided by 10^3 is (pause) 0.0021 or 21 ten-thousandths.

Item 4. 21 divided by 10^4 is (pause) 0.0021 or 21 ten-thousandths.

Item 5. 14.32 or fourteen and thirty-two hundredths is (pause) 0.1432 or one-thousand four hundred thirty-two ten-thousandths.

Item 6. 21,425 divided by 10^4 is (pause) 2.1425 or two and one-thousand four hundred twenty-five ten thousandths.

You are now ready to take the test. Be careful. Think about all the information that has been given to you. Use it and you will do well.

Raise your hand when you have completed the test. I will collect your paper. Do not leave your seat until all papers have been collected.

INSTRUCTION SHEET #2

SKILL: Division by Powers of Ten

The following examples are to help you understand how to divide by powers of ten. Look at each item as reference is made to it.

A. N= [(16,100 ÷ 1000) x 35]11

N= [16.1 x 35] x 11

N= $563.50 x 11

N= $6,198.50

B. 10^1 means 10; 10^2 means 10 x 10 or 100; 10^3 means 10 x 10 x 10 or 1000; 10^4 means 10 x 10 x 10 x 10 or 10,000 and so forth.

C. 1. 13 ÷ 10 is 1.3

2. 13 ÷ 100 is 0.13

3. 10 ÷ 1000 is 0.013

4. 3.5 ÷ 10^1 is 0.35

5. 242 ÷ 10^2 is 0.0242

6. 117.8 ÷ 10^3 is 0.1178

D. 1. 1.8 ÷ 10^1 is ________

2. 0.06 ÷ 10^2 is ________

3. 2.1 ÷ 10^3 is ________

4. 21 ÷ 10^4 is ________

5. 14.32 ÷ 10^2 is ________

6. 21,425 ÷ 10^4 is ________

TEST #2

Math Seven Date__________ Period_______

Name________________________ Teacher____________________

SUBJECT: Division by Powers of Ten

Give quotients in each of the following examples:

1. $35 \div 10 =$ ________	7. $1845 \div 100 =$ ________
2. $72.5 \div 10^1 =$ ________	8. $34.4 \div 10^2 =$ ________
3. $0.125 \div 10 =$ ________	9. $0.12 \div 1000 =$ ________
4. $246.7 \div 10^4 =$ ________	10. $5.7 \div 10^3 =$ ________
5. $437 \div 100 =$ ________	11. $9.05 \div 10^3 =$ ________
6. $1.25 \div 10^2 =$ ________	12. $82.3 \div 10^2 =$ ________

By what power of ten is each dividend to result in the quotient given?

1. $72 \div$ ____________ $= 0.72$
2. $0.45 \div$ ____________ $= 0.45$
3. $3.4 \div$ ____________ $= .034$
4. $0.1 \div$ ____________ $= 0.001$
5. $32 \div$ ____________ $= 0.032$
6. $10 \div$ ____________ $= 1$
7. $5 \div$ ____________ $= 0.05$
8. $46.7 \div$ ____________ $= 0.00467$

Lesson 3

AREA: INTEGERS

SKILL: Adding Integers

Today let us consider a trip along a road. On the instruction sheet is a map of part of the road through Anabru and Zabranchburg. The markers are placed one mile apart at the side of the road. If you ride a bicycle along this road from 'A' directly to 'G', you would say that you have made a trip of 2 miles in the Zabranchburg direction. If you ride from 'S' to 'B', you again say that you have made a trip of 2 miles in the Zabranchburg direction. Think of three other two-mile trips in the Zabranchburg direction. (Pause) You may have said 'K' to 'R', 'T' to 'A', 'R' to 'Q', 'Q' to 'M', and so forth. Now describe some two-mile trips in the Anabru direction. (Pause) You may have said 'B' to 'S', 'W' to 'C', 'S' to 'M', 'C' to 'G', or 'M' to 'Q.'

The two-mile trips toward Zabranchburg and the two-mile trips toward Anabru are alike in an important way. The length of each trip is two miles; that is for each trip, the <u>distance</u> in miles between starting and ending points is two miles. But, the trips are also different in an important way. The trips toward Zabranchburg are made in a <u>direction</u> opposite to that of the trips toward Anabru.

Suppose that we are told that two boys start at 'M' and that each boy makes a two-mile trip. How many miles apart will the boys be at the end of their trips? (Pause) Can you give a definite answer to this question? (Pause) The boys might be 0 (zero) miles apart, or they might be four miles apart, depending on whether or not they travelled in the same direction. We can conclude that it is not enough to know just the distances for the trips. We also need to know something about the directions.

Look at Entry A on the instruction sheet. The counting numbers of arithmetic--1, 2, 3, 4, 5, ... etc. can be used in measuring distances for trips along this road, but we need numbers which will indicate both distance and direction. There are such numbers, and we call them <u>integers</u>. Since the counting numbers can indicate the measure of distance, let's combine signs with these numerals, which will indicate direction. It is standard to use <u>positive</u> and <u>negative</u> signs to indicate the direction in which we move from our starting point.

Look at Entry B. We will call zero our point of origin, or beginning point. Therefore, zero is neither positive or negative.

Follow me on Entry C as I read these integers: negative 5, positive 5, negative 20, positive 20, negative 3, negative 2, negative 1, zero, positive 1, positive 2, positive 3, positive 4.

Look at the number line near the top of the instruction sheet. We are going to take some trips along this number line. We will start at 0. Let us travel first 3 miles in the positive direction, stop, and travel 4 more miles in the positive direction. Where will we be on the number line at the end of our trip? (Pause) We will be at positive 7.

Start back at 0 and let's take another trip. Go 7 miles in the negative direction and stop. We are at negative 7 on the number line. Now go 4 miles in the positive direction. We will be at negative 3.

Since the idea of taking one trip after another is something like "adding," everyone calls this <u>addition of integers</u>. Look at Entry F (1). Positive 3 plus positive 4 is equal to positive 7. This is pictured for you in Entry D. Look at Entry F (2). Negative 7 + positive 4 is equal to negative 3. Now quickly work the problems in Entry G, then we will check our answers. (Pause)

Entry G (1) says to first go 9 miles in the negative direction from 0. Stop. We are -9 on the number line. Then go 5 miles in the negative direction. We end up at -14 on the number line. (-9 + -5) = -14.) G (2) tells us to go 8 miles in the negative direction. We are now at negative 8 on the number line. Go 9 miles in the positive direction, and we end up at positive 1. (-8 + +9 = +1). G (3) equals +1, and G (4) equals -6.

For convenience, let us agree that the omission of a sign on a number will indicate that the number is positive. Study Entry H for a moment. (Pause)

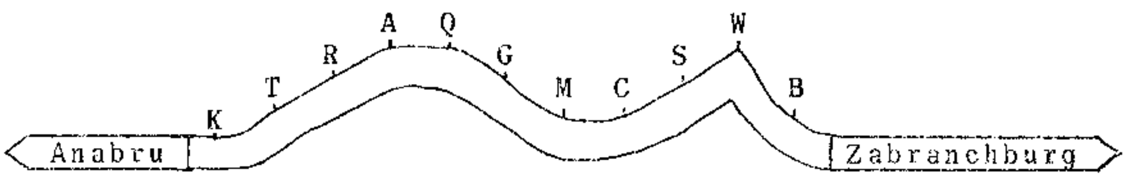
Now look at Entry I. These integers which we have talked about serve many useful purposes. They serve as measures of directed changes. A few examples would be an increase or decrease in weight or height, a rise or fall in temperature, a profit or loss in business, or a gain or loss in altitude of an airplane.

