To the Graduate Council:

I am submitting herewith a dissertation written by Sharon JoAnne Thomasson entitled "The Effects of the Graphing Calculator on the Achievement and Attitude of College Students Enrolled in Elementary Algebra" I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Education.

Donald J. Dessart, Major Professor

We have read this disseration and recommend its acceptance:

Accepted for the Council:

Associate Vice Chancellor and
Dean of the Graduate School

THE EFFECTS OF
THE GRAPHING CALCULATOR
ON
THE ACHIEVEMENT AND ATTITUDE
OF COLLEGE STUDENTS ENROLLED IN
ELEMENTARY ALGEBRA

A Dissertation

Presented for the

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Degree

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Sharon JoAnne Thomasson

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DEDICATION

To my family

ACKNOWLEDGMENTS

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ABSTRACT

The purpose of this study was to investigate the effects of various treatments using graphing calculators on achievement and attitude of college students enrolled in elementary algebra.

This study, a true-experimental pretest-posttest control group design, was conducted with 66 students enrolled in an elementary algebra course at Pellissippi State Technical Community College. The students were randomly assigned to the groups. Two instructors each taught three classes, one of each mode of instruction. The three modes of instruction were: 1) total calculator use, including instructor use as demonstrations and student use at all times including tests, 2) partial calculator use, including instructor use as demonstrations and student use in class only but not on tests, and 3) no calculator use by instructor or student.

The null hypotheses tested were that there were no significant differences among the means of groups on: 1) algebraic achievement, 2) composite attitude, 3) mathematical attitude, and 4) calculator attitude.

Pretest scores were analyzed to determine comparability of achievement and attitudes of groups prior to the treatment. Scores on posttests were used to determine

achievement and attitudes of groups after the treatment. The posttest scores were used to test the hypotheses.

Since the groups were found to be comparable before the treatments, the means of the posttests were analyzed by an analysis of variance. When significant differences were found, Scheffé's post hoc comparisons were performed.

The results indicated that students in the total calculator use group performed higher on posttests of achievement. However, this was not determined to be significant at the .05 level. No significant differences were found in composite attitude or mathematical attitude of the groups. A positive calculator attitude change was found in the total calculator use group. At the .05 level, the mean of the calculator attitude scores for the total calculator use group was found to be significantly higher than the non-calculator group's mean.

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Chapter I

Introduction

Availability of technology has resulted in mathematics curriculum changes. According to the _Curriculum and Evaluation Standards for School Mathematics_ (_Standards_) published by the National Council of Teachers of Mathematics (NCTM), calculations and graphing will assumably be less difficult with this new technology. The _Standards_ assumes that in grades 9-12, scientific calculators with graphing capabilities will be available to all students at all times. Along with graphing calculators, a computer will be available at all times in every classroom for demonstration purposes. (NCTM, 1989, p. 124)

In mathematics, a graphing calculator is a major component of today's technology. It combines the capabilities of a scientific calculator with the screen of a computer. The screen not only displays graphics but also displays numbers and symbols that are keyed into the calculator. The calculator is also programmable. Therefore, the graphing calculator may be ideal for the NCTM _Standards_ not only for calculator use but also as a substitute for computer demonstrations when using it with an overhead display. A graphing calculator overhead model is only a fraction of the cost of a computer and overhead display.

Background of the Problem

The use of calculators and computers in education has been debated since the early 1970's. However, research reveals that students using these technologies perform as well or better on tests of achievement in mathematics than non-users. With this research, the arguments should be one-sided.

Many educational groups have studied the use of calculators and computers in schools. Among these are: The National Advisory Committee on Mathematical Education (NACOME), The National Council of Teachers of Mathematics (NCTM), the National Institute of Education (NIE), and the National Science Foundation (NSF). Each of these educational groups has stated policies for the use of technology in the classroom. NACOME recommended the use of calculators in the mathematics classroom as early as 1975.

Research on technology use began in the 1970's and is still an on-going process. Calculator use research began in the mid 70's and began being replaced in the early 80's with research on computer-use. Research on the latest technology, the graphing calculator, is now beginning to appear in the literature.

The Problem

Colleges that have open-door policies, thus allowing the enrollment of underprepared students, must provide courses to prepare those students for college-level work. In mathematics, these developmental sequences usually consist of elementary algebra and intermediate algebra. The primary goal of the developmental sequence is to prepare students to perform as well or better in their first college course as the students who do not need a developmental course.

The bulk of research on technology use has been in grades K-12. As K-12 classroom teachers follow the recommendations from this research, the college student will be coming from classrooms which used technologies. Therefore, the problems investigated in this study center around the following questions concerning college students:

1) Does the use of graphing calculators in a developmental algebra class result in a greater achievement than in a class where the calculators are not used?

2) If a significant difference in achievement is found, is the graphing calculator more effective when used with some specific algebraic topics than others?

3) Does the use of graphing calculators on tests result in higher test scores?

4) Does the use of graphing calculators in a developmental algebra classroom help students to build positive attitudes toward mathematics and calculators?

The Purpose

This study compared three treatments used in the elementary algebra course:

1) Total calculator use, including instructor use as demonstrations and student use at all times including on tests (TC).

2) Partial calculator use, including instructor use as demonstrations and student use in class only but not on tests (PC).

3) No calculator use by instructor or student (NC).

The purpose of the research was to determine the effect of the three treatments on achievement and attitude of the students.

Need of the Study

The preliminary review of literature found a significant amount of evidence that calculators positively affect the achievement of students. However, this research is primarily concerned with students in grades 1-8. Little research has been completed on the effects of the graphing calculator with older students' achievement and attitude in algebra or higher level courses. There appears to be little research on computer demonstrations and no available research on the overhead graphing calculator demonstrations in the mathematics class and their effects on achievement or attitude. This study will answer the following questions: 1) What is the effect on achievement and attitude of students when using graphing calculator demonstrations in the class and allowing students unrestricted use of the calculators? 2) What is the effect on achievement and attitude of students when using graphing calculator demonstrations in the class and allowing in-class student use of the calculators?

Assumptions

In order to measure students' attitudes, an assumption needs to be made that students will respond honestly. This assumption is accepted because students will see no reason to respond falsely if they are informed that their responses will in no way affect their course evaluation. Also, if the students feel that their responses will have an effect on the way the course will be taught in the future, they will have an incentive to respond truthfully.

Delimitations

The sample of students involved in this study was chosen from DSM 0830, which met during the day (8:00 a.m. - 5:00 p.m.) and at the main campus of Pellissippi State Technical Community College in Knoxville, Tennessee. Only data from students who completed the entire course were used.

Definitions

The following definitions of terms will be used in this study:

1. Achievement. Achievement is the acquisition of skills and is measured by a test score. (Tests consist of items requiring computation, conceptualization, and application.)

2. Attitude. Attitude is a learned predisposition to respond in a consistently favorable or unfavorable manner with respect to a given object. (Fishbein and Ajzen, 1975)

3. Computational algorithm (algorithm). A computational algorithm is a rule or procedure for solving a mathematical problem that frequently involves repetition of an operation.

4. Conceptualization. Conceptualization is the process of generalizing abstract ideas from particular instances.

5. NC. NC is a treatment used in this study involving no calculator use by instructor or student.

6. PC. PC is a treatment used in this study involving partial calculator use, including instructor use as demonstrations and student use in class only but not on tests.

7. Symbolization. Symbolization is the act of using symbols to represent mathematical operations, quantities, and relations.

8. TC. TC is a treatment used in this study involving total calculator use, including instructor use as demonstrations and student use at all times including on tests.

Hypotheses

In this study the following null hypotheses will be tested at a five percent level of significance:

H1: No significant differences exist in the means of algebraic achievement for students among the following groups:
1) total calculator use (TC),
2) partial calculator use (PC),
3) no calculator use (NC).

H2: No significant differences exist in the means of composite mathematics and calculator attitude scores among the following groups:
1) total calculator use (TC),
2) partial calculator use (PC),
3) no calculator use (NC).

H3: No significant differences exist in the means of mathematical attitude scores among the following groups:
1) total calculator use (TC),
2) partial calculator use (PC),
3) no calculator use (NC).

H4: No significant differences exist in the means of calculator attitude scores among the following groups:
1) total calculator use (TC),
2) partial calculator use (PC),
3) no calculator use (NC).

Organization of the Study

This study is organized into five chapters.

Chapter I introduces the study and contains the following components: background of the problem, statement of the problem, purpose of the study, need of the study, assumptions, delimitations of the study, definitions, hypotheses, and organization of the study.

Chapter II contains a review of literature relevant to the study. Effects on achievement and attitude for each of the following technologies are included: graphing calculators, computers, and calculators.

Chapter III presents the methods and procedures for evaluation used in the study and contains the following topics: setting, subjects, design, equipment used, instructional material, instructional strategies, and instruments of the study.

Chapter IV includes an analysis of data organized by hypotheses being tested, i.e., hypothesis 1, 2, 3, and 4.

Chapter V provides a summary of the study, conclusions, limitations, and recommendations for future research.

Chapter II

Review of Literature

This study will examine the effects of graphing calculators on the achievement and attitude of college students enrolled in elementary algebra. As graphing calculators are a relatively new technology, few studies have been completed on this topic. However, the graphing calculator combines the capabilities of a scientific calculator with the screen and memory of a computer. Therefore, the review of literature related to this study includes studies in:

1) Graphing calculator use in mathematics instruction,
2) Computer use in mathematics instruction,
3) Calculator use in mathematics instruction.

In reviewing each of these areas for effects on achievement and attitude, the studies are divided into three levels of mathematics:

1) Arithmetic,
2) Algebra through precalculus,
3) Calculus through college mathematics.

A survey of related literature was conducted with a computerized ERIC search for journal articles. A manual search of Dissertation Abstracts International was completed. Personal letters were also sent to individuals involved in current research in order to receive additional studies which were not in print.

Graphing Calculators

The review of literature on graphing calculators revealed classroom applications of the graphing calculator but did not find completed studies on its effectiveness. A variety of uses for levels of mathematics from algebra through calculus were reported by Demana and Waits (1989), Dion (1990), Foley (1990), Ruthven (1989), Waits and Demana (1989a, 1989b), and Vonder Embse (1990).

Effects on Achievement

No studies were found using graphing calculators on the arithmetic level. This level would not need the capabilities of the graphing technology. Therefore, studies on this level are listed under calculators.

Three studies were found using graphing calculators in the algebra through precalculus range of courses. Two studies, Ruthven (1990) and Vazquez (1990) investigated the effects of the use of graphing calculators on achievement.

Ruthven (1990) reported preliminary results of a 2-year study conducted in England with six groups of upper secondary students. After the first year of the study, students performed significantly superior on symbolization items when using a graphic calculator as a standard mathematic tool than students of similar background who did not have access to graphic calculators.

Vazquez (1990) conducted a study on the effect of graphing calculators on students in two intact eighth grade classes in the learning of graphing linear functions. There was no significant difference in the mathematical achievement in linear functions. However, students in the graphing calculator group did homework more efficiently and showed significant gains in spatial visualization skills.

Melin (1990) provided the only study found on the calculus level. His study was on the effect of achievement in the learning of derivatives. Two intact sections of calculus were studied. It was found that students with access to calculators performed significantly better on the selected calculus topics than students without calculator access.

In all studies on both levels, the use of the graphing calculator in mathematical instruction improved student skills. However, only three studies were found and two of these, Vazquez (1990) and Melin (1990), were of a limited nature using small samples and very defined mathematical skills.

Effects on Attitude

Two studies, Vazquez (1990) and Dunham (1990), researched the effects of the graphing calculator on student attitude. Vazquez (1990) researched mathematical attitudes, while Dunham (1990) researched calculator attitudes. Both of these studies dealt with students in the algebra through precalculus level.

Vazquez (1990) administered a pre- and post- attitude survey and found that eighth graders using graphic calculators had significant gains in attitude toward calculators. However, there was no significant difference between groups in attitude toward mathematics.

Dunham (1990) studied precalculus students at a four year university where the students used graphing calculators extensively. She found students made significant performance gains after instruction. In interviewing the students, males referred to the calculators as computers and spoke of "playing" with the "toys." Females were less likely to explore the capabilities of the calculator but became comfortable users. Some students expressed "guilt" in relying on the calculator or felt that they were "cheating."

As only two studies were found on effects of graphing calculator on student attitudes, no conclusions can be drawn about their usefulness. More studies need to be performed and analyzed in this area.

The limited amount of literature on graphing calculators necessitated the need to further explore other related technological uses in the mathematical classroom. Computers have similar graphic capabilities when used with software packages. Also, software and programs are available for other calculator uses.

Computers

Mathematics classes use computers in a variety of ways. Among these are computer-assisted instruction (CAI), computer-enhanced instruction (CEI), and computer-managed instruction (CMI). CAI consists of computer uses of programs for mathematic tutorials and mathematic drill and practice. CEI uses computers to develop mathematical concepts by manipulation of the computer in programming, simulations, graphical representations, and actual calculations. CMI is a relatively new idea of using the computer to manage mathematic instruction.

CEI is closely related to the purposes of this study. Therefore, this review of literature will review the effects of CEI on achievement in mathematics, attitudes towards mathematics, and attitudes toward computers.

Effects on Achievement

Four studies were found on the arithmetic level. Of these, three studies found a positive significant gain in achievement for the students. Two studies favored students using computers and the other favored students not using computers. The fourth study found no significant difference in achievement for computer or non-computer users.

One study (Morgan, 1986) was conducted in an elementary classroom studying measurement estimation. The non-computer group performed better than the computer group.

Two studies revealed a positive result in favor for the use of computers. Foley (1986) reported effects on high school students in a 9th grade general mathematics classroom. The data revealed a positive significant difference in favor of the computer group. Payton (1988) studied students in a small university. Results of the study found a significant difference in favor of the experimental group in areas of graphs, relations, and functions.

Imboden (1986) studied the effects of CEI on low-achieving college students studying percents. No significant difference was found between groups at the end of the study.

On the level of arithmetic, results of CEI effects are mixed. Therefore, more studies are needed in this area to be able to summarize results into a comprehensive statement.

Five studies in the algebra through precalculus range of courses found no significant difference between computer and non-computer groups. Kent (1987) conducted a three-week study on computer effects on achievement related to functions and graphs with four classes. Even though no significant difference was found, a slight positive effect on achievement was suggested due to comparison between single classes instead of by groups. Payne (1989) found no significant difference in groups studying solving equations graphically. However, the study only included 44 students in intact classes; 19 in experimental group and 25 in control. From the results of his study, Canino (1986) concluded no difference in remedial algebra students achievement. Gresshel-Green (1987) found CEI in interactive computer graphics did not significantly affect student achievement. However, Thomas (1990) found significant gain between pretest and posttest scores for function concepts. The gain in transformational geometry concepts was not significant.

Ganguli (1986) found students in an experimental group performed better in all five sets of achievement over the control group. The study involved students studying graphs, relations, and functions, with the instructor of the experimental group using the computer to control demonstration.

The six studies on the algebra to precalculus level found that students using CEI performed as well or better than students not using CEI. These studies closely relate to this study in that graphical representation was studied in each.

The majority of studies involving CEI are on the level of calculus or higher. This may have to do with the mathematical maturity of students and that they may be more able to relate to CEI at this level.

Two studies on statistical achievement were found. Gilligan (1991) used CEI in teaching a unit of descriptive statistics. The result was that there was no difference in the statistical achievement between the groups. Myers (1990) studied the effectiveness of computer graphics and simulations in illustrating sampling and the central limit theorem. The experimental group performed significantly better on the concepts test, but there was no difference in performance on the applications test.

Two studies on computer programs illustrating the Gauss-Jordan Row Reduction Algorithm in solving linear equations. Meitler (1987) found no significant difference in achievement of students using the computer than students in the control group. Benson (1990) found no difference in achievement in linear programming computational skill, linear programming conceptual skill, long-term Gauss-Jordan elimination and linear programming, and long-term general mathematics on the final. The Gauss-Jordan computational skill achievement was higher for the control group at the end of the five-week period.

Heid (1988) developed a new curriculum emphasizing concepts, application, and problem solving while computers were used to complete algorithms. After three weeks, students in the experimental class showed a better understanding of concepts and performed almost as well as the control group on the skills test. Hawker (1986) examined the effects of using a computer to replace manual skills in a business calculus class. Students in the treatment group showed higher achievement on concepts than the control group. Hamm (1990) developed a computer-oriented instruction of introductory calculus topics. The study concluded that no significant difference in calculus achievement resulted. In these three studies, students using computers for computation understood calculus concepts as well or better than non-computer users.

The meta-analysis of Kulik, Bangert, and Williams (1983) for grades six through twelve found students in computer groups performed higher on final examinations than non-computer groups in 39 of 48 studies. Twenty-three of these studies showed a significant difference in favor of the computer groups.