We can add integers without the use of a number line. See if you can discover a set of rules for adding integers!

INSTRUCTION SHEET #3

SKILL: Adding Integers

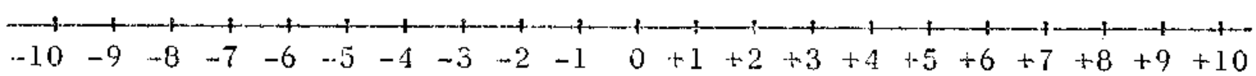
As you hear the lesson, notice the examples as they are referred to.



(-) Negative Direction

(+) Positive Direction

NUMBER LINE



A. Counting Numbers: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, . . .

B. (+) Positive Sign; (-) Negative Sign

C. Examples of Integers:

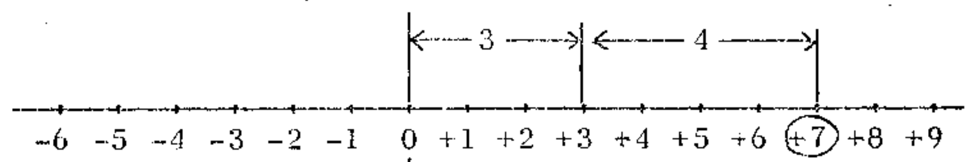
-5. +5, -20, +20, -3, -2, -1, 0, +1, +2, +3, +4;

-5 is read NEGATIVE 5; +5 is read POSITIVE 5;

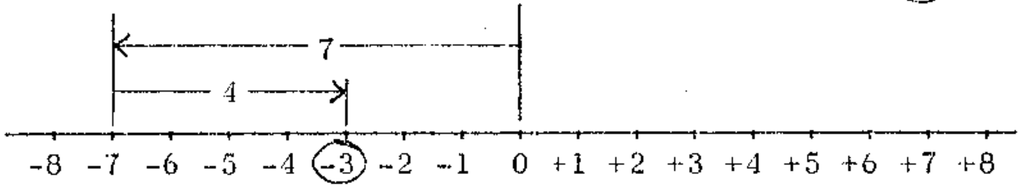
-20 is read NEGATIVE 20; +20 is read POSITIVE 20.

(-) Negative Direction (+) Positive Direction

D.

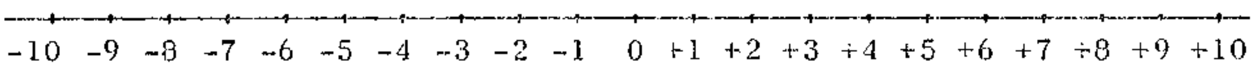


E.



F. 1. ${}^{+}3 + {}^{+}4 = {}^{+}7$ (refer to Entry D)

2. ${}^{-}7 + {}^{+}4 = {}^{-}3$ (refer to Entry E)



G. 1. ${}^{-}9 + {}^{-}5 =$ 3. ${}^{+}7 + {}^{-}6 =$

2. ${}^{-}8 + {}^{+}9 =$ 4. ${}^{+}2 + {}^{-}8 =$

H. ${}^{+}9$ or 9 are both positive; read POSITIVE 9

${}^{+}151$ or 151 are both positive; read POSITIVE 151

${}^{+}72$ or 72 are both positive; read POSITIVE 72

I. ${}^{+}9^{o}$--indicates an increase of 9 in temperature

${}^{-}9^{o}$--indicates a decrease of 9 in temperature

${}^{+}15$ lbs.--indicates an increase of 15 lbs. in weight

${}^{-}15$ lbs.--indicates a decrease of 15 lbs. in weight

${}^{+}\$150$--indicates a gain of \$150; ${}^{-}\$150$, a loss of \$150

TEST #3

Math Seven Date____________ Period______

Name______________________________ Teacher_______________________

SUBJECT: Adding Integers

Place your answer in the blank to the right of each problem.

1. $^{+}5 + {}^{+}11 =$ ____________
2. $^{-}9 + {}^{-}2 =$ ____________
3. $^{-}15 + {}^{+}4 =$ ____________
4. $^{+}5 + {}^{-}8 =$ ____________
5. $^{+}8 + {}^{-}5 =$ ____________
6. $^{-}5 + {}^{-}8 =$ ____________
7. $^{+}7 + {}^{+}7 =$ ____________
8. $^{-}6 + {}^{+}8 =$ ____________
9. $^{+}2 + {}^{-}3 + {}^{+}1 =$ ____________
10. $^{+}119 + {}^{-}2 =$ ____________
11. $^{-}8 + {}^{-}12 =$ ____________
12. $^{-}11 + {}^{+}11 =$ ____________
13. $^{+}54 + {}^{+}21 =$ ____________
14. $^{-}6 + {}^{+}18 =$ ____________
15. $^{-}18 + {}^{+}15 =$ ____________
16. $^{+}13 + {}^{-}19 =$ ____________
17. $^{+}91 + {}^{-}47 =$ ____________
18. $^{-}5 + {}^{-}22 =$ ____________
19. $^{-}200 + {}^{+}201 =$ ____________
20. $^{-}75 + {}^{+}75 =$ ____________

Lesson 4

AREA: INTEGERS

SKILL: Subtracting Integers

Today let's first recall a few things that we know about integers. Our counting numbers (1, 2, 3, 4, 5, ...) are not sufficient to help us work all types of problems. These numbers only give us a measure of distance, a measure of weight, a measure of height, and so forth. We do have a larger set of number which tell us direction as well as distance. This set of numbers is called the set of integers.

Look at Entry A on the instruction sheet. These integers are read negative 20, egative 3, positive 10, zero, positive 31, negative 15, and positive 1000. Remember from our last lesson on integers that these positive and negative "whole" numbers and zero can indicate many things. For example, a positive number can indicate a rise in temperature; a negative number can indicate a drop in temperature. A positive number can indicate an increase in weight; a negative number--a decrease. A positive number can indicate a profit in a business; a negative number--a loss in business.

The sum of two or more integers can easily be found by taking an imaginary trip along the number line. Look at

Entry B (1) on your instruction sheet. Follow me as we take our first trip. $(-3 + {}^{+}5)$. We start at 0. We go 3 miles in the negative direction and stop at -3 on the number line. Then we go 5 miles in the positive direction. (Pause) We are now at +2 on the number line. Therefore, ${}^{-}3 + {}^{+}5 = {}^{+}2$.

Now work B (2) and B (3) by yourself. Write your answers on the instruction sheet. (Pause)

Let's check your answers. ${}^{-}15 + {}^{-}3 = {}^{-}18$ is the answer for B (2). For B (3), we start at 0, go 3 miles in the positive direction, and end up at ${}^{+}3$ on the number line. Next, we go 2 miles in the negative direction. We are now at ${}^{+}1$. Then we go 2 miles in the positive direction and end up at ${}^{+}3$ on the number line. Therefore, ${}^{+}3 + {}^{-}2 + {}^{+}2 = {}^{+}3$.

Now that we are all experts on addition of integers, let's tackle subtraction of integers. The opposite of adding 4 to some number is taking away 4, or rather, subtracting 4. Addition and subtraction are opposite operations. Subtracting ${}^{+}4$ from some number is the opposite of adding ${}^{+}4$ to that number. Let's take a look at your number line and see how subtraction works. Look at Entry C on the instruction sheet. ${}^{+}4 + {}^{+}3$ says to start at 0 and go first 4 miles in the positive direction. Move your pencil on the number line from 0 to ${}^{+}4$. Then move 3 more units in the positive direction. Do this with your pencil. We are at ${}^{+}7$. Therefore, ${}^{+}4 + {}^{+}3 = {}^{+}7$. Now let's subtract. $({}^{+}4 - {}^{+}3)$. We start at 0 and go first

4 units in the positive direction. Since subtraction is the opposite of addition, we want to now do the opposite of moving 3 units in the positive direction; so move 3 units in the negative direction. We end up at $^{+}1$. Therefore, $^{+}4 - {}^{+}3 = {}^{+}1$.

Let's take some more examples. Look at Entry D (1) Move 6 units in the negative direction, starting at 0. (Refer to the number line in Entry B.) We are now at -6. Now do the opposite of moving 2 units in the positive direction--move 2 units in the negative direction. ($^{-}6 - {}^{+}2 = {}^{-}8$).

Listen carefully as you look at Entry E. An easy rule for the subtraction of integers is this: we can change subtraction to addition _if_ we also change the direction sign of the subtrahend, the number that follows the minus sign. Entry E (1). Change the subtraction sign to addition, but also change the negative sign to a positive sign. $^{-}5 - {}^{-}3$ is equivalent to $^{-}5 + {}^{+}3$. In Entry E (2), change subtraction to addition. Change $^{-}3$ to $^{+}3$. Now, $^{+}8 + {}^{+}3 = {}^{+}11$.

On E (3), work the problem on your paper as I give you the instructions. Change the subtraction sign to an addition sign. Change the sign of the subtrahend. Add those two numbers. Use your number line (Entry B) to help you if you need it. (Pause) Your new problem should read, $^{-}1 + {}^{+}6$. The answer is 5. Therefore, $^{-}1 - {}^{-}6 = {}^{+}5$.

Now quickly work the problems in Entry F. (Pause)

Let's check your answers. F (1). $^{-}4 - {}^{-}6$. Change subtraction to addition and change the sign of the subtrahend. The problem should now read, $^{-}4 + {}^{+}6 = {}^{+}2$.

F (2). $^{+}4 - {}^{-}4$. Change subtraction to addition and change the sign of the subtrahend. The problem now reads $^{+}4 + {}^{+}4 = {}^{+}8$. F (3). $^{-}5 - {}^{+}1$. Change to $^{-}5 + {}^{-}1 = {}^{-}6$. F (4). $^{+}5 - {}^{-}1$ is changed to $^{+}5 + {}^{+}1 = {}^{+}6$. You will now take a short test over this lesson.

INSTRUCTION SHEET #4

SKILL: Subtracting Integers

As you hear the lesson, notice the examples as they are referred to.

A. Examples of integers: -20, -3, $^{+}10$, 0, $^{+}31$, $^{-}15$, $^{+}1000$

($^{-}20$--read negative 20)

($^{+}10$--read positive 10)

(-) Number Line (+)

B. -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5 +6 +7 +8 +9 +10

1. $^{-}3 + {}^{+}5 = {}^{+}2$
2. $^{-}15 + {}^{-}3 =$
3. $({}^{+}3 + {}^{-}2) + {}^{+}2 =$

C. Contrast

1. $^{+}4 + {}^{+}3$

   $^{+}4 + {}^{+}3 =$ ______

2. $^{+}4 - {}^{+}3$

   $^{+}4 + {}^{-}3 =$ ______

D. $^{-}6 - {}^{+}2$

$^{-}6 + {}^{-}2 = {}^{-}8$

E. 1. $^{-}5 - {}^{-}3 = {}^{-}2$

$^{-}5 + {}^{+}3 = {}^{-}2$

2. $^{+}8 - {}^{-}3 =$

$^{+}8 + {}^{+}3 = {}^{+}11$

3. $^{-}1 - {}^{-}6 =$ ______

F. 1. $^{-}4 - {}^{-}6 =$ ______

2. $^{+}4 - {}^{-}4 =$ ______

3. $^{-}5 - {}^{+}1 =$ ______

4. $^{+}5 - {}^{-}1 =$ ______

TEST #4

Math Seven Date__________ Period________

Name______________________________ Teacher______________________________

SUBJECT: Subtracting Integers

Place your answers in the spaces provided.

1. $^{-}3 - ^{-}7 =$ ________

2. $^{-}7 - ^{-}3 =$ ________

3. $^{+}3 - ^{-}7 =$ ________

4. $^{-}3 - ^{+}7 =$ ________

5. $^{-}5 - ^{-}1 =$ ________

6. $^{+}15 - ^{+}6 =$ ________

7. $^{+}20 - ^{-}100 =$ ________

8. $^{-}13 - ^{+}2 =$ ________

10. $^{-}23 - ^{-}2 =$ ________

10. $0 - ^{-}1 =$ ________

11. $^{+}2 - ^{+}5 =$ ________

12. $^{-}11 - ^{-}7 =$ ________

13. $^{-}15 - ^{+}17 =$ ________

14. $^{+}38 - ^{+}38 =$ ________

15. $0 - ^{+}91 =$ ________

16. $^{-}17 - ^{+}6 =$ ________

17. $^{+}25 - ^{+}71 =$ ________

18. $^{-}14 - ^{-}9 =$ ________

19. $^{-}3 - ^{+}1 =$ ________

20. $^{-}200 - ^{-}200 =$ ________

Lesson 5

AREA: PROPERTIES OF THE OPERATIONS OF ARITHMETIC

SKILL: Understanding and Use of the Distributive Property

Listen carefully to the following lesson on Distributive Property. There will be no comments made nor questions asked until the test papers, which will be handed out immediately after the lesson presentation, have been collected.

Just as there are laws that govern our universe, such as the law of gravity, so there are certain laws or properties that govern a system of numbers. We have been using some of these laws or properties almost without realizing that we were doing so. Let's examine a typical problem. Look at the instruction sheet you were handed. Consider Example 1, which is a multiplication problem. You are probably accustomed to thinking, "three 3's are nine" and writing down "9." Then "three 1's are three" and writing the 3 to the left of 9--which is correct. However, the problem may be looked at in another way. Thirteen could be re-written as ten plus three--so the problem is then one of multiplying three by ten plus three. Three tens are thirty, and three three's are nine; then thirty plus nine is thirty-nine. This law or property is called the DISTRIBUTIVE PROPERTY.