These studies revealed that students using computer-enhanced instruction on all levels of mathematics performed as well as or better than students who were not exposed to any computer use. Conceptual achievement was found to improve more often than application or skill achievement.

Effects on Attitude

Foley (1986), Imboden (1986), and Payton (1988) have all conducted studies of mathematical attitude of students in arithmetic; none found significant differences between experimental and control groups. However, Payton (1988) did have positive differences in attitudes, but not significantly, for the treatment group.

Mathematical attitude for the algebra to precalculus level significantly improved in the computer groups for Ganguli (1986) and Thomas (1990). However, Collis (1987) found females were more likely to associate negative attitudes toward mathematics than males.

Myers (1990), Benson (1990), and Hamm (1990) found no significant changes in mathematical attitude in their studies. Hawker (1987) found a small positive difference in attitude for the treatment group. Gilligan (1991) found a significant gain in attitudes toward statistics.

Few studies were found to evaluate student attitude toward computers. Foley (1986) found no significant difference in attitudes between groups of the arithmetic level. On the algebra to precalculus level, Coles (1990) interviewed subjects and found all treatment subjects to have a positive attitude about computers. Collis (1987), again, found more negative attitudes among female subjects than male subjects. Gilligan (1991) on the calculus level found the same attitudinal difference in males and females. Mixed results came from Benson (1990) and Hawker (1987) with Benson (1990) finding computer subjects' attitudes improved significantly and Hawker (1987) finding no difference. Kulik, Bangert, and Williams (1983) in their meta-analysis for grades six through twelve found in the ten studies reporting that eight had positive student attitudes toward mathematics. Of the four studies reporting on computer attitude, all had positive attitudes toward computers.

These studies show that computers either do not affect or positively affect students' attitudes toward both mathematics and computers at all levels of mathematics. However, a difference in attitudes of males and females was found.

Calculators

Research revealed a study by Estees (1990) which examined the effect of graphics calculators and computers in Applied Calculus. The student survey revealed that most students believed calculators and computers were helpful in learning. However, students indicated that they preferred the hands-on-calculator over the computer. Most students stated that they would like to have learned college algebra with technology.

With this in mind and with the limited amount of studies found using graphing calculators, this review of literature will include research found on calculators.

Effects on Achievement

Previous research divides achievement into four topics: 1) basic facts, 2) computational algorithms, 3) problem-solving, and 4) testing. This review will discuss each topic by levels of mathematics.

The majority of the literature on calculator use falls under the level of arithmetic. This would take the place of the gap in literature found under graphing calculators. Once again, arithmetic skills do not require the powerful technology of a graphing calculator.

Calculator research in the area of basic facts is rather limited. This is probably related to the fact that 80% of educators and lay people feel that students should know the basic facts before calculators are used (Reys, 1980). However, research shows that this need not be the case. In her state-of-the-art report, Suydam (1979) found nineteen cases of calculator students scoring higher on basic facts, eighteen cases of no difference, and three cases of non-users scoring higher. Shumway (1981) found basic fact achievement higher for users over non-users whether calculators were used on the test or not.

Dean (1981) found no significant difference in the achievement of three groups' mastery of basic facts when studied over a four-week period. The three groups were calculator-use for all calculations, calculator-use for checking paper-pencil calculations, and no calculator use. This study seemed well designed and conducted, although the high pretest scores placed a low ceiling on potential achievement that could be measured by the posttest. Therefore, this study would be more appropriate for a third grade class than the fourth grade in which it was used.

Szetela (1981) in an eight week study found no decrease in basic skills of third, fifth, seventh, and eighth grade students who used calculators during instruction. This, again, was a short study of students with high pretest skills.

Bartos's (1986) study of two third grade classes, one using calculator and the other one not, found no significant difference between the two groups in achievement in addition, subtraction, and division. However, a significant difference in the area of multiplication was found in favor of the control group which did not use calculators.

Hembree and Dessart (1986) integrated 79 research reports by meta-analysis to assess the effects of calculators on achievement. At all grades except fourth the use of calculators with traditional instruction improved the students' basic skills. Extensive calculator use in the fourth grade appeared to hinder development of the basic skills for the average student.

Calculator research in learning algorithms by calculator is also limited. This is probably due to the fact that 78% of educators feel students should know algorithms before calculators are used (Suydam, 1980). Review of research has indicated this to be false. Roberts (1980) concluded that in six out of eleven cases algorithm computational advantages fell to calculator users. Moser (1979) found no harmful effect on computation of algorithms with second and third graders using calculators. Wheatley

(1979) found no decline in learning of algorithms with the use of calculators.

Rabe (1981) in a study of elementary students (no grade level given) found calculator use produced significant gains in computational performance of algorithms. Calculators motivated the students and reduced computational difficulties. This research used three groups (calculator, paper-pencil, and combination). The calculator group not only showed significant gains in performance but also in retention of material as measured by a follow-up posttest which came three and one half months later. Rabe's review of literature also came to the same conclusion: twenty-four out of twenty-six studies found calculators produced significant gains in math computations. One of her recommendations was that complex algorithms such as the long division algorithm be eliminated because they were very time consuming and test results showed lack of concept understanding.

Leechford and Rice (1982) conducted a study on the effects of calculators on randomly assigned sixth graders' achievement in computation. All students used the calculator in their lessons. However, students were randomly assigned to posttest groups of calculator or non-calculator use. In comparison by sex there was no significant difference in performance. Also, no significant difference was found in use of calculators on tests versus no calculator use. A possible explanation for the results may be the design of the instructional program lessons which emphasized the use of estimation and the use of hand calculations along with the calculator use.

Problem-solving has been the basis of the largest volume of research in using calculators for arithmetic. These research studies have found a variety of results.

Shult (1980) conducted a study on thirty sixth-grade students on the effect of calculators on problem-solving abilities. Fifteen students were put in each group (calculator and control) by stratified random sampling to account for equal representation of high, medium, and low level students. No significant difference in achievement was found. Calculator students did, however, require more time to solve problems, used more illogical strategies, and checked solutions more often. Much thought and planning went into this study. However, the sample was very small and the very high number of variables for each problem added to the complexity of the analysis.

Szetela (1981) randomly assigned students to two groups from each of grades three, five, seven, and eight. The same teacher taught both groups for each grade level. The first posttest allowed the calculator group to use the calculator. Twenty-nine comparisons were made. Twenty of these favored the use of the calculator group. These results supported the findings of previous reviews of the literature. The analysis was quite complex and all nine comparisons in favor of non-calculator use were found in grade five. This non-calculator group also had significantly higher pretest results.

Szetela (1982) continued to study grades three, five, seven, and eight with story problem solving and calculator use. These results were, again, in favor of calculator group in all data analysis.

Kelly (1985) conducted a study to determine the impact of calculator use on problem-solving abilities of sixth grade students. He concluded that calculators can enhance students' use of deductive reasoning, their ability to explain strategies, and their ability to effectively use solution evaluation techniques.

General review of problem-solving research has found that calculators are helpful when a student knows what to do and cannot perform the calculations. The number of strategies used by students has produced a variety of results. Wheatley (1980) found sixth graders used more strategies when allowed to use a calculator. Two other studies reported approximately the same number of strategies used by calculator and non-calculator users. Miles (1980) found no evidence of a larger number of problems worked by calculator users over non-calculator users. In the area of problem-solving, five studies (Elliott, 1981; Miles, 1980; Shult, 1980; Stewart, 1980/1981; and Szetela 1981a, 1981b, 1983) produced the results that no significant difference was found in problem-solving scores of users versus non-users of calculators. Hembree and Dessart (1986) in their meta-analysis concluded that calculator use along with the traditional instruction can improve an average student's problem-solving skills.

As calculators are used more extensively, the question arises, "If calculators are used in the learning process, why can't they be used on the test?" Therefore, using calculators during posttesting ranked second in the amount of research completed. These research studies report a variety of results.

Lewis (1981) researched the effect on pupil performance of using calculators on standardized math achievement tests of fourth and eighth graders. Students were given parallel forms of mathematics subtests of Iowa Basic Skills, once using calculators and once without. Performances were then compared. Mean scores on problem-solving and computation subtests were significantly higher with calculators, but no difference was found for the concept subtests. In both grades, students completed fewer problems when using a calculator. However, the relative rankings within the grade levels remained unchanged by calculator use.

Szetela (1981) performed a different type of study which involved all students (grades fifth through seventh) using calculators during instruction. Two randomly assigned groups participated in the posttest. The posttest was of two parts: group I used a calculator on the first part and group II used paper-pencil; the groups alternated for the second part, reversing the method used. The students with the calculators performed as well as paper-pencil students, but when there was a difference it favored the calculator group. However, the analysis of the many variables was quite complex and the differences were not in a significant range.

Murphy (1981) investigated the effects of calculator treatment on problem-solving achievement. However, the seventh graders were divided into four groups for posttesting.

1. Calculator treatment - calculator on posttest,
2. Calculator treatment - pencil-paper on posttest,
3. No calculator - calculator on posttest,
4. no calculator - pencil-paper on posttest,

The results showed that students with calculator treatment and posttesting achieved higher scores in total problem-solving achievement. Also, this group achieved higher scores in three of the four cognitive skill areas.

Hembree and Dessart (1986) in their meta-analysis of K-12 grades found similar results and concluded:

> The use of calculators in testing produces much higher achievement scores than paper-and-pencil efforts, both in basic operations and in problem solving. This statement applies to all grades and ability levels. (p. 96)

Boyd and Carson (1991) conducted a study of calculator use in a prealgebra course at the college level. Students in the experimental group used calculators on all work and on all tests. Students in the experimental group had lower test scores on the pretest SAT but still performed as well on one test and better on the remaining five tests. However, results were not significant at the .05 level. An interesting survey was conducted at the end of the experiment and found 86% of the students in the control group reported using calculators on homework assignments and 91% protested not being able to use calculators in class.

The number of studies on calculator use in the level of mathematics from algebra to precalculus is somewhat limited. Four studies were found which dealt with effects on achievement. Achievement was defined in these studies as: 1) retention of basic skills, 2) algebra or trigonometry skills, 3) problem-solving, and 4) testing. Whisenant (1990) found no significant difference in adjusted mean scores in basic math skills between algebra students who used calculators and students who did not use calculators in a seven-month study. Also, no difference was found in algebra achievement between the groups. Connor (1981) found no significant difference in groups on trigonometric achievement. Magee (1986) investigated the effects of calculators in consumer math and found that the use of the calculator did not appear to be an aid for problem-solving. However, it did not appear to adversely affect learning. Also, once again, Hembree and Dessart (1986) included this level in their meta-analysis and concluded that the use of calculator improved performance in basic skills, problem solving, and on test scores.

In the level of calculus and higher, no research was found on effects of calculators on achievement. The reason for the lack of research at this level is the acceptability of calculator use in these classes. Boyd and Carson stated that "in two- and four-year colleges, and in universities, calculators are widely used in problem solving in almost every course that requires numeric computations." (1991, p.8).

Extensive studies on calculator use and effects on achievement were found. As seen before, the majority of these studies were on the lowest level of mathematics. A few studies were found on the next level. These studies reported that students performed as well or better than students not using calculators.

Effects on Attitude

Research studies on how the calculator affects attitudes toward mathematics showed a difference in findings. Four studies were found on the arithmetic level, only one on the algebra through precalculus level, and one study which covered both levels. Bartos (1986), Brekke (1991) and Moore (1982) found the calculator group with less positive attitudes. Rabe (1981) found better mathematical attitudes and self confidence. Connor (1981) in the second level of mathematics found no significant difference in math attitude. However, Hembree and Dessart (1986) in their meta-analysis for K-12 concluded:

> Students using calculators possess a better attitude toward mathematics and an especially better self-concept in mathematics than non-calculator students. This statement applies across all grades and ability levels. (p. 96)

Only one study, Bartos (1986), examined effects of calculators on attitude toward calculators. His findings revealed that there was a significance in favor of the control group. The study was small and used third grade students.

This review resulted in different findings about calculator effect on attitudes toward mathematics and calculators. The variety of results from so few studies indicates that more research is needed in this area.

Summary

The review of literature for this study researched the effects of technology in the mathematics classroom on student achievement and attitudes toward mathematics and technology. The results indicate that students using technology, i.e., graphing calculators, computers, and calculators, performed as well or better on tests of achievement in mathematics. Results were mixed as to the effects of technology on attitudes toward mathematics and the technology. Very few studies were conducted on the latest technology, graphing calculators, or at the elementary algebra level of mathematics. Therefore, additional research is needed on the effects of graphing calculators on achievement and attitudes of elementary algebra students.

Chapter III

Methods and Procedures

The purpose of this study was to evaluate the effect of graphing calculator use in a college elementary algebra class on achievement and attitude of the students. This chapter describes the experimental design of the study.

Setting

Pellissippi State Technical Community College (PSTCC) located in Knoxville, Tennessee, has an open-door policy, i.e., any student with a high school diploma or equivalent may be accepted into the college. Many of these students may not have the mathematical background to enroll in the college-level mathematics courses needed for their programs of studies. Developmental mathematics was designed for such students.

Developmental mathematics is a competency-based course of study consisting of two courses, Elementary Algebra (DSM 0830) and Intermediate Algebra (DSM 0840). The primary goal of the developmental sequence is that students having completed the developmental sequence should perform as well as or better in their first college-level mathematics course than students who did not need a developmental course. According to department studies on student achievement for fall semester 1989 and fall 1990, comparisons of developmental and non-developmental students enrolled in their first college-level mathematics course show no significant difference in their pass rates for that first course. At PSTCC no calculator use or computer demonstrations were incorporated into the developmental courses prior to this study.

Subjects

Three class times during the day on the main campus of PSTCC were randomly selected by drawing the times from all possibilities. During the fall semester 1991, two classes of DSM 0830 met at each of the times chosen, 9:00, 10:00, and 1:00. The students were randomly assigned to each class by numbers from a random chart. All subjects signed consent forms (see Appendix A) agreeing to participate in the study. No student asked to be moved to an alternate class.

Design

The design for this study was a true - experimental pretest - posttest control group design with two treatments and random assignment of members to the groups. Two instructors each taught three classes, one of each mode of instruction. The mode of instruction and instructor of each class was randomly selected by drawing from choices. The three modes of instruction were:

1) Total calculator use, including instructor use as demonstrations and student use at all times including on tests (TC).
2) Partial calculator use, including instructor use as demonstrations and student use in class only but not on tests (PC).
3) No calculator use by instructor or student (NC).

If a significant difference was found at the .05 level in the achievement, an item-by-item analysis was made. Table 3.1 gives a breakdown of class by instructor, meeting time, mode of instruction, and number of students in completed study.

Equipment Used

The TI-81 graphing calculator was chosen for use in the two classes which had use of a calculator. This calculator was chosen due to its being "user friendly" and less

Table 3.1

Class Description by Instructor, Time, Mode of Instruction, and Number of Students

Instructor	Time	Mode of Instruction	Number of Students
1	9:00	NC ***	9
1	10:00	TC *	12
1	1:00	PC **	13
2	9:00	PC **	10
2	10:00	NC ***	11
2	1:00	TC *	11

* TC - total calculator use
** PC - partial calculator use
*** NC - no calculator use

intimidating in appearance than other graphing calculators available at the time of the study. Also, an overhead model of the TI-81 calculator was used in class instruction with the two classes that used calculators.

Instructional Material

Students in all calculator sections used the same textbook, Algebra for College Students: Pellissippi State College Edition by Steffenson and Johnson, and followed the same syllabus and lecture schedule prepared by the instructor. (see Appendix B) Students in the non-calculator section used the same textbook. They followed the same lecture schedule but replaced the calculator exercises with similar activities not using calculators.

Worksheets and activities were developed for calculator use prior to the study. At least one activity per chapter was developed. The two groups using the calculators used these exercises in class. The worksheets used in the classes are in Appendix B. These worksheets were used in a pilot study during the summer term prior to the beginning of the study. Table 3.2 shows the topics covered on the worksheets.

Table 3.2

Worksheets Used in Study by Topic and Use

Topic	Calculator Used For
Fundamentals of whole numbers	Exploration of properties
Rational and real numbers	Exploration of properties
Solving equations and inequalities	Checking solutions
Geometry	Application problems
Graphing linear equations	Exploration of graphs
Systems of equations	Exploration of linear relationships & solutions
Graphing linear inequalities and systems	Exploration of graphs
Statistics	Calculation of descriptive statistics

Both instructors had attended workshops on TI-81 graphing calculators in order to prepare for classroom instruction. Each instructor had used graphing calculator overhead demonstrations in the classroom prior to the study.

Instructional Strategies

The method of instruction used in all sections participating in the study was a traditional lecture format with the instructor as the leader. There were teacher-class discussions and at times discovery techniques were used. All sections were taught in the same instructional manner.

The course syllabus, lecture schedule, and tests were developed prior to the study. A few minor changes were made in conjunction with the investigator during the study. The only variation in teaching was that the two calculator sections used the graphing calculator as a tool to demonstrate mathematical concepts. The activities using the calculator were designed to supplement instruction of concepts rather than to replace the instructor.

The usual class format was to begin by discussing questions from the previous day's assignment. Lesson objectives were developed by solving problems. Students were encouraged to participate in the development of the concepts taught by guessing, asking questions, working problems on their own, and discussing solutions. After the development of the lesson objectives, homework problems were assigned. Depending on the length of the lesson and questions asked, the students may have had class time to begin homework. Homework was due at the next class time.

Each instructor used the same problems in developing the lesson for each section. The only deviation came from student involvement during discovery of the concepts. All classes met for 50 minutes, 5 days a week, for 15 weeks.

In the calculator groups, students used a TI-81 graphing calculator as the instructor demonstrated with an overhead model. At times the white board was used simultaneously with the calculator graphics as a supplement. The students followed the instruction by listening to the instructor, watching the graphic screen, guessing, asking questions, answering questions, discovering answers, and working on their own calculator. There was no difference in the instruction of the PC and TC groups.

In the control group, NC, the instructor attempted to do similar lectures with examples by using the white board and overhead graphs. However, as the calculator could graph or calculate faster than the instructor, fewer examples were used.

Instruments of the Study

Several instruments were used to measure the effectiveness of the graphing calculator in the elementary algebra classroom. These included: Tennessee Board of Regents Academic Assessment and Placement Program (AAPP), departmental pretest and posttest, and an attitude survey.

Tennessee Board of Regents AAPP

The AAPP Elementary Algebra Skills Subtest was used to measure the students' algebra knowledge prior to the study. The test consists of 35 multiple choice questions and is administered in a 30 minute timeframe. Three clusters make up the test. They are 1) operations with real numbers; 2) operations with algebraic expressions; 3) solutions of equations, inequalities, and word problems. (MAPS, 1985) The reliability coefficient for the subtest is .91. (MAPS, 1985)

Departmental Pretest and Posttest

The departmental pretest was used to measure pretreatment algebra knowledge of the students. A parallel form of the test was used as a posttest to measure posttreatment algebra knowledge.

These tests were developed by the investigator and were designed to be given to all DSM 0830 students and not specifically for this study. The objective of the tests is to measure students' elementary algebra knowledge. The reliability coefficient of the tests in this experimental study was .74 and was found by using the KR-20 formula.

The tests consist of 30 multiple choice questions. The students are allowed a 50 minute timeframe to complete the test. The questions measure knowledge in fractions, order of operations, signed numbers, absolute values, solving equations, solving systems of equations, solving inequalities, graphing linear equations and inequalities, geometry, probability, and related word problems. A copy of the pretest and posttest are in Appendix B.

Attitude Survey

Student attitudes were measured at the beginning of and at the end of the 15-week study. Students were identified by social security number on the pre and post surveys. The students were verbally assured that their responses would not affect their course evaluation and would be used only by the investigator.

An adaption of the attitude survey used by Benson (1990a) was used in this study. The reliability for the subtests were: mathematics .87 and calculators .74.

The survey used a 5-point Likert scale with responses ranging from Strongly Disagree (SD) to Strongly Agree (SA). The survey had 32 statements of which 18 were concerning mathematics and 14 were concerning calculators. The statements were stated both in a positive and in a negative manner. The statements in the survey were also mixed in regards to mathematics and calculators.

The distribution of the statements was: mathematics positive - 10, mathematics negative - 8, calculators positive - 7, and calculators negative - 7. A copy of the survey is in Appendix A.

The survey was scored by giving a value of 1 to 5 for each response. Table 3.3 is a summary of values awarded for responses. A total of 90 points for a mathematics score, 70 points for a calculator score, and a total of 160 points for an overall attitude score was possible.

Table 3.3

Value of Response to Attitude Statement

	Response				
	SA	A	U	D	SD
Positive Item	5	4	3	2	1
Negative Item	1	2	3	4	5

Chapter IV

Results of the Investigation

This chapter presents the analysis of data needed to test the hypotheses stated. Results are given of data analysis for each hypothesis individually. A final summary of results will then conclude this chapter.

All hypotheses were tested on the .05 level of significance. The three treatments studied in each hypothesis are as follows:

1) Total calculator use, including instructor use as demonstrations and student use at all times including on tests (TC).
2) Partial calculator use, including instructor use as demonstrations and student use in class only but not on tests (PC).
3) No calculator use by instructor or student (NC).

All hypotheses were tested by an analysis of variance (ANOVA) on posttest data. The assumptions to use an ANOVA to analyze posttest data for each hypothesis were accepted due to the following results:

1) A side-by-side boxplot of the pretest data to justify the assumption of normality of the populations.

2) An ANOVA on pretest means to determine equality of pre-treatment means.

3) An acceptance that variance differences would not significantly affect the ANOVA model because the sample groups had nearly equal sizes. (Netler, Wasserman, & Kutner, 1990)

Research Hypotheses

Hypothesis 1

H1: No significant differences exist in the means of algebraic achievement for students among the following groups:
1) total calculator use (TC),
2) partial calculator use (PC),
3) no calculator use (NC).

AAPP data of each group were analyzed in addition to pretest data to determine if the assumptions for an analysis of variance were met. Table 4.1 reports the descriptive statistics for the treatment groups. The NC group obtained a lower mean score than the other groups but with a larger standard deviation.

An ANOVA was used to find that no significant differences existed in the means of the groups. The results are reported in Table 4.2. Since $\underline{F}(2, 63) = 0.18$, $\underline{p}>.05$, the pre-treatment means were considered comparable prior to treatment.

Table 4.1

Means and Standard Deviations of Academic Assessment and Placement Program (AAPP) Scores by Treatment Groups

Treatment	n	Mean	SD
TC *	23	14.83	5.52
PC **	23	14.39	5.50
NC ***	20	13.80	5.74

* TC - total calculator use
** PC - partial calculator use
*** NC - no calculator use

Table 4.2

ANOVA of Means for Academic Assessment and Placement Program Scores

Source	Sum of squares	Degree of freedom	Mean square	F
Between Treatments	11.29	2	5.65	0.18*
Within Treatments	1961.98	63	31.14	
Totals	1973.27	65		

*$p > .05$

The statistics for the pretest and posttest achievement data are found in Table 4.3. Once again, the pretest of the NC group resulted in a lower mean score. This group also had the largest gain in achievement. However, the TC group pretested higher and gained the second greatest amount which resulted in the highest posttest scores of all groups.

An ANOVA on pretest data found that no significant differences in the pre-treatment means existed. The results are reported in Table 4.4. Since $F(2, 63) = 1.12$, $p>.05$, the pre-treatment means were considered comparable. Therefore, posttest data were analyzed by an ANOVA.

Table 4.5 presents the results of posttest analysis with $F(2, 63) = 2.33$, $p>.05$. Therefore, no significant differences in achievement were found in this study between groups of varying calculator use and non-use.

Hypothesis 2

> H2: No significant differences exist in the means of composite mathematics and calculator attitude scores among the following groups:
> 1) total calculator use (TC),
> 2) partial calculator use (PC),
> 3) no calculator use (NC).

The attitude survey was given at the beginning and end of the study. The survey composed of two separate subtests: attitude toward mathematics and attitude toward

Table 4.3

Means and Standard Deviations of Pretest and Posttest Achievement Scores by Treatment Groups

	Pretest		Posttest	
Treatment(*n*)	Mean	*SD*	Mean	*SD*
TC (23) *	13.87	4.35	26.30	3.25
PC (23) **	13.30	4.10	24.39	3.29
NC (20) ***	12.05	3.58	25.05	2.45

* TC - total calculator use
** PC - partial calculator use
*** NC - no calculator use

Table 4.4

ANOVA of Means for Pretest Achievement Scores

Source	Sum of squares	Degree of freedom	Mean square	*F*
Between Treatments	36.60	2	18.30	1.12*
Within Treatments	1030.43	63	16.35	
Totals	1067.03	65		

$^{*}p > .05$

Table 4.5

ANOVA of Means for Posttest Achievement Scores

Source	Sum of squares	Degree of freedom	Mean square	*F*
Between Treatments	43.32	2	21.66	2.33*
Within Treatments	585.30	63	9.29	
Totals	628.62	65		

*p>.05

calculators. A composite score was analyzed for this hypothesis.

Table 4.6 reports the statistics for this analysis. This research found that all groups had a positive increase in attitude based on comparison of pretest and posttest scores. The two calculator treatments had a larger positive increase in comparison to the non-calculator group.

An ANOVA on pretest data tested for comparability of pre-treatment means. The results are reported in Table 4.7. Since $F(2, 63) = 1.25$, $p>.05$, the means were considered comparable prior to treatment. Therefore, the posttest data were analyzed by an ANOVA.

Table 4.8 shows the results of posttest analysis with $F(2, 63) = 0.37$, $p>.05$. Therefore, no significant

Table 4.6

Means and Standard Deviations of Pretest and Posttest Composite Attitude Scores by Treatment Groups

	Pretest		Posttest	
Treatment (*n*)	Mean	*SD*	Mean	*SD*
TC (23) *	113.30	11.85	115.22	11.20
PC (23) **	108.70	11.38	112.21	12.21
NC (20) ***	114.55	15.64	116.00	16.31

* TC - total calculator use
** PC - partial calculator use
*** NC - no calculator use

Table 4.7

ANOVA of Means for Pretest Composite Attitude Scores

Source	Sum of squares	Degree of freedom	Mean square	*F*
Between Treatments	419.93	2	209.97	1.25*
Within Treatments	10584.69	63	168.01	
Totals	11004.62	65		

*$p > .05$

Table 4.8

ANOVA of Means for Posttest Composite Attitude Scores

Source	Sum of squares	Degree of freedom	Mean square	*F*
Between Treatments	131.34	2	65.67	0.37*
Within Treatments	11092.78	63	176.08	
Totals	11224.12	65		

*$p > .05$

differences in composite attitude of the students in the various treatments were found in this study.

Hypothesis 3

H3: No significant differences exist in the means of mathematical attitude scores among the following groups:
1) total calculator use (TC),
2) partial calculator use (PC),
3) no calculator use (NC).

The mathematics subtest of the attitude survey was analyzed for this hypothesis. The TC group had a slight decrease in mathematics attitude while the other two groups showed a gain in attitude. Table 4.9 reports the descriptive data for this analysis.

Table 4.9

Means and Standard Deviations of Pretest and Posttest Mathematical Attitude Scores by Treatment

	Pretest		Posttest	
Treatment (n)	Mean	SD	Mean	SD
TC (23) *	60.43	10.00	59.82	9.25
PC (23) **	55.74	9.65	60.30	10.29
NC (20) ***	62.70	13.09	65.80	12.93

* TC - total calculator use
** PC - partial calculator use
*** NC - no calculator use

An ANOVA of the pre-treatment means revealed comparability of means prior to treatment. The results of $F(2, 63) = 2.31$, $p>.05$ are reported in Table 4.10. Therefore, posttest data were analyzed by an ANOVA.

Table 4.11 shows the results of the posttest analysis. This results in $F(2, 63) = 1.97$, $p>.05$. Therefore, no significant differences in mathematics attitudes of the students in the various treatments were found in this study.

Hypothesis 4

H4: No significant differences exist in the means of calculator attitude scores among the following groups:
1) total calculator use (TC),
2) partial calculator use (PC),
3) no calculator use (NC).

Table 4.10

ANOVA of Means for Pretest Mathematics Attitude Scores

Source	Sum of squares	Degree of freedom	Mean square	*F*
Between Treatments	550.20	2	275.10	2.31*
Within Treatments	7504.29	63	119.12	
Totals	8054.49	65		

*$p > .05$

Table 4.11

ANOVA of Means for Posttest Mathematics Attitude Scores

Source	Sum of squares	Degree of freedom	Mean square	*F*
Between Treatments	461.07	2	230.53	1.97*
Within Treatments	7389.37	63	117.29	
Totals	7850.44	65		

*$p > .05$

The calculator subtest of the attitude survey was analyzed for this hypothesis. Table 4.12 reports the statistics for this analysis. The TC group was the only group to have a positive calculator attitude change.

An ANOVA was used to find the difference in means prior to the treatment. The results of $F(2, 63) = 0.39$, $p>.05$ are in Table 4.13. The treatments were considered comparable prior to treatment according to these results. Posttest data were then analyzed by an ANOVA.

Table 4.14 reports the results of the ANOVA on the posttest data. This results in $F(2, 63) = 5.37$, $p<.05$. There is evidence that differences exist in the mean scores.

Post hoc analyses were used to determine where the significant differences among groups could be found. Table 4.15 summarizes the analysis. Scheffé multiple comparison procedure was chosen because it is not seriously affected by unequal variances when the sample sizes are approximately equal (Netler et al., 1990). Sheffé's Test, which is considered a conservative procedure, found a significant difference between TC and NC, with TC having a significantly higher gain at the .05 level than the NC group.

Therefore, significant differences in posttest means were found. With further post hoc comparisons, the TC group showed a significantly higher gain in attitude toward the calculator than the NC group.

Table 4.12

Means and Standard Deviations of Pretest and Posttest Calculator Attitude Scores

	Pretest		Posttest	
Treatment (*n*)	Mean	SD	Mean	SD
TC (23) *	52.87	3.65	55.39	4.64
PC (23) **	52.96	3.67	52.39	5.29
NC (20) ***	51.85	5.97	50.20	5.77

* TC - total calculator use
** PC - partial calculator use
*** NC - no calculator use

Table 4.13

ANOVA of Means for Pretest Calculator Attitude Scores

Source	Sum of squares	Degree of freedom	Mean square	*F*
Between Treatments	15.84	2	7.92	0.39*
Within Treatments	1266.12	63	20.10	
Totals	1281.95	65		

$*p>.05$

Table 4.14

ANOVA of Means for Posttest Calculator Attitude Scores

Source	Sum of squares	Degree of freedom	Mean square	*F*
Between Treatments	293.43	2	146.72	5.37*
Within Treatments	1722.16	63	27.34	
Totals	2015.59	65		

*$p<.05$

Table 4.15

Scheffé's Post Hoc Analyses for Calculator Attitude

TC *	PC **	NC ***

* TC - total calculator use
** PC - partial calculator use
*** NC - no calculator use

<u>Note</u>: The lines above the group symbols indicate that the means of the groups were not different.

Summary of the Results

In summarizing the hypotheses testing, the following results were found:

H1 (not rejected): No significant differences exist in the posttest means of algebraic achievement scores for students among the three treatment groups.

H2 (not rejected): No significant differences exist in the posttest means of composite mathematics and calculator attitude scores among the three treatment groups.

H3 (not rejected): No significant differences exist in the posttest means of mathematical attitude scores among the three treatment groups.

H4 (rejected at 0.05 significant level): Significant differences exist in the posttest means of calculator attitude scores among the three treatment groups. **Scheffé's procedure showed the TC group's attitude was better than the NC group.**

Chapter V

Summary, Conclusions, Limitations, and Recommendations

This chapter presents a summary and conclusions of the study. Limitations of the study are also described and recommendations for future research are offered.

Summary of the Study

This research was an experimental study designed to investigate the effects of various treatments using graphing calculators with college students enrolled in elementary algebra. Since the review of literature revealed few studies of this problem, this researcher designed a study with a true-experiment pretest-posttest control group design using two treatments and random selection of members for the groups. The study was conducted at Pellissippi State Technical Community College (PSTCC) during fall semester 1991 with students enrolled in the elementary algebra course. Two instructors each taught three classes, one of each mode of instruction. The mode of instruction and instructor of each class were randomly selected. The three modes of instruction were:

1) Total calculator use, including instructor use as demonstrations and student use at all times including on tests (TC).

2) Partial calculator use, including instructor use as demonstrations and student use in class only but not on tests (PC).

3) No calculator use by instructor or student (NC).

The null hypotheses tested were that there were no significant differences among the means of groups on:

H1) Algebraic achievement measured by departmental posttest.

H2) Composite attitude toward mathematics and calculators as measured by composite attitude survey scores.

H3) Mathematics attitude as measured by mathematical attitude subtest scores.

H4) Calculator attitude as measured by calculator attitude subtest scores.

TI-81 graphing calculators were used by students of the two calculator treatments. The differences in these treatments were that students used (a) calculators at home and on the tests in one group and (b) in class only and not on the tests in the other group. The control group did not use calculators.

The Academic Assessment and Placement Program (AAPP) test was used to determine if the groups were considered comparable prior to the beginning of the study. The scores were analyzed for equal means by an ANOVA. Department pretests and posttests were used to measure algebraic achievement. These scores were also analyzed by an ANOVA.