Let's consider another problem--Example 2. In finding the perimeter of the top of a desk, Jim measured the length of each side in feet and found the measurements as shown. Then he found the perimeter in feet by finding the sum-- 5' plus 3' plus 5' plus 3' is 16'. Bob said he thought that this was all right but it was more work than was necessary. He said he would add 5' and 3' and multiply the sum by 2. Do you think this will give the same answer as Jim's problem? She said she thought it would be better to multiply 5' by 2 and 3' by 2 and then add these two products. Will the result be the same as Jim's and Bob's? You can see that it is. Therefore, we may write 2(5' + 3') = (2x5') + (2x3') which is 10' + 6' which is 16'. This problem is also an illustration of the DISTRIBUTIVE PROPERTY.

We find that the distributive property makes multiplying in some problems easier. Consider Example 3 which is a whole number times a mixed number. Using fraction form we write 12¼ as $\frac{49}{4}$ which is multiplied by 8. Eight forty-nine's are 392 and one four is 4; then 392 divided by 4 is 98. Let's see if the result is the same when we use the distributive property. Since 12¼ is the same as 12 plus ¼, we may use the distributive property and multiply (8x12) and add that to (8x¼). Eight twelves are 96 and eight fourths are 2-- then 96 + 2 = 98. The distributive property follows a definite pattern. Notice that there is only one multiplier and two (or sometimes more) addends. Follow the pattern in Example 4 and try to work exercises (a) through (f). (Pause)

Now compare your answers with those listed beneath as I read them to you. (Refer to answers.)

Just as there may be dangerous results because of the law of gravity for one who jumps from a ten-story building, there will be incorrect results for problems when you try to apply the distributive property when its use is not appropriate. Please take note that I am about to point out the DANGER signs or examples when the distributive property does not apply.

Consider Example 5 on the instruction sheet. You come across many times problems in which you multiply a mixed number by a mixed number. Some students think that you may multiply (4x3) and (½x¼) and add. This does not give the correct answer. To find the correct answer, you should rewrite 4½ in fraction form as $\frac{9}{2}$ and 3¼ as $\frac{13}{4}$. Multiply numerators; multiply denominators and simplify. Of, you may prefer to write 4½ in decimal form as 4.5 and 3¼ as 3.25, then multiply. As you can see, the result is 14.625 which is the decimal for 14 5/8. Notice that the fraction and decimal forms both give the same result. And they are different from 12 1/8 -- the incorrect answer. Remember--to multiply a mixed number by a mixed number, change to either a fraction or decimal form. DO NOT try to use the distributive property. Look at the distributive property pattern in

Example 5. Can you see that (4½) x (3¼) is a pattern of (a+b) x (c+d) rather than (a+b) + (axc)? Notice that the signs are reversed.

Another problem that APPEARS to adapt itself to the distributive property but does not is like that shown in Example 6. When you are finding the area measure of a rectangle, you multiply the length by the width--that is, 3'2" by 2'2". Some students think that you may multiply 3' by 2' and 2" by 2". Notice that this does not fit the pattern (axb) + (axc), but rather, (a+b) X (c+d); the signs are reversed. To find the correct answer, you should rewrite 3'2" as 38" and 2'2" as 26", then multiply. The result, 988 square inches may be changed to square feet by dividing by 144, since there are 144 square inches in a square foot. The final result, 6 square feet and 124 square inches is correct.

Try to establish the distributive property pattern well in your mind--a(b+c) = (axb) + (axc), and use only when applicable.

Now, examine Example 7. Circle those problems which lend themselves to using the distributive property. (Pause) Check your answers as I read them. (Refer to answers.)

Follow the instructions on the test sheet which I shall hand to you. Raise your hand when you have finished and I will collect your papers.

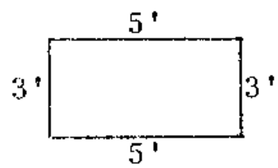
INSTRUCTION SHEET #5

SKILL: Understanding and Using Distributive Property

EXAMPLE 1

$$\begin{array}{r} 13 \\ \underline{\times\ 3} \\ 39 \end{array} \qquad 3(10+3) = (3\times10) + (3\times3) = 30 + 9 = 39$$

EXAMPLE 2



Jim's Idea

5' + 3' + 5' + 3' = 16'

Bob's Idea

(5' + 3') x 2 = ?

Sue's Idea

(5' x 2) + (3' x 2) = ?

10' + 6' = 16'

Then

2(5' + 3') = (2 x 5') + (2 x 3') = 10' + 6' = 16'

EXAMPLE 3

$$8(12\tfrac{1}{4}) = \frac{8}{1} \times \frac{49}{4} = \frac{392}{4} = 4\overline{)392} = 98$$

$$\begin{array}{r} 98 \\ 4\overline{)392} \\ \underline{36} \\ 32 \\ \underline{32} \end{array}$$

12¼ is 12 + ¼

$8(12 + \tfrac{1}{4}) = (8 \times 12) + (\frac{8}{1} \times \frac{1}{4}) = 96 + 2 = 98$

EXAMPLE 4

Pattern 1: $5(6+4) = (5 \times 6) + (5 \times 4)$

a.	$3(9 + 6) =$	$(3 \times 9) + (3 \times 6)$
b.	$12(6 + 2/3) =$	$(12 \times 6) + (12 \times 2/3)$
c.	$(5 + 4)3 =$	$(3 \times 5) + (3 \times 4)$ or $(5 \times 3) + (4 \times 3)$
d.	$(5\ 3/4)4 =$	$(4 \times 5) + (4 \times 3/4)$ or $(5 \times 4) + (3/4 \times 4)$
e.	$a(b + c) =$	$(a \times b) + (a \times c)$
f.	$c(d + e) =$	$c(d + e)$

D-A-N-G-E-R

EXAMPLE 5

$4\frac{1}{2} \times 3\frac{1}{4}$ $(4 \times 3) + (\frac{1}{2} \times \frac{1}{4}) = 12 + 1/8 = 12\ 1/8$ is incorrect

$$\frac{9}{2} \times \frac{13}{4} = \frac{117}{8} = 14\ 5/8$$

$4\frac{1}{2} = 4.5$

$3\frac{1}{4} = 3.75$

$$\begin{array}{r} 3.75 \\ \times\ 4.5 \\ \hline 1875 \\ 1500\ \ \\ \hline 16.875 \end{array}$$

DISTRIBUTIVE PROPERTY

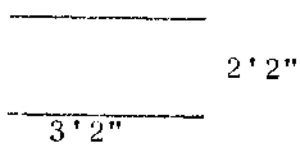
$$a(b + c) = (a \times b) + (a \times c)$$

Pattern of $(4\frac{1}{2}) \times (3\frac{1}{4})$

$(4 + \frac{1}{2}) \times (3 + \frac{1}{4})$

$(a + b) \times (c + d)$

EXAMPLE 6



3'2" x 2'2" = (3'2") + (2" x 2")

is incorrect

3'2" x 2'2" = 6 sq" + 4 sq"

38" x 26" = 988 sq"

```
       6 sq'  124 sq"
144)988
    864
    124
```

EXAMPLE 7

a. (4'3") x (5'7")

b. 2(3 1/2)

c. 4(6 + 3)

d. (5 2/3) x 6 1/2

e. a(b + c)

f. (4 x 7) + (4 x 8)

g. 8(3 1/3)

h. 5(4'2")

i. 8(7'3")

j. (4'5") x (8'3")

k. 5(4 + 2)

l. (8 x 7) + (8 x 4)

m. (6 x 3) + (6 x 2)

n. m(n + p)

TEST #5

Math Seven Date__________ Period_________

Name______________________________ Teacher__________________________

SUBJECT: Distributive Property

Circle the examples that illustrate the distributive property pattern.