An attitude survey was administered prior to the study and at the end of the study. This was analyzed by an ANOVA as a composite score for total attitude change, a mathematics subscore for a mathematics attitude change, and a calculator subscore for a calculator attitude change.

Conclusions

In this section the conclusions based upon each of the four hypotheses will be discussed. These hypotheses are divided into two sections, algebraic achievement and attitude.

Algebraic Achievement

Hypothesis H1 dealt with the effect of the graphing calculator treatments on algebraic achievement. The results of this experiment indicated that students using graphing calculators, either as a total immersion including use on the tests or as an instructional tool in the classroom, performed as well as students in the control group that had no calculator use.

This hypothesis answered questions 1, 2, and 3 under the problem.

1) Does the use of graphing calculators in a developmental algebra class result in a greater achievement than in a class where the calculators are not used? **No.**

2) If a significant difference in achievement is found, is the graphing calculator more effective when used with some specific algebraic topics than others? **No significant differences were found.**

3) Does the use of graphing calculators on tests result in higher test scores? **No.**

Attitude

Hypotheses H2, H3, and H4 dealt with students' attitude change during the study. The results of this study for H2 found no significant difference in means among the groups on the posttest that measured combined attitude toward mathematics and calculators. Results for H3 found no significant differences in means of post mathematical attitude among the groups. However, for H4, results showed a significant difference in means of post attitude toward the calculator with a greater mean attitude score of the students with total calculator use.

These hypotheses answered question 4 under the problem.

4) Does the use of graphing calculators in a developmental algebra classroom help students to build positive attitudes toward mathematics and calculators? **Students with total calculator use build more positive attitudes toward calculators.**

Limitations

This section will discuss briefly the limitations of this study. The major limitations were due to the shortness of the study, the requirements of the course, and to the students involved in the study.

The time limit of one semester limited the amount of calculator skills developed and represents a very short time in which to change student attitudes. Certain topics of algebra allow for calculator use more than others. Therefore, at times the calculator was not used extensively on a day-to-day basis. Due to these facts, students did not become proficient users of the calculator. At times the students had to be reminded to use the calculators.

The DSM 0830 course was a competency-based course. Therefore, the data used in this study came from students who had successfully completed the course. An attrition of approximately half of the students beginning each class was experienced. This may have influenced the results of achievement because all the students who completed the course had passed all chapter tests with a minimum score of 80 percent. The posttest had to be passed with a minimum score of 60 percent. This would result in a smaller dispersion of achievement gain than would be found in a non-competency based course. The attitude of students may also be affected due to the fact that all students who took the attitude posttest had successfully completed the course.

Another limitation is that this study is limited to using calculators with students who were previously underachievers. These results cannot be generalized to average or above-average students in algebra.

Discussion

The results of this study indicate that when a graphing calculator is used in an elementary algebra course in college the students perform as well as students not using a graphing calculator. This result supports the findings of Magee (1986), Connor (1981), and Boyd and Carson (1991).

Also, students using the graphing calculator on the tests do not perform any differently from those who are not permitted to use the calculator on the tests. However, students using the graphing calculator are exposed to a technology to which the other students are not and, therefore, have a broader base with which to build on with no expense to their algebraic knowledge.

The students showed no significant differences in composite attitudes or mathematics attitude alone. Attitude toward the calculator improved with calculator use. Students with total use of calculators including use on the tests had a significant positive change toward calculators. This result is the same as reported by Vazquez (1990). The positive increase in attitude change toward calculators is important in today's technological world.

With these positive results, the researcher feels that elementary algebra students should be required to use graphing calculators as a part of their course of study. These students need a new approach to a course of study in which many of them have had poor prior experiences. Students should not be exposed to the same material, taught in the same manner, in a shorter period of time than in high school and be expected to achieve. The calculator used on an everyday basis would allow the student to spend less time in computations and more time in understanding underlying concepts.

The results of this study support previous findings that technological methods of delivery provide students with a means to gain in achievement and attitude. This study should encourage those who support the use of technology in the mathematics classroom. The results suggest that a calculator-enhanced method of instruction is as effective as, and may be an alternative to, traditional instruction.

Recommendations

The results and experiences of this study have led the investigator to offer two types of recommendations. First, a recommendation of additional needed studies is given. Second, recommendations of instructional uses of the graphing calculator are included.

Additional Studies

There is a need for the following studies to be conducted:

1) This study should be replicated with the same design but with a non-competency based course. This would allow for a greater

dispersion of student achievement in the class. Students not completing the course requirements would also be included in the study.

2) The elementary algebra course should be partitioned into individual topics and then studied topic by topic to determine if the graphing calculator has different student learning effects related to individual topics. Certain topics seem to lend themselves well to calculator use and others do not. Recommendations for suggested topics are included in the next section of recommendations.

3) A longer study involving two semesters, elementary and intermediate algebra, should be designed. The students' achievement in the subsequent college-level course should also be studied. A long-term study of this type with intensive use of the graphing calculator would reveal more realistic results as to effects on student achievement and attitude.

4) A similar study dividing students into ability groups and studying the effects of the graphing calculator on different ability groups would also be appropriate. This study would reveal the

different types of instruction needed for different ability groups.

Instructional Uses

This study revealed the need for a more intensive use of graphing calculators on a day-to-day basis. Graphing calculators lend themselves to certain topics of study. The course of study with which this research was involved contained many of these topics. The researcher would recommend using calculators on a daily basis not only for computation but also as a means to inquire into underlying principles, concepts, and problem solving. Both exploring topics as an introduction to a lesson and understanding how to use calculators are equally important.

Students should be required to purchase graphing calculators along with their algebra text. They should use their calculator on a daily basis so that they are comfortable using it. They should be taught when calculator use is necessary and when it is not. For example, they should use a calculator to do multiple step calculations but not to determine facts such as -2 + 5.

Exploration of introductory calculation topics such as integer calculations and order of operations are not normally addressed with calculators. However, the researcher would recommend graphing calculator use with these topics. Examples of such use are as follows:

1. Division problems involving zero are difficult concepts for elementary algebra students to understand. After explaining this concept to the student, the student will need to experiment with the calculator. The calculator will give an error message when the student attempts to divide by zero.

2. The use of patterns to introduce topics such as integer multiplication rules are easily understood when seen on the graphics screen of the calculator. For example:

$$\begin{array}{ll} 2 \cdot 3 = 6 & -2 \cdot 3 = -6 \\ 2 \cdot 2 = 4 & -2 \cdot 2 = -4 \\ 2 \cdot 1 = 2 & -2 \cdot 1 = -2 \\ 2 \cdot 0 = 0 & -2 \cdot 0 = 0 \\ 2 \cdot -1 = ? & -2 \cdot -1 = ? \end{array}$$

3. Once students understand integer operations and proceed to order of operation problems, the graphing calculator is a very useful tool. The student simply enters the problem as it appears in the text. Most texts require students to perform very complicated order of operation problems that would not be found in real life applications. The student will need calculator instructions in entering these.

Evaluating expressions with variables and applying formulas are other topics which lend themselves to the graphing calculator use. After storing values for all variables, the student need only enter the expression to be evaluated to obtain the results.

Checking solutions to equations is a process students are asked to do but rarely follow through with when working alone. The graphing calculator will test for equality by displaying 1 for true and 0 for false. The student must first store the solution and then enter the equation. Therefore, checking solutions are not very time consuming for the student and they may be more likely to follow through with checking solutions.

The most obvious use of the graphing calculator is the introduction of graphing and systems of equations. Worksheets in Appendix B illustrate examples of developmental activities in the following areas:

1. Graphing linear equations ($y = mx + b$) and the significance of "m" and "b" to the line.
2. The relationship between lines in a system, i.e., intersecting, parallel, or perpendicular.
3. The graphical solution of a system.

Examples of additional application topics studied in this developmental course which are not normally taught in elementary algebra are included in Appendix B. These include the following:

1. Geometry,
2. Probability,
3. Statistics.

As students progress into intermediate algebra, many additional topics may be addressed with the graphing calculator. These topics of study in intermediate algebra may include the following:

1. Effects of exponents (positive and negative) on bases greater than one,
2. Scientific notation,
3. Finding roots of equations with the quadratic equation,
4. Graphing quadratic functions,
5. Graphing quadratic functions to picture solutions to quadratic inequalities,
6. Evaluating square roots of large numbers and understanding that radical terms are really numbers.

The above examples and examples in the appendix are only illustrations of graphing calculator uses that are recommended by the researcher. As students and instructors become comfortable using the graphing calculator, many more topics may be explored. It is the recommendation of the researcher to expand calculator use to as many topics as possible in order to enable the student to develop an understanding of the many uses of the calculator and to explore topics independently rather than by asking for help from the instructor.

Concluding Remarks

This study was initiated to encourage the use of graphing calculators in a course of study, elementary algebra, in which it had not been used. The positive results of this study indicate that use of the graphing calculator did not adversely affect the students' algebraic knowledge but did broaden their technological base and improve their attitudes toward technology. It is, therefore, the recommendation of the researcher to implement the use of graphing calculators in college algebra courses of study.

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Appendices

Appendix A

Materials Used

INFORMATION ABOUT GRAPHING CALCULATOR EXPERIMENT

We will be conducting an educational experiment in this course. The data collected from this experiment will be used by the department to determine the best possible way to teach the content of this course and by the department head, JoAnne Thomasson, as the basis for her Ph.D. dissertation.

The purpose of this experiment is to find out the effect of graphing calculators on the achievement and attitude of the students. As you are enrolled in this course, we would like you to participate in this experiment and sign this form.

If you decide to participate, you will be randomly assigned to a section which meets at the time of the day which you have chosen but the classroom and the instructor may change. You will be asked to fill out questionnaires concerning your attitudes toward mathematics. Your test scores will be used to determine the effect of using graphing calculators in teaching. Any information gathered about you will be coded with and identification number so that no one will be able to identify your name with any of the information collected. Also, you are free to discontinue participation at any time without prejudice.

If you decide not to participate, you will be free to choose a nonexperimental section of the course.

Your decision whether or not to participate in this study will not affect your achievement or grade in this course.

If you have any question regarding this study, please ask your instructor or contact JoAnne Thomasson (694-6694, C-115).

GRAPHING CALCULATOR EXPERIMENT

SUBJECT CONSENT FORM

FALL, 1991

You are making a decision whether or not to participate in the graphing calculator experiment. Your signature indicates that you have read the information provided and decided to participate. You may withdraw at any time without prejudice after signing this form should you choose to discontinue participation in this study.

Name: (Please print your name clearly)

____

Last First Middle

Social Security Number: ______________________

Signature: ___________________________________

Date: ________________

GRAPHING CALCULATOR EXPERIMENT

FALL, 1991

As part of this experiment you will be assigned a TI-81 graphing calculator to be used throughout the semester. At the end of the semester, the calculator will be returned to your instructor. Failure to return the calculator will result in no grade for the course and a hold put on all PSTCC records.

I have read the above statements and agree to abide by them. I have received a TI-81 graphing calculator serial number ____________________

Signature: ____

Social Security Number: _________________________________

Date: _____________________

The above TI-81 graphing calculator was returned:

Date: _____________________

Instructor Initials: _________________

ATTITUDE SURVEY

Fill in your Social Security Number and Section Number on the scantron card. Blacken in the appropriate answer with a number 2 pencil.

Using a five point scale, indicate the extent to which you agree with the feelings expressed in each statement. Fill in the letter corresponding to the choice which best describes your feelings. Please answer each item.

Fill in one letter on your scantron card for each of the following statements. Please do not write on the survey questions.

1. Solving word problems is more fun if you use a calculator.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

2. I usually understand what we are talking about in mathematics class.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

3. I am willing to work a long time in order to understand a new idea in mathematics.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

4. Mathematical ideas can be learned faster if you use a calculator.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

5. Knowledge of mathematics is not necessary in most occupations.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

6. I really want to do well in mathematics.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

7. Calculators are not used in most jobs.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

8. Using a calculator helps me solve mathematical problems faster.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

9. I would like to work at a job that lets me do mathematics.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

10. If you use a calculator, you do not have to learn to calculate.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

11. I think mathematics is fun.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

12. Using calculators makes learning mathematics more mechanical and boring.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

13. Everyone should learn something about calculators.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

14. It scares me to have to take mathematics.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

15. I enjoy working with calculators.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

16. It takes me more time to do mathematics homework when I use a calculator.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

17. The only people who can use calculators easily are those who are gifted in mathematics.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

18. Mathematics is difficult for me.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

19. When I cannot figure out a problem, I feel as though I am lost in a maze and cannot find my way out.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

20. I would take more mathematics courses if there were time in my schedule.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

21. Calculators are useful tools in business.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

22. Mathematics is a good field for creative people.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

23. If I could use a calculator to solve problems, I would spend more time thinking about what the answer means.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

24. No matter how hard I try, I do not do well in mathematics.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

25. Calculators make me nervous.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

26. Mathematics is harder for me than for most persons.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

27. It is less fun to learn mathematical ideas if you use a calculator.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

28. I am not willing to spend a lot of my own time doing mathematics.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

29. Most of mathematics has practical use on the job.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

30. I usually feel calm when doing mathematics problems.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

31. There are many different ways to solve most mathematics problems.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

32. If I had my choice, I would not learn any more mathematics.

A	B	C	D	E
Strongly disagree	Disagree	Undecided	Agree	Strongly agree

Appendix B

DSM 0830 Course Materials

COURSE SYLLABUS
Developmental Studies Mathematics
DSM 0830
(revised April 1991)

Class Hours: 5 **Credit Hours:** 5
Laboratory Hours: *none required, although Lab is available*

Catalogue Course Description: DSM 0830 includes a short review of arithmetic concepts, the introductory linear algebra topics of positive and negative numbers, simple equations, order of operations, graphing linear equations and inequalities, determining equations of lines, solving systems of two equations, determining the surface area and volume of various solids, and elementary probability and statistics. The elementary problem solving skills of estimating, judging reasonableness of answers, and selecting appropriate solution methods are integrated throughout the course.

Pre-requisite: RSM 0730 or equivalent
Co-requisite: none

Textbook: Steffensen/Johnson. Algebra for College Students: Pellissippi State College Edition, New York: HarperCollins Publishers Inc., 1991.

I. **Weeks/Unit/Topic Basis:**
1. Fundamentals: fractions, decimals
2. Fundamentals: percents, variables, exponents, order of operations, calculator exercises
3. Rational and Real Numbers: number line, addition, subtraction, multiplication, division, distributive law, simplifying expressions
4. Rational and Real Numbers: identify irrational and real numbers, calculator exercises
5. Linear Equations and Inequalities: addition-subtraction rule, multiplication-division rule, combining rules, language of problem solving, applications, percent
6. Linear Equations and Inequalities: graphing linear inequalities, calculator exercises
7. Geometry: lines, angles, triangles, perimeter, area, volume, surface area
8. Geometry: geometry applications, calculator exercises
9. Graphing: rectangular coordinate system, graph linear equation, slope of a line, forms of the equations of a line

10. Graphing: graphing linear inequalities calculator exercises
11. Systems of Linear Equations: parallel, coinciding, interesting lines, solve by graphing, substitution, and elimination
12. Systems of Linear Equations: applications, calculator exercises
13. Supplementary Concepts: system of inequalities, calculator exercises, absolute value equations
14. Probability and Statistics: Probability, outcomes, descriptive statistics
15. Review and Posttest

II. Central Competencies: DSM 0830 is a mathematics course in the TBR mandated R/D program. According to the program goals:

A. Students shall learn skills which support their success in college-level curricula and enable them to achieve their educational goals.
B. Students course and AAPP posttest results shall show skill improvement compared to their pretest evaluation.
C. Students who complete the R/D program shall experience about the same or better success in college - level classes as students who did not enroll in developmental courses.

In this course, the student shall:

D. Solve one-variable equations involving integers and rational numbers.
E. Solve word problems using one-variable equations.
F. Graph equations.
G. Determine the equation of a specific linear graph.
H. Solve systems of two equations.
I. Solve and graph linear inequalities.
J. Determine the surface area and volume of various solids.
K. Solve elementary probability and statistics problems.