1. (5'2" x (4'3")
2. 5(4 1/2)
3. 6(3+2)
4. (5x7) + (5x8)
5. (6½)3
6. 4(5+8)
7. a(b+c)
8. 6 1/2 x 3 2/3
9. 8(4 1/3)
10. m(n + o)
11. (3'3") x (4'7")
12. 3(4 2/7)

Use the distributive property and find the value of these:

13. 6(3+4) = __________
14. 5(3 1/2) = __________
15. 8(2 1/4) = __________
16. (6 1/4)2 = __________
17. 5(4+3) = __________
18. 10(90 + 4) = __________
19. 14(3 + 8) = __________
20. 7(3 5/7) = __________

Lesson 6

AREA: DECIMAL NUMERALS

SKILL: Rounding Decimals

Do you know how many miles light travels in a year? That is, what is a light-year? If you should look in a dictionary, you would see that light travels approximately 6,000,000,000,000 miles in a year. Notice the word approximately. I doubt that the distance is ever given exactly, because, first, it is not known exactly, and second, it is not practical to give such a quantity exactly. The process of stating numbers approximately is called rounding off.

Since you have been, or will be dealing with decimal numbers that are repeating, or that are too long for practical use, you need to know how to round off numbers to certain decimal places. Listen carefully and follow with your pencil as examples are explained on the instruction sheet. There will be no comments nor questions during this lesson. You will take a short test when we are finished.

Some of you may have been dealing with the value we call π. You may know that its fraction form is 3 1/7 and its decimal form is approximately 3.14. Why do we use the approximate value? Look at Example 1. In changing 1/7 to decimal form, we divide 1 by 7 and you can see that the decimal is point 142857 repeating--that is if we continued to annex zeroes and divide, the problem would NEVER end. Because we use 3 1/7 in calculating the circumference and area of a circle, it is not practical to use all six digits in the repeating pattern; so we "round off" the number to point 14. We have rounded off to two places--that is, we have two digits to the right of the decimal in the answer. Look at the number line on your sheet to see why .142857... was rounded off to .14 rather than .15. Perhaps you can see that .142857 lies between .1 and .2. Since .142857 may be thought of as .1 + .04 + .002 + .008, etc., it is certainly greater than .1, the first number in the sum. Also, .1 is less than .2; .14 is less than .20; .142 is less than .200; .1428 is less than .2000, etc. No matter how far the decimal is computed, what we get is always less than .200000... On the second number line you can see that .145 is half way between .14 and .15; so .142 is closer to .14 than .15 since it is to the left of .145, the halfway mark.

Suppose we wish an approximate decimal value for 2/7. Its decimal form is .285714 ... You can see that expressed as a sum, it is more than .2 but less than .3. Since .25 is halfway between .20 and .30, you can see on Number Line A that .285714 is between .25 and .30. If we rounded to one place, 2/7 would be approximately .30. Now look at Example

2 (B). If we rounded to two places, .285714 would be more than .28 and less than .29. Since .285 is halfway between .28 and .29, and .2857 is more than .285, it is closer to .29. What do you think .285714... rounded to three places would be? Look at Example 2 (C). Since it lies between .285 and .286, and .2857 is halfway, do you see that it is closer to .286?

This rounding is useful in estimating results. For instance, suppose we have to find the product in Example 3, 1.34 x 3.56. This would be approximately 1 x 4 = 4, or, if we wanted a little closer estimate, we could compute: 1.3 x 3.6 = 4.7 approximately.

Rounding is also useful when we are considering approximations in percents. If it turned out to be true that about 2 out of 7 families have dogs, it would be foolish to carry this out to many decimal places in order to get an answer in percent. We would usually just use two places and say that about 29% of all families have dogs, or we could round this still further and refer to 30%.

Now with the help of number lines drawn on your instruction sheet, see if you can round off some numbers. Look at Example 4, Number Line A. Below the number line are five numbers to be rounded to two places. That means the final answers will have only two digits to the right of the decimal. The "curly" equal sign you see is read as "approximately equal to." Number 1, $\frac{347}{1000}$ is located between .34 and .35. Do you see that it is more than .345 which is the halfway mark and is closer to .35 than .34?

Now, you do numbers 3, 4, and 5 while I wait for you. (Pause) For number 3, you should have .36. Number 4 is .39 and number 5 is .36.

Look at Number Line B of Example 4. See if you can round off numbers 1 through 5 while I wait. (Pause) The answers are as follows:

1. is .6
2. is .3
3. is .5
4. is .6
5. is .2.

Now without the number line, try to round off the numbers listed under Example 5. We will check your answers in a few minutes. (Pause)

1. $.375 \approx .37$	6. $.9734 \approx .97$
2. $.232 \approx .23$	7. $.8832 \approx .88$
3. $.5825 \approx .58$	8. $.1324 \approx .13$
4. $.357 \approx .36$	9. $.246 \approx .25$
5. $.8420 \approx .84$	10. $.258 \approx .26$.

Now you are ready to take a test on rounding decimals to one or two places. Raise your hand when you are finished and the teacher will take your paper.

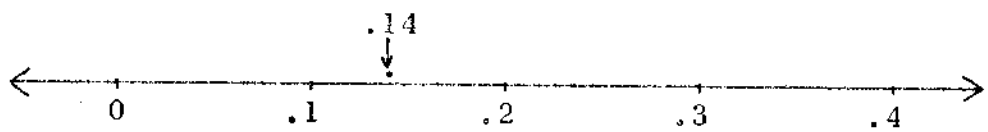
INSTRUCTION SHEET #6

SKILL: Rounding Decimals

EXAMPLE 1

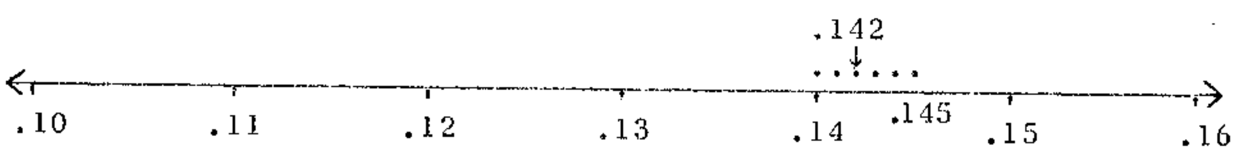
$\frac{1}{7}$ ⟶

```
      .142857...
   7)1.000000
      7
      30
      28
       20
       14
        60
        56
         40
         35
          50
          49
           10
```



Since .142857 may be thought of as .1 + .04 + .002 + .0008, etc., it is greater than .1.