III. Instructional Objectives:

1. Given an expression with positive and negative integers, the student shall correctly add, subtract, multiply, or divide, according to the operations indicated. (D)
2. Given a single variable, first-order equation with two or more terms, the student shall apply the associative law, distributive law, commutative law, and the order of operations to solve the equation. (D)
3. Given values to substitute in multiple-variable expressions, the student shall correctly evaluate equations and/or formulas. (E)
4. Given a word problem to solve using a single variable, the student shall correctly define the variable(s) sought, set up a suitable equation, and solve using acceptable algebraic procedures. (E)
5. Given equations in one or two variables, the student shall graph the statements. (F)
6. Given an equation in slope-intercept form, the student shall write an equation of a line parallel and/or perpendicular through a given point. (G)
7. Given two points in a rectangular coordinate system, the student shall write the equation of the line through those two points. (G)
8. Given a system of equations, the student shall solve the system by substitution, addition, and/or graphing. (H)
9. Given a word problem in multiple variables, the student shall use systems of equations to solve the problem. (H)
10. Given a linear inequality, the student shall solve the expression and graph the solution. (I)
11. Given the measurements of a rectangular solid, cylinder, and sphere, the student shall determine the surface area and volume. (J)
12. Given data, the student shall determine various averages and probabilities. (K)

IV. Evaluation: **Evaluation will be based on class participation, exams, and projects as outlined on the course Schedule of Instruction.**

To begin the next level of coursework, a student must:

1. achieve a course average of "C" or better.
2. achieve at least 60% correct on the comprehensive exam for the course.
3. receive an 80% proficiency on each chapter test.

Grade Average Scale:

A = 94 - 100
B = 87 - 93
C = 78 - 86

F = below 78

Attendance Policies: Regular Attendance is very important for successful completion of this course. Absences will be recorded and monitored. Students who miss the equivalent of one week of class may be dropped from the roll and receive an "F" for the course at the instructor's discretion.

Policy on Cheating: Cheating in any form will not be tolerated. The penalty for cheating is a grade of "F" for the course.

Two Attempt Rule: According to TBR policies, a student must complete this course within two semesters of enrollment. This includes grades received of A,B,C,F,I, or W.

DSM 0830 SEMESTER LECTURE SCHEDULE

HOUR	SECTION
1	PRETEST
2	INTRODUCTION
3	1.1
4	1.2
5	1.3
6	1.4
7	1.5
8	CAL./REVIEW ***
9	CHAPTER 1 TEST
10	2.1
11	2.2
12	2.2 (CONT.)
13	2.3
14	2.3 (CONT.)
15	2.4
16	2.5
17	2.5 (CONT.)
18	CAL./REVIEW ***
19	CHAPTER 2 TEST
20	3.1
21	3.2
22	3.3
23	3.4
24	3.5
25	3.5 (CONT.)
26	3.7
27	3.7 (CONT.)
28	CAL./REVIEW ***
29	CHAPTER 3 TEST
30	A.1
31	A.2
32	A.3
33	A.3 (CONT.)
34	A.4
35	A.4 (CONT.)
36	3.6
37	3.6 (CONT.)
38	CAL./REVIEW ***

HOUR	SECTION
39	APPENDIX A/3.6 TEST
40	4.1
41	4.2
42	4.2 (CONT.)***
43	4.3
44	4.3 (CONT.)***
45	4.4
46	4.4 (CONT.)***
47	4.5 ***
48	CAL./REVIEW ***
49	CHAPTER 4 TEST
50	5.1 ***
51	5.2 ***
52	5.3
53	5.3 (CONT.)
54	5.4
55	5.4 (CONT.)
56	5.5
57	5.5 (CONT.)
58	CAL./REVIEW ***
59	CHAPTER 5 TEST
60	4.6 S
61	4.6 S (CONT.)
62	CALCULATOR ***
63	2.7 S
64	REVIEW
65	SUPPLEMENT TEST
66	7.1S/7.2S
67	7.3S
68	9.6S
69	9.8S
70	CAL./REVIEW ***
71	PROB./STAT. TEST
72	REVIEW
73	REVIEW ***
74	PRACTICE POSTTEST
75	POSTTEST

*** USE GRAPHING CALCULATORS

DSM 0830
PRETEST

CHOOSE THE BEST ANSWER.

Perform the indicated operation and reduce to lowest term.

1.) $\frac{6}{21} + \frac{5}{14} - \frac{2}{28}$

A. $\frac{9}{28}$ B. $\frac{-4}{7}$ C. $\frac{-9}{28}$ D. $\frac{4}{7}$

Solve each problem.

2.) It takes Gene 3/4 hour to paint a chair. How many chairs can he paint in 3 3/4 hours?

A. 5 chairs B. 4 chairs C. 3 chairs D. 15 chairs

Multiply these numbers.

3.) $\begin{array}{r} 1.19 \\ \underline{\times\ 14} \end{array}$

A. 15.19 B. 16.66 C. 16.77 D. 17.76

Solve each problem.

4.) Dick got 7 hits in 57 times at bat. What is his batting average to the nearest hundredth?

A. 0.07 B. 0.04 C. 0.81 D. 0.12

Evaluate each expression.

5.) $(5 + 3)[6 + (5 + 3)]$

A. 112 B. 210 C. 56 D. 315

Evaluate when $x = 2$, $y = 3$, $a = 4$, and $b = 0$.

6.) $6x + 5y - 2a$

A. 19 B. 26 C. 35 D. 20

Solve each problem.

7.) The perimeter of a rectangle, P, is given by $P = 2L + 2W$, where L is its length and W is its width. What is the perimeter of a rectangle of length 30 ft. and width 14 ft?

A. 44 ft. B. 74 ft. C. 88 ft. D. 176 ft.

DSM 0830
PRETEST
Perform the indicated operation.

8.) 0.07 - 0.88

A. 0.0616 B. -0.81 C. -0.85 D. -0.95

Simplify each expression by removing the parentheses.

9.) -4 + (5k - 2)

A. -12k B. 8 + 5k C. -6 + 5k D. -6k - 2

Evaluate the absolute value.

10.) $|-11|$

A. 11 B. -11 C. 0 D. ± 11

Collect like terms and solve each equation.

11.) 5z + 18 = 4z + 2

A. z = -16 B. z = 16 C. z = -20 D. z = 20

Solve each equation.

12.) 5r + 6 = 51

A. r = 4 B. r = 44 C. r = 9 D. r = 40

13.) 50(x - 200) = 100

A. x = 198 B. x = 202 C. x = 100 D. x = 200

Solve each inequality.

14.) $a - 10 \le 2a + 14$

A. $a \ge -\frac{24}{3}$ B. $a \le 1$ C. $a \le -24$ D. $a \ge -24$

Solve each problem.

15.) Find the length of a rectangular lot with a perimeter of 126 meters if the length is 7 meters more than the width. (P = 2L + 2W)

A. 35 m B. 70 m C. 28 m D. 63 m

DSM 0830
PRETEST

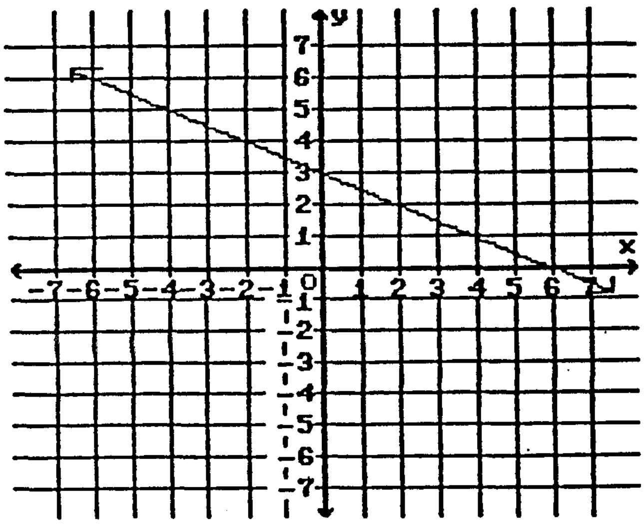
16.) Two trains leave Knoxville at the same time, one traveling north and one south. If one is traveling 14 mph slower than the other and if after 4 hours they are 336 miles apart, how fast is the fastest train going?

A. 21 mph B. 35 mph C. 49 mph D. 63 mph

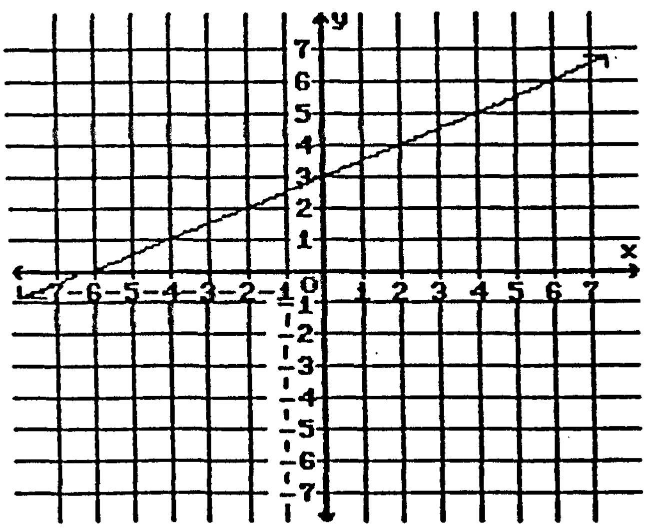
Graph the equation.

17.) $2y = x + 6$

A.



B.



DSM 0830
PRETEST
Find the slope of the line going through each pair of points.

18.) (-5,-9) and (-9,-1)

A. $m = 2$ B. $m = -2$ C. $m = 8$ D. $m = 4$

Find the slope of each line.

19.) $4x + 5y = 22$

A. $m = \frac{5}{4}$ B. $m = \frac{4}{5}$ C. $m = \frac{-5}{4}$ D. $m = \frac{-4}{5}$

Write the standard form of the equation of the line satisfying the given conditions.

20.) $m = \frac{-5}{4}$ y-intercept $= \frac{31}{4}$

A. $5x + 4y = -31$
B. $5x - 4y = 31$
C. $5x + 4y = 31$
D. $-5x + 4y = 31$

21.) Through (4,3), $m = \frac{-3}{5}$

A. $3x + 5y = -27$
B. $5x + 3y = -27$
C. $3x - 5y = 27$
D. $3x + 5y = 27$

Write a general form of the equation of the line satisfying the given conditions.

22.) Through (2,3) and (0,7)

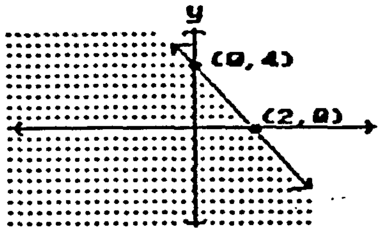
A. $2x - y + 7 = 0$
B. $-2x - y - 7 = 0$
C. $2x + y - 7 = 0$
D. $-2x + y - 7 = 0$

DSM 0830
PRETEST

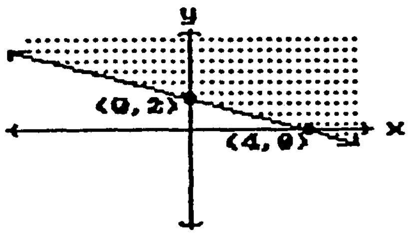
Graph each linear inequality by shading. Use a solid line to include the boundary and a dashed line to exclude it.

23.) $2x + y \leq 4$

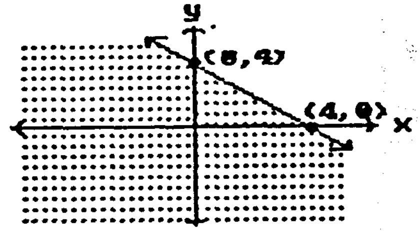
A.



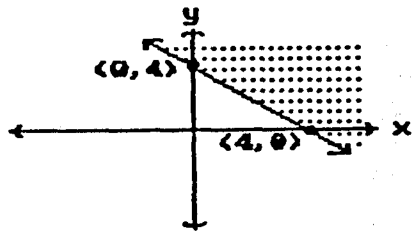
B.



C.



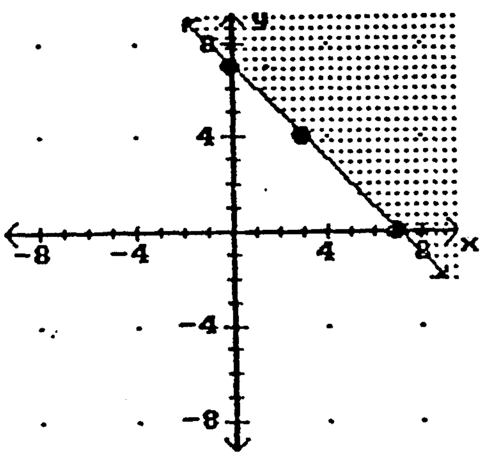
D.



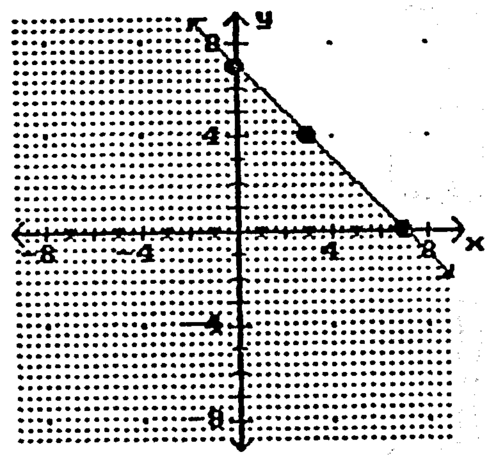
Complete each graph by shading the correct region.

24.) $x + y \leq 7$

A.



B.



DSM 0830
PRETEST

Solve each system.

25.) $x + 6y = 6$
$9x - 7y = -7$

A. (1,0) B. (1,1) C. (0,1) D. (0,0)

26.) $3x + 64y = 64$
$4x - 8y = -8$

A. (1,0) B. (0,1) C. (0,0) D. (1,1)

Solve each problem.

27.) The perimeter of a rectangle is 42 cm. The longer side has a length of 7 cm more than the shorter side. Find the length of the longer side.

A. 28 cm B. 21 cm C. 14 cm D. 7 cm

28.) Joe has a collection of nickels and dimes that is worth \$8.65. If the number of dimes were doubled and the number of nickels were increased by 19, the value of the coins would be \$14.10. How many dimes does he have?

A. 57 dimes B. 45 dimes C. 69 dimes D. 83 dimes

Solve each problem.

29.) If John has three pairs of jeans and two shirts, how many different outfits can he have?

A. 6 B. 9 C. 18 D. none of these

30.) If a couple has three children, what is the probability of the family being all girls?

A. 1/6 B. 1/8 C. 1/3 D. none of these

DSM 0830
POSTTEST FORM A

CHOOSE THE BEST ANSWER.

Multiply these numbers.

1.) $$\begin{array}{r} 18.55 \\ \underline{\times\ 0.008} \end{array}$$

A. 0.2484   B. 0.1484   C. 0.2584   D. 1.2484

Evaluate each expression.

2.) (7 + 5)[3 + (8 + 8)]

A. 228   B. 2,345   C. 60   D. 665

Evaluate when x = 2, y = 3, a = 4, and b = 0.

3.) $-4y - 9y + 7a$

A. -7   B. -2   C. -29   D. -23

Solve each problem.

4.) The amount of money in an account is given by $A = P(1 + r)^t$, where P is the principal invested, r is the interest rate (as a decimal), and t is the time of the investment. Find the amount at the end of 3 years if $500 is invested at 5%.

A. $525.00 B. $750.00 C. $1,687.50 D. $578.81

5.) Linus paid $25 for 9 paperback books. What was the cost of each book to the nearest cent?

A. $2.25   B. $2.50   C. $2.78   D. $0.36

Perform the indicated operation and reduce to lowest terms.

6.) $\frac{27}{35} + \frac{11}{14} - \frac{1}{7}$

A. $\frac{99}{35}$ B. $\frac{119}{70}$ C. $\frac{99}{70}$ D. $\frac{37}{70}$

Solve each problem.

7.) Karl Mason sold 1/4 gross of data disks on Monday, 1/8 gross on Tuesday, and 5/12 on Wednesday. What was the total gross sold?

A. $\frac{19}{24}$ gross B. $\frac{1}{3}$ gross C. $\frac{16}{12}$ gross D. $\frac{5}{6}$ gross

DSM 0830
POSTTEST FORM A

Simplify each expression by removing the parentheses.

8.) $-6(2m - 3) - 4(4m - 3)$

A. $-28m - 30$ C. $-28m - 6$
B. $6m + 30$ D. $-28m + 30$

Perform the indicated operation.

9.) $0.85 - (-0.21)$

A. 1.16 B. 1.06 C. 0.1785 D. 0.64

Evaulate the absolute value.

10.) $|3.9|$

A. 4 B. 3.9 C. 3 D. -3.9

Collect like terms and solve each equation.

11.) $10y = 5y + 9 + 4y$

A. $y = 9$ B. $y = 90$ C. $y = -9$ D. $y = -90$

Solve each equation.

12.) $13 = 9x - 5$

A. $x = 13$ B. $x = 2$ C. $x = 6$ D. $x = 9$

13.) $6x - (3x - 1) = 2$

A. $x = -1/3$ B. $x = 1/3$ C. $x = 1/9$ D. $x = -1/9$

Solve each problem.