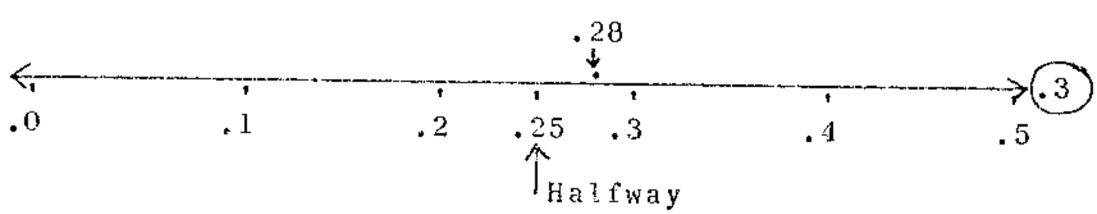
Also .1 is less than .2; .14 is less than .20; .142 is less than .200; .1428 is less than .2000, etc.



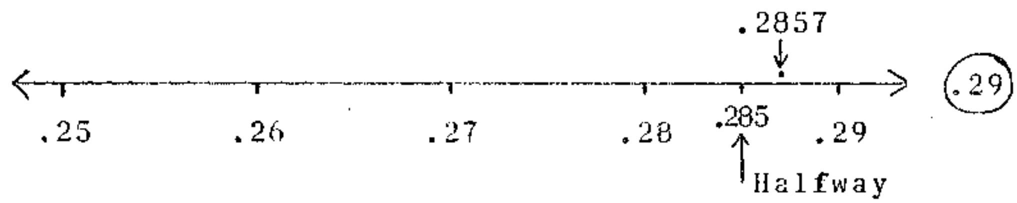
EXAMPLE 2

$\frac{2}{7} \approx$ .285714... and .2 + .08 + .005 + .007, etc. is greater than .2 but always less than .3.

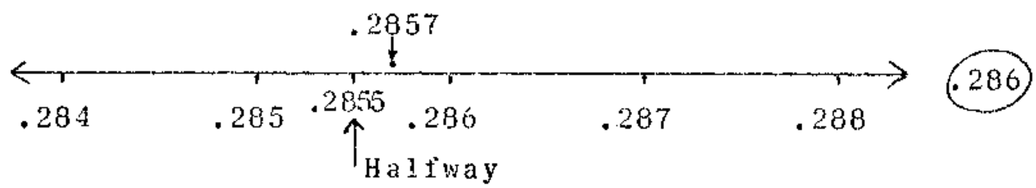
A.



B.



C.

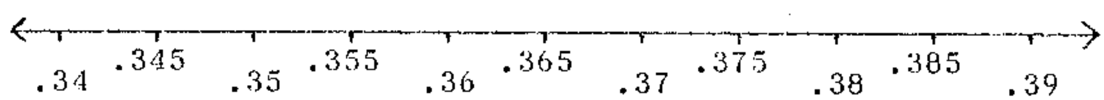


EXAMPLE 3 1.34 x 3.56

Estimated: 1 x 4 = 4 or 1.3 x 3.6 = 4.7 approximately

EXAMPLE 4

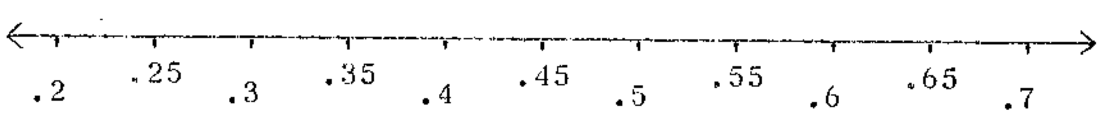
A.



Round to two places:

1. .373 ≈ ______
2. .437 ≈ ______
3. .361 ≈ ______
4. .388 ≈ ______
5. .357 ≈ ______

B.



Round to one place:

1. .57 ≈ ______
2. .28 ≈ ______
3. .473 ≈ ______
4. .634 ≈ ______
5. .2345 ≈ ______

EXAMPLE 4

Round to two places:

1.	.375 ≈ ______	6.	.9734 ≈ ______
2.	.232 ≈ ______	7.	.8832 ≈ ______
3.	.5825 ≈ ______	8.	.1324 ≈ ______
4.	.357 ≈ ______	9.	.246 ≈ ______
5.	.8420 ≈ ______	10.	.258 ≈ ______

TEST #6

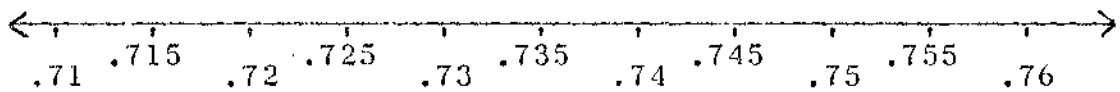
Math Seven Date______________ Period_______

Name______________________________ Teacher__________________________

SUBJECT: Rounding Decimals

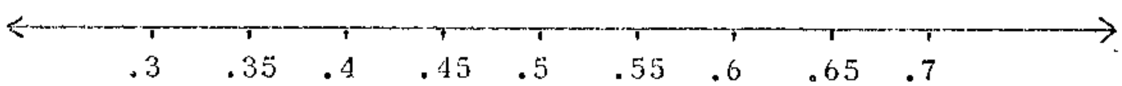
Using NUMBER LINE A, round these to two places.

A.



1. .717 ≈ _______
2. .731 ≈ _______
3. .7534 ≈ _______
4. .7278 ≈ _______
5. .713 ≈ _______
6. .758 ≈ _______
7. .761 ≈ _______
8. .7213 ≈ _______
9. .743 ≈ _______
10. .748 ≈ _______

B.



Using NUMBER LINE B, round off these to one place.

11. .37 ≈ _______
12. .57 ≈ _______
13. .453 ≈ _______
14. .32 ≈ _______
15. .673 ≈ _______

Without using a number line, round these to two places.

16. .578 ≈ _______
17. .432 ≈ _______
18. .2745 ≈ _______
19. .3832 ≈ _______
20. .172 ≈ _______

Lesson 7

AREA: RATIO AND PROPORTION

SKILL: Solving Proportion Problems

Listen carefully as I explain to you the meaning and use of ratios and proportions. There will be enough explanation given in this lesson so that you will learn a special way to solve proportions like those at the bottom of your guide sheet.

Remember that you are going to take a test over the material when the lesson is over; so follow along on the guide sheet as I talk to you.

First we must find out what the term RATIO means. On the instructional sheet you will see two groups or sets of balls. Count them. If we wish to show a comparison between the two sets of balls, we could say that there is a 4 to 12 correspondence between the sets. We are simply saying that there are 4 balls in the first set corresponding to the 12 balls in the second set. Incidentally, we could say also that there is a 1 to 3 correspondence between the two sets. Can you see why? We mean that there is one ball in the first set for every 3 balls in the second set. Couldn't we also say it is a 2 to 6 correspondence?

Another way we could express this correspondence is to say that there is a 4 to 12 ratio between the sets. This means the same thing as the expression, "4 to 12 correspondence." It is just another way of saying it. So, we can see that a ratio is simply a comparison between two sets.