14.) The area of a trapezoid is 40 square feet. If the bases are 5 and 11 feet, find the altitude of the trapezoid. [$A = \frac{1}{2}(B + b)h$]

A. 5 ft. B. 1.5 ft. C. 3 ft. D. 10 ft.

15.) Two trains are 455 miles apart and traveling toward each other. One travels 7 mph faster than the other. After 5 hours they meet, how fast is the slowest train?

A. 42 mph B. 58 mph C. 51 mph D. 35 mph

DSM 0830
POSTEST FORM A

Solve each inquality.

16.) $a - 3 \leq 2a + 7$

A. $a \geq -10$ B. $a \leq -10$ C. $a \leq 1$ D. $a \geq -10/3$

Find the slope of the line going through each pair of points.

17.) (-3,-5) and (2,3)

A. $m = 1$ C. $m = 8/5$
B. $m = -8/5$ D. m is undefined

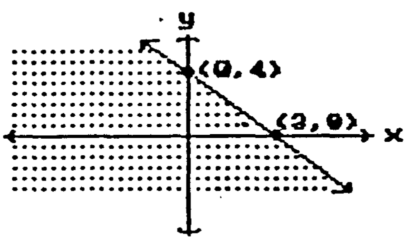
Find the slope of each line.

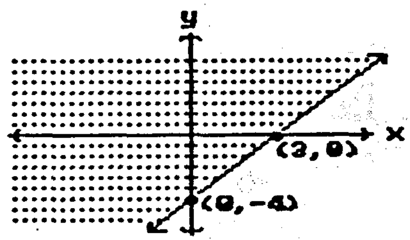
18.) $2x + 3y = 15$

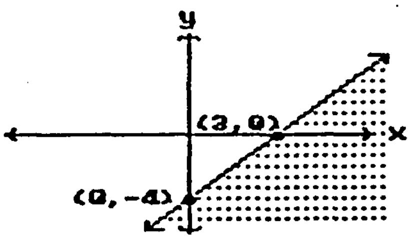
A. $m = 1\ 1/2$ C. $m = 2/3$ D.
B. $m = -1\ 1/2$ D. $m = -2/3$

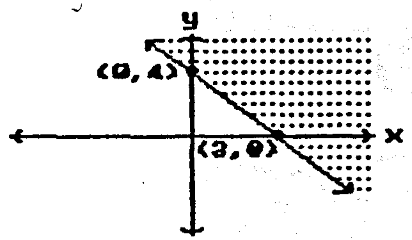
Graph each linear inequality by shading. Use a solid line to include the boundary and a dashed line to exclude it.

19.) $4x - 3y \leq 12$

A.


C.


B.


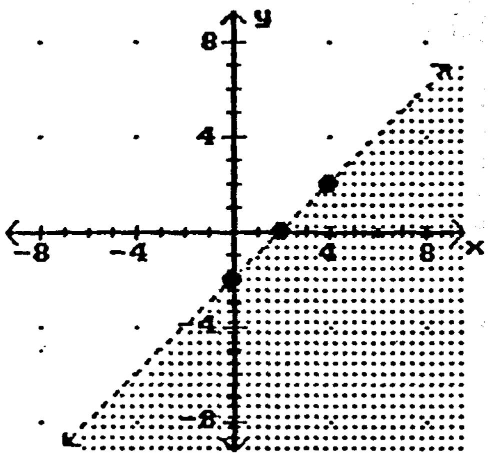
D.


DSM 0830
POSTTEST FORM A

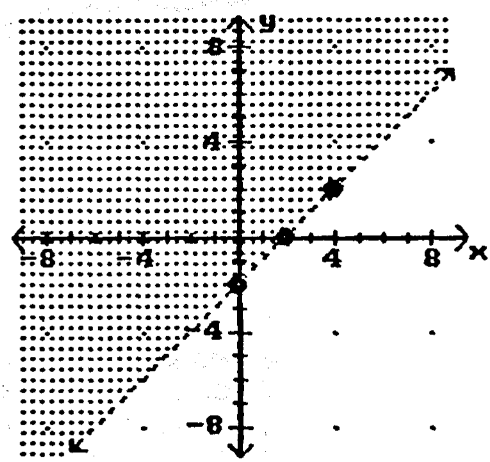
Complete each graph by shading the correct region.

20.) $y + 2 < x$

A.



B.



Write the standard form of the equation of the line satisfying the given conditions.

21.) $m = 1/2$ y-intercept = 1

A. $x - 2y = -2$ C. $-x - 2y = 2$
B. $-x + 2y = -2$ D. $x + 2y = -2$

22.) Through (0,2), $m = 7/4$

A. $7x + 4y = -8$ C. $7x - 4y = -8$
B. $7x - 4y = 8$ D. $4x - 7y = -8$

Write a general form of the equation of the line satisfying the given conditions.

23.) Through (4,2) and (0,1)

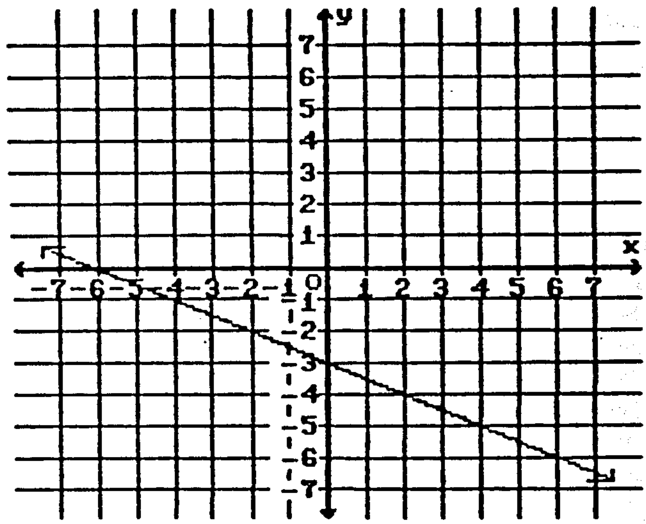
A. $-x - 4y + 4 = 0$ C. $-x - 4y + 4 = 0$
B. $x + 4y + 4 = 0$ D. $x - 4y + 4 = 0$

DSM 0830
POSTEST FORM A

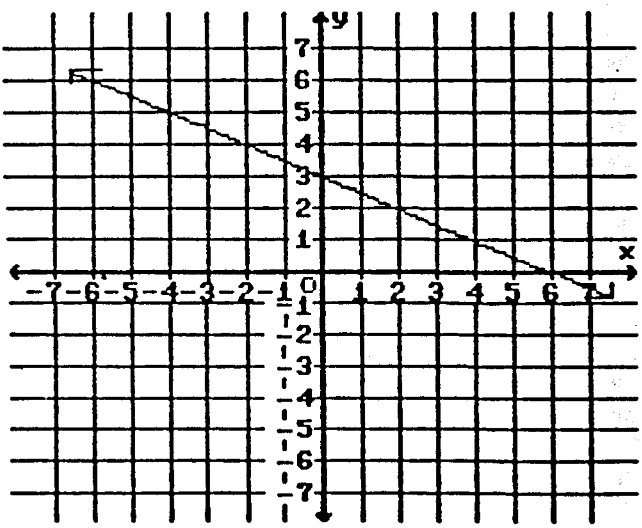
Graph the equation.

24.) $-6x - 12y = 36$

A.



B.



Solve each system.

25.) $5x + 3y = 80$
$2x + y = 30$

A. (10,10) B. (0,0) C. (0,10) D. (10,0)

DSM 0830
POSTTEST FORM A

Solve each problem.

26.) Two angles are supplementary (their sum is 180°), and one is 40° more than three times the other. Find the smaller angle.

A. 35° B. 145° C. 75° D. 105°

27.) Don runs a charity fruit sale, selling boxes of oranges for $11 and boxes of grapefruits for $10. If he sold a total of 762 boxes and his total income was $8125, how many boxes of oranges did he sell?

A. 458 boxes C. 257 boxes
B. 383 boxes D. 505 boxes

Solve each system.

28.) $2x + 8y = -10$
$2x + 2y = 26$

A. (-19,8) B. (19,-6) C. (-19,2) D. (-6,19)

Solve each problem.

29.) If June has five skirts and three tops, how many different outfits does she have?

A. 75 B. 15 C. 20 D. none of these

30.) If a jar contains three black, two blue, and one red marble, what is the probability that a red marble would be chosen if a person chooses one marble from the jar.

A. 1/6 B. 1 C. 6 D. none of these

Appendix C

DSM 0830

Calculator Lab Reports

Calculator Steps to Graph Functions

1) To clear previous problems

$\boxed{\text{Y=}}$ $\boxed{\text{CLEAR}}$ $\boxed{\blacktriangledown}$ $\boxed{\text{CLEAR}}$ $\boxed{\blacktriangledown}$ $\boxed{\text{CLEAR}}$ $\boxed{\blacktriangledown}$ $\boxed{\text{CLEAR}}$

Continue until all four functions are cleared

2) To clear graph screen

$\boxed{\text{2ND}}$ $\boxed{\text{DRAW}}$ $\boxed{1}$ $\boxed{\text{ENTER}}$ OR $\boxed{\text{2ND}}$ $\boxed{\text{DRAW}}$ $\boxed{\text{ENTER}}$ $\boxed{\text{ENTER}}$

3) To set default range for x & y $\pm$ 10

$\boxed{\text{ZOOM}}$ $\boxed{6}$

4) To check values of range

$\boxed{\text{RANGE}}$

You may change these values by replacing values with new values. The arrow keys will move you to the values you want.

5) To change contrast

$\boxed{\text{2ND}}$ $\boxed{\blacktriangle}$ to darken

$\boxed{\text{2ND}}$ $\boxed{\blacktriangledown}$ to lighten

6) To graph a linear function such as $Y = 3x + 2$.

$\boxed{\text{Y=}}$ $\boxed{3}$ $\boxed{\text{X|T}}$ $\boxed{+}$ $\boxed{2}$ $\boxed{\text{GRAPH}}$

7) To graph a quadratic function such as $y = 2x^2 + 5x - 2$

$\boxed{\text{Y=}}$ $\boxed{2}$ $\boxed{\text{X|T}}$ $\boxed{x^2}$ $\boxed{+}$ $\boxed{5}$ $\boxed{\text{X|T}}$ $\boxed{-}$ $\boxed{2}$ $\boxed{\text{GRAPH}}$

8) To graph a system of equations such as $y = 2x - 5$
$y = x + 1$

$\boxed{\text{Y=}}$ $\boxed{2}$ $\boxed{\text{X|T}}$ $\boxed{-}$ $\boxed{5}$ $\boxed{\text{ENTER}}$ $\boxed{\text{X|T}}$ $\boxed{+}$ $\boxed{1}$ $\boxed{\text{GRAPH}}$

9) To find the coordinates of a point such as the intersection of the system in #8

[TRACE] Use left and right arrows [►] [◄]

to reach point of intersection.
Note: x & y values are on the bottom of the screen.

10) A ZOOM FUNCTION will allow you to zoom in or out of pt.

BOX [ZOOM] [1] USE ARROW TO CORNER OF VIEWING BOX

[ENTER] MOVE ARROW TO DIAGONAL CORNER [ENTER]

IN [ZOOM] [2] USE ARROWS TO PT [ENTER]

OUT [ZOOM] [3] USE ARROWS TO PT [ENTER]

11) To graph inequality

a) such as y < 3x - 4

[2ND] [DRAW] [7] [VARS] [◄] [4] [ALPHA] [,] [3] [X|T]

[-] [4] [)] [ENTER]

b) such as Y > 3x -4

[2ND] [DRAW] [7] [3] [X|T] [-] [4] [ALPHA] [,] [VARS] [◄] [5]

[)] [ENTER]

c) Such as system

$$y < -2x + 3$$
$$y > x - 4, \quad \text{when } -2 < x < 2$$

[2ND] [DRAW] [7] [X|T] [-] [4] [ALPHA] [,] [(-)] [2] [X|T] [+] [3]

[ALPHA] [,] [1] [ALPHA] [,] [(-)] [2] [ALPHA] [,] [2] [)] [ENTER]

12) To draw a line between 2 pts such as (2, -5) and (2, 7)

[2ND] [DRAW] [2] [2] [ALPHA] [,] [(-)] [5] [ALPHA] [,] [2]

[ALPHA] [,] [7] [)] [ENTER]

Note: This is the only way to graph x = c equations.

13) To graph function such as y= $x^2 - 3x$ if $x < 2$
$-x + 5$ if $x > 2$

[Y=] [(] [X|T] [x^2] [-] [3] [X|T] [)] [(] [X|T] [2ND] [TEST]

[5] [2] [)] [ENTER] [(] [(-)] [X|T] [+] [5] [)] [(] [X|T] [2ND]

[TEST] [3] [2] [)] [GRAPH]

Note: Broken line at x = 2 is not included on graph.

To see this try [MODE] Highlight [DOT] [ENTER] [GRAPH]

Name ____________________________

Date ____________________________

PSTCC Lab Report

Fundamentals

In this lab we will explore
- a) order of operations
- b) division problems with zero
- c) evaluating expressions

The calculator will use order of operation. Enter the problem exactly how it appears below.

1) $(25 - 3)^2 + 10 - 2 - 1$

2) $53(8 + 5) - (6 - 3)^3 + 24$

3) $12[8 - 2(9 - 7) + 5^2]$

4) $11[15 + 28(67 - 12) - 48 - 16]$

5) $4^3 + 7^2(16 - 2) - 8^2 - 4^2$

Division problems with zero. Notice the calculator does not tell dividing by 0 is undefined. However, it gives an error.

1) $6 \div 0$

2) $0 \div 6$

If division is required in a problem with an expression in dividend or division, parenthesis must be added for the proper calculations to take place.

1) $\dfrac{3 + 5}{2}$

2) $\dfrac{6 + 4}{2 + 3}$

3) $\dfrac{6^2 + 4}{24 - 2^2}$

4) $\dfrac{37 + 4 - 3^3}{16 - (2 + 2)^2}$

5) $\dfrac{42 + (6 + 2) - 2(5)^2}{7(12 - 3)}$

In evaluating expressions with variables, store the correct value for each variable and then enter the problem.

1) Evaluate $3ab - 1$ if $a = 2$ and $b = 3$

2) Evaluate $2x^2 + x - 1$ if $x = 7$

3) Evaluate $\dfrac{2a^2 + b - c}{b - c}$ if $a = 4$ $b = 6$ $c = 2$

4) Evaluate $3[2 + m(n - p)^2]$ if $m = 3$ $n = 6$ $p = 2$

5) Evaluate $\dfrac{3x + 2y - z}{8xyz}$ if $x = 6$ $y = 2$ $z = 0$

For formulas, store value of each variable needed and then enter formula.

1) If $l = 6$ and $w = 3$, find the Perimeter. ($P = 2l + 2w$)

2) If $l = 1.2$, $w = 3.1$, and $h = 7$, find the Volume. ($V = lwh$)

3) If $r = 3.4$, find the Circumference. ($C = 2\pi r$)

4) If $r = 35$ and $t = 4$, find the distance traveled. ($d = rt$)

5) If $P = \$1000$ $r = 11\%$, and $t = 2$, find the amount of money in the account. ($A = P(1 + r)^t$)

Name ______________________

Date ______________________

PSTCC Lab Report

Rational and Real Numbers

In this lab we will explore

- a) negative signs
- b) absolute values
- b) input fractions
- c) squares and square roots
- d) testing expressions

The calculator distinguishes between negative signs $\boxed{(-)}$

and subtraction signs $\boxed{-}$. Be careful which you use.

1) (-18) + (-6)

2) -2 + 5 - 6

3) $\frac{-27}{3}$

4) (-3) (-6) (8)

5) $\frac{-3.5}{-.5}$

The calculator has an absolute value function.

$\boxed{\text{2nd}}$ $\boxed{\text{ABS}}$ will give the absolute value function. To evaluate the absolute value of an expression, place the expression in parenthesis.

1) $| -2 |$

2) $| 3 |$

3) $| 4 + 5 |$

4) $| -7 - 3 |$

5) $| -2 + 3 - 6 |$

To use a fraction such as $\frac{3}{4}$, enter $\boxed{3}\boxed{\div}\boxed{4}$. If $\frac{3}{4}$ is

in an expression such as $\frac{3}{4} \div \frac{1}{4}$, put each fraction in

parenthesis for clarity. $\boxed{(}\boxed{3}\boxed{\div}\boxed{4}\boxed{)}\boxed{\div}\boxed{(}\boxed{1}\boxed{\div}\boxed{4}\boxed{)}$

The answer will be written in decimal not fraction form.