Now look at the illustration B on your instruction sheet. Notice that there are 4 X's and 5 Y's. This would be a 4 to 5 correspondence, wouldn't it? Then the ratio of the number of X's to the number of Y's is 4 to 5. This could be written in any one of the three forms you see under the illustration on your guide sheet. Look at them: ... 4 to 5 ratio (4:5, which is read 4 to 5 ratio)... and 4/5. The most common form is the fraction form. It has one big advantage, it is easy to reduce the ratio to lowest terms because it is just like reducing any other fraction. On your guide sheet you will find several ratios given as a practice exercise. I will pause for a moment to let you write each of these ratios in the fraction form. Notice that the first problem is a 3 to 7 ratio. In fraction form this will be 3/7; so this would be your answer. Now, you do the rest of them. (Pause)

Your answers should be: (1) 3/7; (2) 9/14; (3) 7/3. In (3), keep it in fraction form rather than change it to 2 1/3. It is easier to use in proportion problems if it is still a fraction. (4) 15/25...Some of you may have noticed that this could be reduced to 3/5. Either answer will express the ratio, so either is correct. There will probably be some advantage in having it in reduced form, so 3/5 would be the best answer. (5) 6/18 is correct, but 1/3 is the best form. (6) 12/9...This can be reduced to 4/3, but keep it in ratio form rather than change it to 1 1/3 as you would it with other fractions.

Now, if you will remember that the fractions you see in each problem are ratios, you will know enough to understand the other word, PROPORTION. By definition, a proportion is a statement that two ratios are equal. The statement 3/4 = 6/8 is a proportion. In other words, a proportion says one fraction (or ratio) is equal to the other fraction (or ratio). All of the problems you will be working will be proportions. Of course, to be any kind of a problem, one or more terms in the proportion must be unknown. You can see some examples of simple proportion problems in illustration C on your guide sheet. You probably know enough about them that you can figure out what numbers the "n" represents. In problem 1, the answer is n=5 (1/3 = 5/15). In problem 2, the answer is n=3 (14/21 = 2/3). If the problem is easy, you can probably find the answer without much trouble. The method we are going to try now can make even the difficult problem easy.

Look at illustration D on your guide sheet. These problems are easy, I know. However, don't work ahead. The special method I want you to use has two steps. Read them with me: Cross-multiply, and divide...first, cross-multiply, and then second, divide. That's all. Look at problem 1 and I will show you what I mean. The first step in solving the problem 4/n = 6/12 is to cross multiply. Draw an X across the problem if it will help. You multiply 4 x 12 and 6 x n. These two products are equal to each other and this is why I have written 6n=48 as the first step in solving the problem. The second step is obvious. If we could get rid of the six we would have a statement "n" is, "whatever it is." We can get rid of the six if we do the inverse to both sides, in other words, if we divide by six. Forty-eight divided by six is 8; so 8 is the answer. n=8.

Try problem 2 with me. (3/8=n/12) First cross-multiply; 8xn = 3x12. You will put 8n = 36 for your first step in the solution. Second, divide by 8. Eight goes into 36 4½ times, so the answer is n=4½. You can show your answer as a decimal if you prefer. In the problems where there are decimals in the other numerals, the decimal answer would be preferable.

Look at problem 3. When we cross multiply we get .4n=16.0. Dividing by 14 we get the answer, n=40. If you will write your problems in the form I have used you will be less likely to get mixed up. Now I will give you a few moments to complete the other practice exercises on your guide sheet. (Pause)

Your answers are:

(4) n=3 3/5 (or, if you gave your answer in decimal form, n=3.6.

(5) n=28

(6) n=16.8

(7) n=44 4/5 or 44.8

You are now ready to take a test on this lesson. Remember the two steps in solving a proportion problem are first, cross multiply; and second, divide.

Raise your hand when you have finished the test and the teacher will take your paper.

INSTRUCTION SHEET #7

SUBJECT: Ratio and Proportion

A.

First Set	Second Set
0	0 0 0
0	0 0 0
0	0 0 0
0	0 0 0

4 to 12 correspondence

or 1 to 3 correspondence

or 4 to 12 ratio

or 1 to 3 ratio

B.

X X	Y Y Y
X X	Y Y Y

4 to 5 ratio

4:5 (read also 4 to 5 ratio)

$\frac{4}{5}$ (fraction)

C.

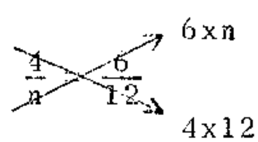
1. 3:7= ________
2. 9 to 14 ratio=______
3. 7:3= ________
4. 15 to 25 ratio=_____
5. 6:18 ratio=______
6. 12:9=________

D.

1. $\frac{4}{n} = \frac{6}{12}$

   $6n = 48$

   $n = 8$

2. $\frac{3}{8} = \frac{n}{12}$

3. $\frac{n}{5} = \frac{3.2}{.4}$

   $.4n = 16.0$

   $n = 40$

   $.4\overline{)16.0}$ = 40; 16; 0 0

4. $\frac{n}{6} = \frac{9}{15}$

5. $\frac{4}{n} = \frac{1}{7}$

6. $\frac{8.4}{7} = \frac{n}{14}$

7. $\frac{5}{7} = \frac{32}{n}$

TEST #7

Math Seven Date____________ Period_______

Name____________________________ Teacher_________________________

SUBJECT: Ratio and Proportion

Express each of the following ratios as a fraction:

1. 13 to 17 ratio = ________

2. 12 to 18 ratio = ________

3. 5 : 8 = ________

4. 20 : 15 = ________

5. 12 to 9 ratio = ______

Find the value of "n" in each of the following proportions:

6. $\frac{n}{6} = \frac{16}{96}$ n = _____

7. $\frac{8}{9} = \frac{n}{63}$ n = _____

8. $\frac{3}{n} = \frac{57}{95}$ n = _____

9. $\frac{n}{5} = \frac{3.4}{8.5}$ n = _____

10. $\frac{2}{3} = \frac{n}{8.1}$ n = _____

11. $\frac{21}{9} = \frac{14}{n}$ n = _____

12. $\frac{9}{16} = \frac{6}{n}$ n = _____

13. $\frac{n}{6} = \frac{9}{15}$ n = _____

14. $\frac{n}{8} = \frac{6}{16}$ n = _____

15. $\frac{5}{8} = \frac{n}{15}$ n = _____

16. $\frac{7}{9} = \frac{12}{n}$ n = _____

17. $\frac{n}{8} = \frac{13}{6}$ n = _____

18. $\frac{21}{5} = \frac{4.2}{n}$ n = _____

19. $\frac{14}{49} = \frac{n}{7}$ n = _____

20. $\frac{4}{n} = \frac{1}{7}$ n = _____

Lesson 8

SUBJECT: SCIENTIFIC NOTATION

SKILL: Multiplication Using Scientific Notation

Most of the problems we give you to work in class involve small numbers to make the solution easy and to make the principles involved more obvious. In actual practice, there will be many very large numbers we will have to work with. When you get home, look through the newspaper and see how many numbers you can find in the news which are in the billions or higher. When we study some of the physical sciences it is quite often necessary to multiply and divide by these huge numbers. Because of this, someone worked out a new way to write these large numbers so that they will be easier to compute. It is called SCIENTIFIC NOTATION.

It will be important for you to know how to use scientific notation next year because you will use it in your science class. Listen carefully and I will explain to you how to put a number into scientific notation and then how to multiply numbers which are in scientific notation. Remember that you will take a test over this lesson when you have listened to the lesson. There will be no opportunity for questions or comments until the test is completed.