1) $\frac{3}{8} \div 3$

2) $\left(\frac{-1}{4}\right)\left(\frac{2}{3}\right)\left(-6\right)$

3) $-\frac{3}{4} + \frac{5}{8} - \frac{1}{8}$

The calculator has a square and square root function.

a) To square a number, enter the number and then $\boxed{x^2}$

For example, 5^2 is $\boxed{5}\boxed{x^2}$ and $(-5)^2$ is $\boxed{(}\boxed{(-)}\boxed{5}\boxed{)}$

$\boxed{x^2}$ and $\left(\frac{2}{5}\right)2$ is $\boxed{(}\boxed{2}\boxed{\div}\boxed{5}\boxed{)}\boxed{x^2}$.

b) To take a square root of a number, enter $\boxed{2ND}\boxed{\sqrt{}}$

and then the number. For example $\sqrt{4}$: $\boxed{2ND}\boxed{\sqrt{}}\boxed{4}$ and

$-\sqrt{5}$ is $\boxed{(-)}\boxed{2ND}\boxed{\sqrt{}}\boxed{5}$ and $\sqrt{\frac{4}{9}}$ is $\boxed{2nd}\boxed{\sqrt{}}\boxed{(}$

$\boxed{4}\boxed{\div}\boxed{9}\boxed{)}$.

1) 9^2

2) $(-9)^2$

3) $\left(-\frac{3}{7}\right)^2$

4) $\sqrt{225}$

5) $\sqrt{8}$

6) $-\sqrt{\frac{75}{48}}$

The calculator is able to test expressions for true or false values. To answer true or false, enter the expression. The calculator will answer 1 for true and 0 for false. For example to test 5 < 6, enter $\boxed{5}$ $\boxed{\text{2ND}}$ $\boxed{\text{TEST}}$ $\boxed{5}$ $\boxed{6}$.

The calculator will display 1 for true.

1) $6 < -2$

2) $0 > -3$

3) $-1.2 > -1.3$

4) $\frac{1}{2} > \frac{2}{3}$

5) $-\frac{2}{3} < -\frac{3}{4}$

Name ______________________

Date ______________________

PSTCC Lab Report

Solving Equations and Inequalities

In this lab, we will solve equations and inequalities and check the solutions by the calculator.

In the equation $14y - (4y + 30) = 0$ the solution is $y = 3$. In order to check the solution store 3 in y and then key in the equation. Remember the calculator will give a result of 1 for true and 0 for false.

$\boxed{3}$ $\boxed{\text{STO}}$ $\boxed{\text{Y}}$ $\boxed{\text{ENTER}}$

$\boxed{1}$ $\boxed{4}$ $\boxed{\text{ALPHA}}$ $\boxed{\text{Y}}$ $\boxed{-}$ $\boxed{(}$ $\boxed{4}$ $\boxed{\text{ALPHA}}$ $\boxed{\text{Y}}$ $\boxed{+}$ $\boxed{3}$ $\boxed{0}$ $\boxed{)}$

$\boxed{\text{2nd}}$ $\boxed{\text{TEST}}$ $\boxed{1}$ $\boxed{0}$ $\boxed{\text{ENTER}}$

Solve the following equations. Check the solution by the above method.

1. $-4x = 8$
2. $x - 3 = 2x + 4$
3. $3(x + 2) = -3$
4. $-2y + 13 = -3(y - 10)$
5. $2a - (3a + 4) = 6a + (a - 6)$

Solve the following inequalities and check. (Note: inequality symbols are under TEST Menu. $\boxed{\text{2nd}}$ $\boxed{\text{Test}}$)

1. $-3a < 6$
2. $2y - 3 < 3y + 12$
3. $5(x + 7) > 2x - 4$

4. $2 - (-3x - 4) \leq 14 - (4x - 2)$

5. $\frac{3}{4} + \frac{1}{2} \geq - \frac{1}{4} - \frac{3}{8}x$

Write an algebraic equation. Solve and check.

1. The sales tax is 7%. If June buys a dress and pays $34.24, what was the cost of the dress?

2. The sales price of a table is $38.60. The table was marked 20% off. What was the original price of the table?

3. If Bob has 108 feet of fencing and wishes to enclose a rectangular lot with the length 6 feet more than the width. What dimensions would the lot be if Bob used all his fencing?

4. To receive a discount on his membership, Darren must lose an average of at least 3 pounds per week. The first three weeks of his diet Darren lost 4 pounds, gained 1 pound and lost 3 pounds. How much must he lose the last week to receive a discount?

Name______________________________

Date______________________________

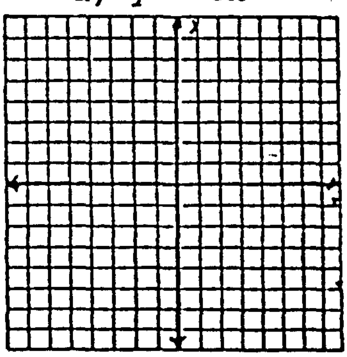
PSTCC LAB REPORT

Graphs of Linear Equations: $y = mx + b$

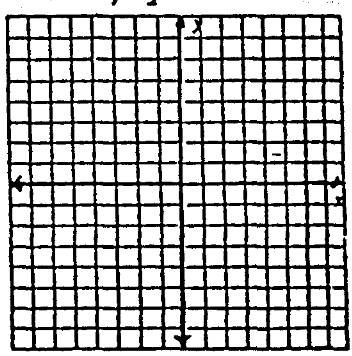
In this lab, we will examine the significance of the "m" and "b". We begin with the cases where b = 0 and the equation is $y = mx$.

1. All linear equations in two variables may be expressed in the form $y = mx + b$. Using the calculator, turn grid on $\boxed{\text{MODE}}$ $\boxed{\blacktriangledown}$ clear previous problems (1,) clear graph screen (2), set range to $\pm$ 8 (4), and graph each equation (6) and sketch a copy on the corresponding axes below. (Use a ruler.)

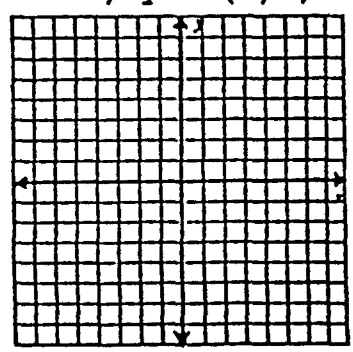
a) $y = 6x$



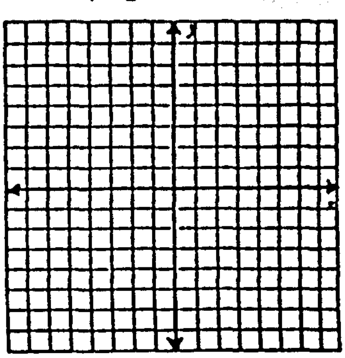
b) $y = 2x$



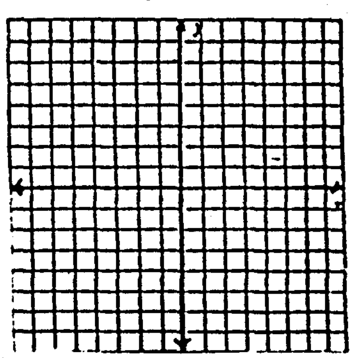
c) $y = (1/2)x$



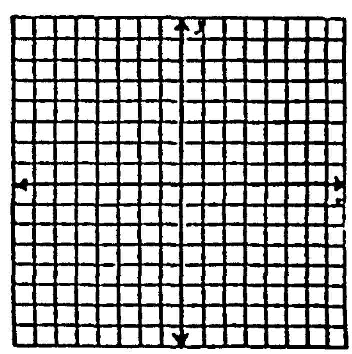
d) $y = -6x$



e) $y = -2x$



f) $y = (-1/2)x$



2. Use your sketches from Problem 1 to answer the following questions:

   a) What do the graphs have in common?______________

   b) When does the graph of $y = mx$ rise as you scan the line from left to right?__________________
   When does it fall?______________________________

   c) How is the inclination of the graph affected by larger values of the absolute values for "m"____
   ____

Let's take another look at the significance of "m" in the equation $y = mx$.

3. Using the calcular, graph $y=4x$. Using TRACE and left and right arrows find two integer coordinates on the line and record below.

   x_1 __________ y_1 __________

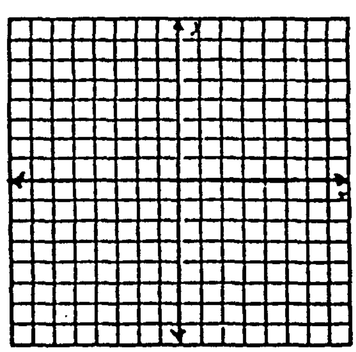
   x_2 __________ y_2 __________

   Now using your calculator and the formula for slope

   $m = \frac{y_2 - y_1}{x_2 - x_1}$, compute the slope: m = ________________

Draw a geometric interpretation of slope by drawing the line

$y = 4x$. Plot the two points of your choice. Show the vertical segment $y_2 - y_1$ and the horizontal segment $x_2 - x_1$.



4. As before, using the calculator, graph the line and using $\boxed{\text{TRACE}}$ and arrow buttons to find points of your choice to compute the slope:

	Function	1st point	2nd point	slope
a.	y = 5x	x:____y:____	x:____y:____	m:______
b.	y = -3x	x:____y:____	x:____y:____	m:______
c.	y = (1/2)x	x:____y:____	x:____y:____	m:______
d.	y = -.4x	x:____y:____	x:____y:____	m:______

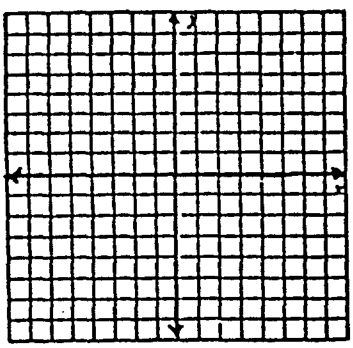
5. What can you conclude about the relationship between the slope of a linear function and the "m" coefficient in y = mx?________________________________

6. What can you conclude about the algebraic sign of the "m" coefficient and the direction of the line? ______
____

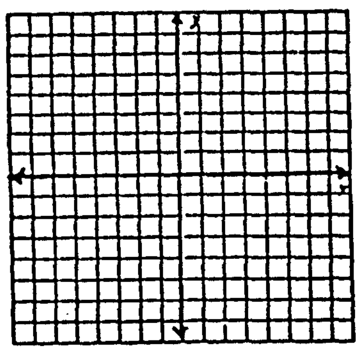
Now we are ready to graph the next type of linear equation, y = mx + b. What we have just learned about "m" in y = mx, holds true for equations of the form y = mx + b.

7. Graph the following functions using the calculator and sketch the graphs on the axes below:

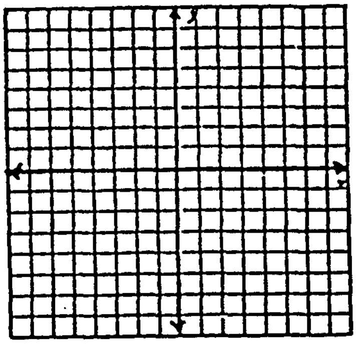
a) y = 2x



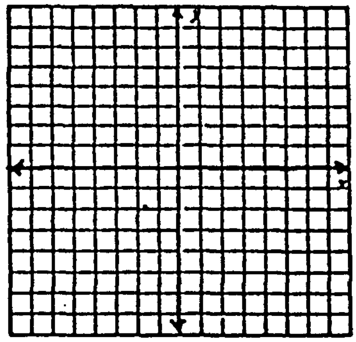
b) y = 2x + 3



c) $y = 2x - 5$



d) $y = 2x + 6$



8. Use your sketches in Problem 7 to answer the following questions:

   a) How does the value of "b" affect the graph of $y = 2x + b$?

   ____

   b) The graph of $y = 7x + 9$ would intersect the y-axis at the point (____,____).

   c. The y-intercept of the graph of $y = .3x - 6$ would be the point (____,____).

9. Without using the calculator, indicate whether each of the graphs of the following functions would incline upward (↗) or downward (↘) and if it crosses the y-axis above or below the origin:

	Inclined (up or down)	y-intercept (above or below the origin)
a) $y = 6x - 3$	____________	____________
b) $y = 2x + 5$	____________	____________
c) $y = 8x - .8$	____________	____________
d) $y = .41x + .62$	____________	____________
e) $y = -.01x - 3.8$	____________	____________

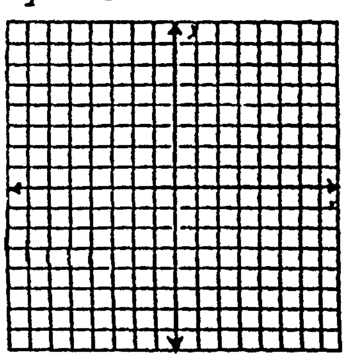
10. Without using the calculator, determine the slope of the graph that is the amount y would change given the indicated change in the x-value:
Recall: slope = $\frac{\text{change in y}}{\text{change in x}}$

	function	slope	y-intercept
a.	y = 2x - 7	______	____________
b.	y = 4x + 9	______	____________
c.	y = .6x - 3	______	____________
d.	y = -10x + 5	______	____________
e.	y = 5.8x - 3.9	______	____________

Let's consider some special linear equations. When m=o in the linear equation y=mx+b, we have equations in the form y=b, where "b" is a constant. Therefore, we have equations where y is always a constant regardless of the x-value.

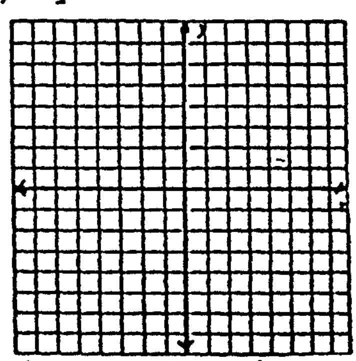
11. Using the calculator, graph the following equations. After graphing use the TRACE and left and right arrows to determine the coordinates of any three points on the line.

a) y = 5



List three points:
(,) (,) (,)

b) y = -2



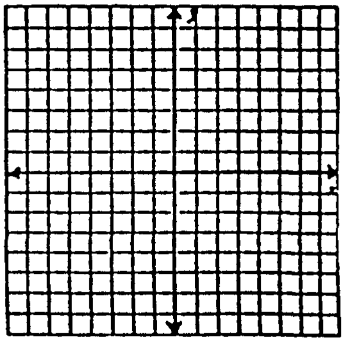
List three points:
(,) (,) (,)

12. Based on your observations of the ordered pairs above, what can you conclude about any point on the graph of $y = b$? ______________________________

Now let's see what happens when we deal with equations of the form $x = c$, where "c" is a constant and there is no "y" term. In other words it's like having the equation $x = c + 0\,(y)$ no matter what value of y is chosen, $x = c$.

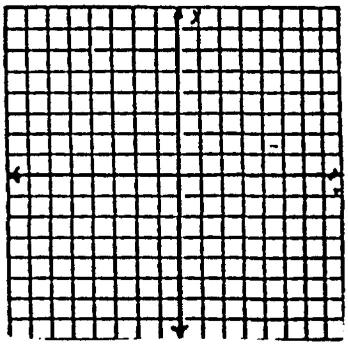
13. Without using the calculator, sketch the following equations and list three points on each line.

a) $x = 4$



List three points:
(,) (,) (,)

b) $x = -3$



List three points:
(,) (,) (,)

14. Based on your observations of the ordered pairs above, what can you conclude about <u>any</u> point on the graph of $x = c$? ______________________________

Use your sketches from Problems 11 and 13 to complete the following statements.

15. a) The graph of the line $y = c$ is always a ______line.

b) The graph of the line $x = c$ is always a ______line.

Conclusions: Summarize in complete sentences what you have learned about the linear equation $y = mx + b$ and the various effects of "m" and "b" including the two special cases.

Name ____________________

Date ____________________

PSTCC Lab Report

Graphical Solutions to Systems of Equations

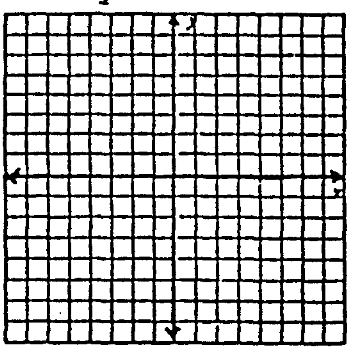
In this lab you will explore:

a) The relationship between two lines.

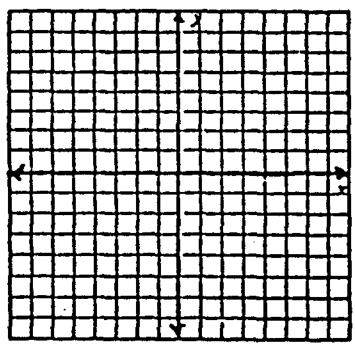
b) The graphical solutions to two linear equations.