In any good dictionary you will find scientific notation defined as "the product of a number between one and ten and a power of ten." Here's an example: 2×10^3. Notice that two is a number between one and ten, and that 10^3 is a power of ten. The amount represented by 2×10^3 is the product, 2 times 10^3. Since 10^3 means multiply ten times itself three times, we have $2 \times 10 \times 10 \times 10$ which is 2000.

There is a shorter way to determine the value of a number written in scientific notation. You used it in a previous lesson. To multiply by some power of ten, simply move the decimal to the right the number of times given by the exponent. So, to determine the value for 2×10^3 we need only move the decimal to the right three places to get the answer. Two is a whole number, so every time we move the decimal to the right, we will have to annex a zero. Two-zero-zero-zero is our answer, 2000.

Try the next example, 3.4×10^5. We begin with 3.4 and move the decimal to the right five places since it is 10^5. This gives us three-four-zero-zero-zero-zero, which is 340,000. All we have to do to find the value of the number in scientific notation is to move the decimal to the right the number of times given by the exponent of ten. Look at illustration "A" and try finding the values of the numerals there. In problem one, we would first write the number 7, which is a whole number, and then we would move the decimal to the right three places. Annex as many zeros as necessary. The answer is 7000.

In number two, first write 6.72 and then move the decimal to the right seven places since it is 10^7. This gives 67200000 which is read 67,200,000. Now solve the other problems in illustration "A." (Pause) Your answers are 26,000 for problem 3; 840,000 for problem 4; and 4,000,000 for problem 5.

Now look at illustration "B" on your guide sheet. To put a number into scientific notation, we must make it into a product of a number between one and ten and some power of ten. First, can you figure out any way to change 6000 into a number between one and ten? If we could move the decimal so that it would be just after the first digit, the 6, we would have 6.000, which is 6 and no tenths, no hundreds, and no thousandths. Since the zeros now mean nothing to the number, we usually drop them off, and six is the number between one and ten that we want. What would we have to multiply 6 by to get the number back to 6000? Since 6 x 1000 is 6000, and since 10 x 10 x 10 or 10^3 is one thousand, then 6 x 10^3 is the scientific notation form for 6000.

Actually we don't have to go to that much trouble to put a number into scientific notation. All we need to do is move the decimal so that it will be right after the first digit and the result will be a number between one and ten.

Now count the places you moved the decimal and it will be 10 to that power. Try this method on problem one, illustration "B." First move the decimal to just past the first digit as I have shown. This means we move it over three places and our answer for problem one is 6×10^3.

Solve problem 2 the same way. First move the decimal so that it will be right after the 5 because 5.3 is a number between one and ten. We had to move the decimal two places to put it there so it would be 10^2. Our answer then is 5.3×10^2. Now try the other three problems. Read the part in parentheses if you have trouble. (Pause) Your answers should be 2.7×10^6 for problem three; 6.75×10^4 for problem four; and 3×10^6 for problem 5.

The major reason for using scientific notation is to make it easier to multiply very large numbers. To multiply two numbers which are in scientific notation, we must consider each part of the numeral separately. In illustration "C" there are several multiplication problems using scientific notation. Look at problem one, $(2 \times 10^3) \times (4 \times 10^5)$. To solve this problem, first multiply the 2 and the 4 together. These are regular decimal numerals so we must multiply them together $(2 \times 4 = 8)$. This is the first part of our answer--- 8 x some power of ten, which we have yet to find. To multiply the powers of ten, we do something you probably never dreamed could be done. To multiply powers, we ADD the exponents! That's all! Then $10^3 \times 10^5 = 10^8$. Our answer, then, is 8×10^8. Try this on problem 2 $(3.1 \times 10^6) \times (.4 \times 10^9)$. First, multiply 3.4 x .4. This gives us 1.24. Now multiply the powers $10^6 \times 10^9$ by simply adding the expondnts (10^{15}). So we have the answer 1.24×10^{15}. By the way, if you are interested, this answer written the regular way is 1,240,000,000,000,000 which is read one quadrillion, 240 trillion! Numbers this large are much more common than you might imagine, but we usually keep them in scientific notation. Now you try the other three problems on the guide sheet.

First, multiply the decimal numerals and then add the exponents. (Pause) Your answers are 6×10^9 for problem 3; 7.8×10^5 for problem 4; and 6.5×10^9 for problem 5.

You are now ready to take a test on this lesson. When you have finished, raise your hand and the teacher will take your paper.

INSTRUCTION SHEET

SUBJECT: Scientific Notation

Scientific Notation is "the product of a number between one and ten and a power of ten." Examples: $2x10^3$; 3.4×10^5;

$2 \times 10^3 = 2x10x10x10 = 2000$; | 2.000 |

$3.4 \times 10^5 = 340{,}000$ | 3.40000 |

A. Find the value of each numeral below:

1. 7×10^3 = ______________ 7.000
2. 6.72×10^7 = ______________
3. 2.6×10^4 = ______________
4. 8.4×10^5 = ______________
5. 4×10^6 = ______________

B. Change into scientific notation:

| 6000. = 6×10^3 |

Move the decimal to make it a number between 1 and 10. Count the places you moved the decimal and it is 10 to that power.

1. 6000= ______________
2. 530 = ______________
3. 270,000= ______________
4. 67,500 = ______________
5. 3,000,000= ______________

C. Multiply using Scientific Notation. You may leave the answer in scientific notation.

| 4x2=8
$10^3 x 10^5 = 10^8$ |

Multiply the decimal numerals together, to multiply powers (with same base) just add the exponents together.

1. $(2x10^3) \times (4x10^5)$= ________
2. $(3.1x10^6) \times (.4x10^9)$= ________
3. $(1x10^4) \times (6x10^5)$ = ________
4. $(1.3x10^2) \times (6x10^3$= ________
5. $(1.05 \; x10^7) \times (6.2x10^2)$=

TEST #8

Math Seven Date____________ Period_______

Name__________________________ Teacher________________________

SUBJECT: Scientific Notation

I. What amount is represented by each of the following numerals?

1. $3 \times 10^2 =$ __________
2. $7 \times 10^5 =$ __________
3. $5.2 \times 10^4 =$ __________
4. $4.325 \times 10^6 =$ __________
5. $9 \times 10^7 =$ __________
6. $5.53 \times 10^1 =$ __________
7. $7.3 \times 10^5 =$ __________

II. Write each amount below in Scientific Notation:

8. 74,000 = ________________
9. 6,350 = ________________
10. 20,000 = ________________
11. 230 = ________________
12. 905,000 = ________________
13. 6,400 = ________________

III. Multiply using Scientific Notation. Answers may be left in Scientific Notation.

14. $(2 \times 10^2) \times (4 \times 10^4) =$ ____________________
15. $(1 \times 10^6) \times (3.2 \times 10^4) =$ ____________________
16. $(3 \times 10^4) \times (3 \times 10^4) =$ ____________________
17. $(3 \times 10^7) \times (2 \times 10^6) =$ ____________________
18. $(9 \times 10^2) \times (1 \times 10^8) =$ ____________________
19. $(3.0 \times 10^4) \times (2.2 \times 10^3) =$ ____________________
20. $(1.2 \times 10^8) \times (1.2 \times 10^6) =$ ____________________

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