1. Using the calculator, clear previous problems (1), clear graph screen (2), set the range values (4) to -9,9,1,-6,6,1,1,graph the following equations on the same axes (8) and sketch a copy below. (Use a ruler).

a) $y = 2x + 5$
$y = 2x - 3$



b) $y = (-1/2)x + 2$
$y = (-1/2)x - 3$

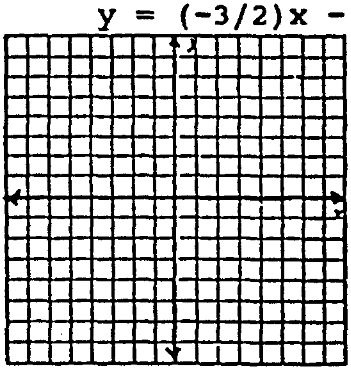


c) What is similar about each graph? ______________
What is different? ______________________________

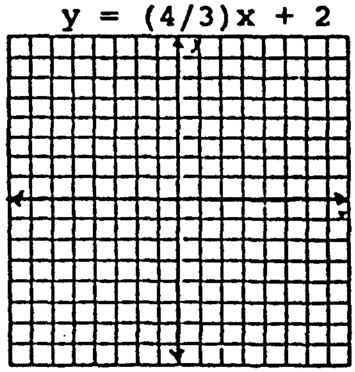
d) What is the relationship of the two lines in a? ________________in b? ________________

2. Graph the following equations on the same axes

a) $y = (2/3)x + 3$
$y = (-3/2)x - 1$



b) $y = (-3/4)x - 4$
$y = (4/3)x + 2$



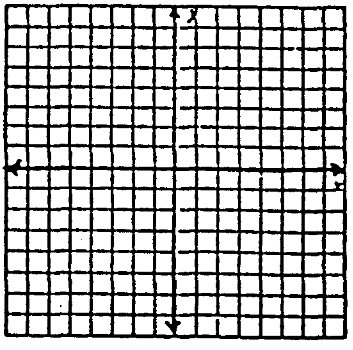
c) What is similar about each graph? ______________
What is different? ______________________

d) What is the relationship of the two lines in
a? ______________________________
in b? ______________________________

You will learn to use the zoom-in factor and produce an answer rounded to nearest tenth.

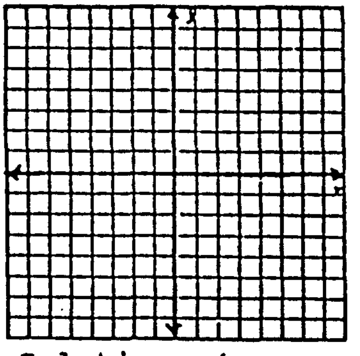
3. Using the calculator, return to Standard Range (3) graph the following systems of linear equations, sketch the graphs on the axes provided and find the point of interesection, that is, an "x" and "y" coordinate (if any) rounded to the nearest tenth. Use the zoom-in factor by ZOOM 2 Use arrows to point of interesection ENTER TRACE Use arrows to point of intersections. Record coordinates given.

a. $y = -x + 6$
$y = x + 4$



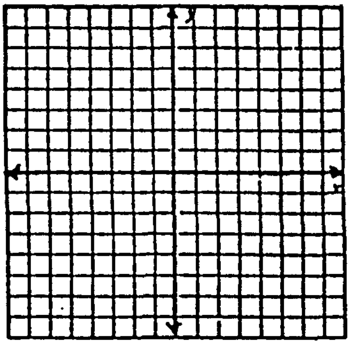
Solution: (_____,_____)

b. $y = -x + 7$
$y = 2x - 5$



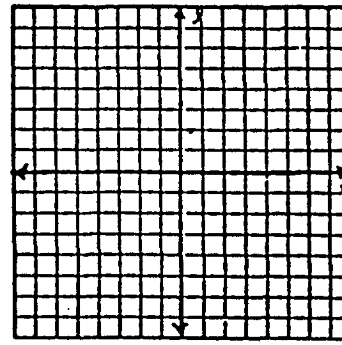
Solution: (_____,_____)

c. $y = 6x + 3$
$y = .5x - 3.3$



Solution: (_____,_____)

d. $3x - 2y = 2$
$y = 5x - 7$



Solution: (_____,_____)

Conclusions: Summarize in complete sentences what you have learned about parallel and perpendicular lines and how to find a solution to a system of equations.

Name ______________________

Date ______________________

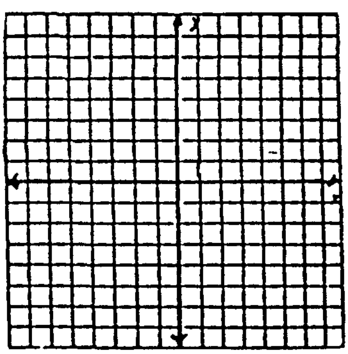
PSTCC Lab Report

Graphing Linear Inequalities Systems

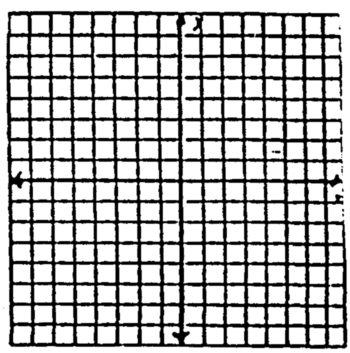
In this lab you will:
- a) graph a linear inequality.
- b) find graphical solutionis to a system of linear inequalities.

1. Using the calculator, clear previous problems (1), clear graph screen (2), set the default range values (3), graph an inequality (11), and sketch a copy below. (Use a ruler.)

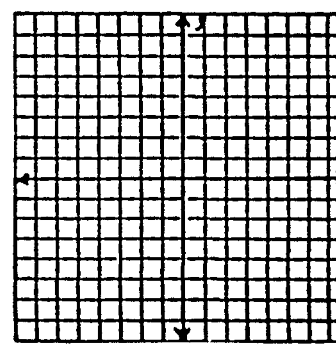
a. $y < 2x + 3$



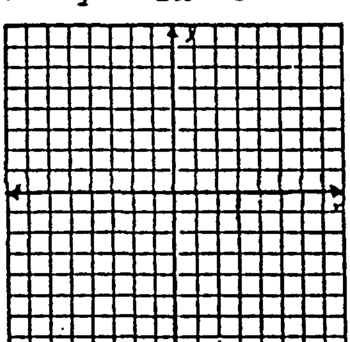
b. $y < -3x + 2$



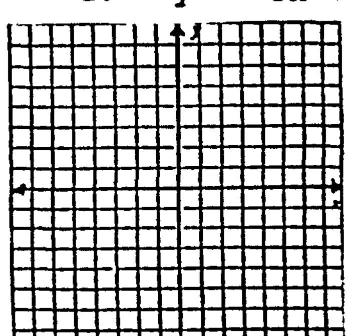
c. $y < x$



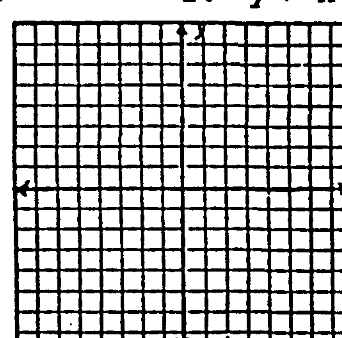
d. $y > 2x + 3$



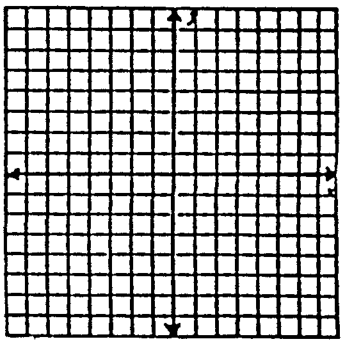
e. $y > -3x + 2$



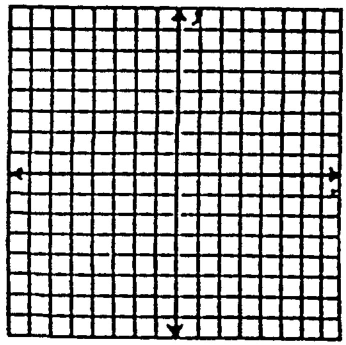
f. $y > x$



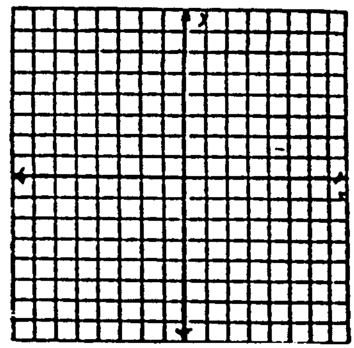
d. $x + 2y > -1$
$x - 3y < 9$



e. $y < 5$
$y > x$



f. $y < 2$
$y + 5 > 3$



4. In 3, some of the systems had points of intersections of the boundaries. Label the points on the graphs. We will later need to use these points.

Name ______________________

Date ______________________

PSTCC Lab Report

Statistics

In this lab, we will input data and allow the calculator to help us complete descriptive statistics.

Daily high and low temperatures for a month are recorded below.

SUN	MON	TUE	WED	THU	FRI	SAT
	1 89/62	2 93/68	3 86/61	4 84/55	5 81/55	6 79/52
7 82/59	8 90/62	9 94/68	10 87/62	11 85/56	12 82/56	13 80/54
14 83/60	15 84/57	16 81/50	17 83/53	18 86/53	19 88/63	20 95/70
21 91/64	22 90/60	23 90/65	24 92/61	25 87/55	26 85/53	27 81/55
28 84/62	29 88/65	30 80/58				

1. To enter the data for high temperature,

   $\boxed{\text{2nd}}$ $\boxed{\text{STAT}}$ $\boxed{\blacktriangleright}$ $\boxed{\blacktriangleright}$ $\boxed{1}$

   Enter high temperatures under x values

   x1 = $\boxed{8}$ $\boxed{9}$

   y1 = $\boxed{1}$

   x2 = $\boxed{9}$ $\boxed{3}$

   y2 = $\boxed{1}$

   etc.

2. To find the mean temperature,

   $\boxed{\text{2nd}}$ $\boxed{\text{STAT}}$ $\boxed{1}$ $\boxed{\text{ENTER}}$

   $\bar{x}$ is the mean temperature

   $\bar{x}$ = ________

3. To sort the high temperatures in order from lowest to highest

   $\boxed{\text{2nd}}$ $\boxed{\text{STAT}}$ $\boxed{\blacktriangleright}$ $\boxed{\blacktriangleright}$ $\boxed{3}$ $\boxed{\text{ENTER}}$

   $\boxed{\text{2ND}}$ $\boxed{\text{STAT}}$ $\boxed{\blacktriangleright}$ $\boxed{\blacktriangleright}$ $\boxed{1}$ $\boxed{\text{ENTER}}$

   x1 value is the lowest high temperature
   x1 = ________

   Hold down $\boxed{\blacktriangledown}$ to move to the last data value

   x30 value is the highest high temperature
   x30 = ________

The range of temperature is the difference in the highest temperature and the lowest temperature.

x30 - x1 = ________

4. Since there are 30 temperatures, the median is the average of x15 and x16.

$$\frac{x15 + x16}{2} = \_\_\_\_\_\_\_\_\_\_\_\_\_\_ .$$

5. To draw a histogram of the high temperatures, first set the range.

RANGE

x min	=	x1 value
x max	=	x30 value +1
x scl	=	1
y min	=	0
y max	=	5
y scl	=	1
x res	=	1

[2nd] [STAT] [►] [1] [ENTER]

To read this histogram each bar represents a temperature in consecutive order from lowest temperature to highest temperature. The vertical scale is from 0 to 5.

Draw and label the histogram below.

The mode is the temperature or temperatures which appear most often. The data of high temperature has three modes. They are _______________, _________________, ________________.

6. To clear data

   [2nd] [STAT] [▶] [▶] [2] [ENTER]

7. Follow the above steps 1-5 to record statistics for the low temperatures.

mean low temperature	$\bar{x}$ =	________
lowest low temperature	x1 =	________
highest low temperature	x30 =	________
range of low temperatures	x30 - x1 =	________
median of low temperatures	$\frac{x15 + x16}{2}$ =	______

histogram of low temperatures

mode of low temperatures _________

NAME________________________________

DATE________________________________

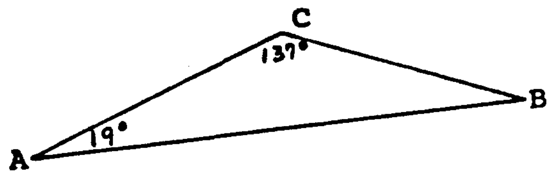
PSTCC LAB REPORT

Geometry

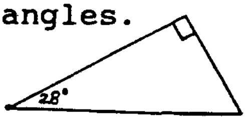
In this lab, we will
- a) determine the measure of a third angle of a triangle when other two angle measures are known
- b) determine if triangles are similar
- c) use geometric formulas

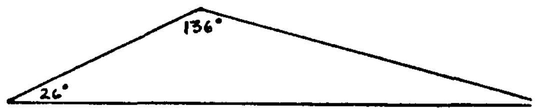
The sum of the measures of the three angles of a $\triangle$ is 180°. Therefore, if the measure of $\measuredangle$ 1 = 60° and the measure of $\measuredangle$ 2 = 40°, to find the measure of $\measuredangle$ 3 use the following expression 180 - (60 + 40).

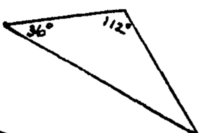
1. $\triangle$ ABC is given. What is the measure of $\measuredangle$ B?

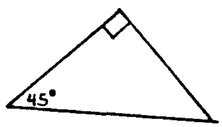


2. Match the similar triangles.

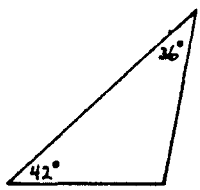
1.


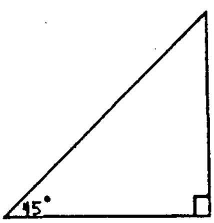
A.


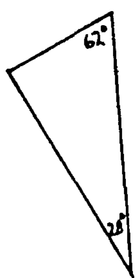
2.


B.


3.

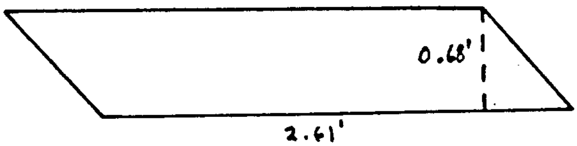

C.


4.


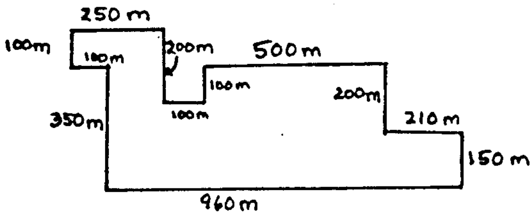
D.


3. Find the area enclosed by the following figures.

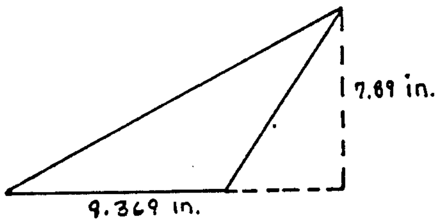
a)



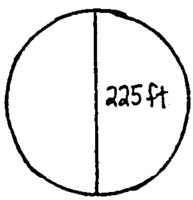
b)



c)



d)



4. If the radius of the earth is 4000 miles, find the surface area.

5. How much soda will a can 5.7" tall with a radius of 1.3" hold?

6. Find the volume of the cube with the given edge length.

a) 6.723 m

b) 72.54 ft

c) 0.2534 in.

VITA

Sharon JoAnne Thomasson was born in Hammond, Indiana, on December 5, 1950. She is married to Thomas Jackson Thomasson III and is the mother of two children, Tracy Anne and Thomas Jackson IV.

Ms. Thomasson holds a Bachelor of Science Degree in Liberal Arts with a major in Mathematics and a Master of Science in Mathematics Education, both from The University of Tennessee in Knoxville, Tennessee. This dissertation completes requirements for a Ph.D. in Education with an emphasis in Mathematics Education at The University of Tennessee in Knoxville, Tennessee.

Ms. Thomasson has taught course in mathematics and computers on the secondary level, grades 7 through 9, and mathematics on the community college level. Secondary experiences were in Knoxville City Schools and Anderson County Schools, both in eastern Tennessee. Community college experiences were at Roane State Community College and Pellissippi State Technical Community College, both in Knoxville, Tennessee. Her mathematical teaching experiences include: seventh grade mathematics, high school mathematics, developmental mathematics, and college-level mathematics.

At the present time, Ms. Thomasson is assistant professor and head of the Mathematics Department for

Developmental Studies at Pellissippi State Technical Community College in Knoxville, Tennessee.